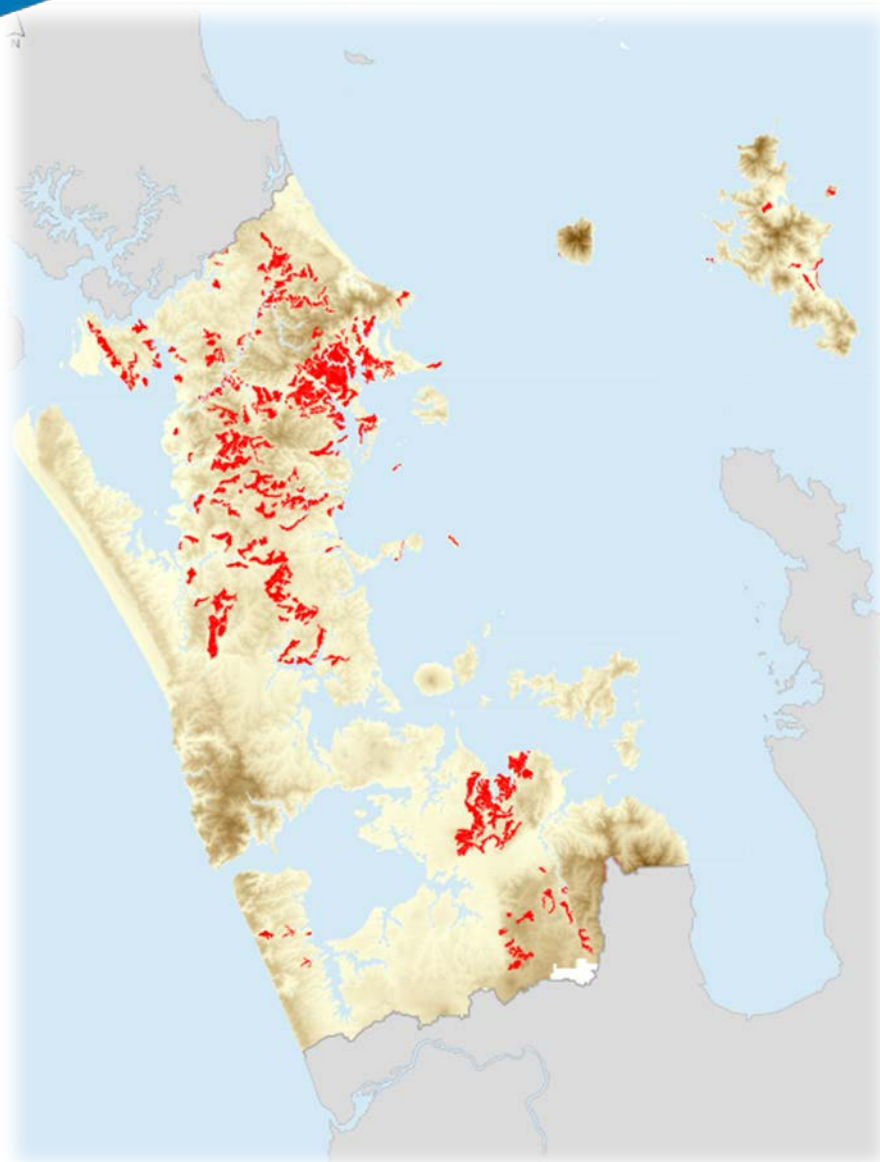


Soil Information Inventory:

Whangaripo and related soils

October 2018

Soil Information Inventory 27





Soil Information Inventory 27: Whangaripo and related soils

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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be understood or used without referring to background information which is dispersed across old maps, publications, or unpublished reports.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

Whangaripo and related soils are depicted on the DSIR's published soil maps of North Auckland (1:100,000) as three separate series i.e. soils with distinct profiles and parent materials.

The soils are labelled as:

| | |
|-----|----------------------|
| WRe | Whangaripo clay |
| WR | Whangaripo clay loam |
| WA | Warkworth clay loam |
| DV | Dome Valley clay |

South of Auckland, similar soils are depicted on DSIR's oldest published maps (1:253,840) as part of the Brookby series.

| | |
|-----|-------------------|
| 34a | Brookby clay loam |
|-----|-------------------|

A recent map of Manukau city (1:20,000) separates the soils into twelve mapping units that contain spatially associated soil types i.e. soils with differences in texture or other characteristics, assigning alphanumerical labels:

| | |
|---------|--|
| BE1- 5 | Brookby clay loam |
| BE6-10 | Brookby clay loam complexed with other soils |
| BXE1, 2 | Brookby complex |
| CE1- 3 | Brookby clay loam |
| CXE1, 2 | Brookby complex |

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 Manukau City

NZ Soil Bureau map unpublished

3 Online maps

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

| | |
|-----------------|--|
| PB, PBH | Whangaripo family, sibling 16b; or Warkworth family, sibling 10a |
| WRe | Whangaripo family, sibling 14 |
| WR | Whangaripo family, sibling 14 |
| WA | Warkworth family, sibling 10, and Whangaripo family, sibling 20 |
| DV | Warkworth family, sibling 10, and Whangaripo family, sibling 14 |
| 34a | No family or sibling assigned |
| BE1, 2, 5, 6, 7 | Whangaripo family, sibling 2 |
| BE3 | Baton family, sibling 14 |
| BE4 | Whangaripo family, sibling 1 |
| BE8, 9 | Baton family, sibling 14, complexed with other soils |
| BXE1, 2 | Whangaripo family, sibling 2 |
| CE1 | Baton family, sibling 14, complexed with other soils |
| CE2 | Whangaripo family, sibling 2 |
| CE3 | Baton family, sibling 14 |
| CXE1 | Brown family, sibling 4 |
| CXE2 | Whangaripo family, sibling 2 |

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

When investigated in the field by local soil mappers, north of Auckland any published map polygon labelled as WR etc. contains a mosaic of Whangaripo, Warkworth and Matakana series. On farm-scale soil maps (1:5,000 - 1: 10,000) north of Auckland they are labelled as:

| | |
|-----|---------------------------|
| Wre | Whangaripo clay |
| Wr | Whangaripo clay loam |
| Wa | Warkworth clay loam |
| Mk | Matakana sandy clay loam. |

Small patches of Whangaripo clay loam (Wr), Warkworth clay loam (Wa) or Matakana sandy clay loam (Mk) are differentiated within published map polygons labelled Whangaripo hill soil (WRH), Warkworth hill soil (WAH) or Dome Valley hill soil (DVH). The larger part of any such polygon turns out to be Puhoi or Atuanui series, so is labelled accordingly on farm maps (refer to the Soil Information Inventory for Puhoi and Atuanui soils).

No farm-scale maps have been prepared in the Brookby clay loam areas south of Auckland. When locating sites for soil sampling, they are differentiated as:

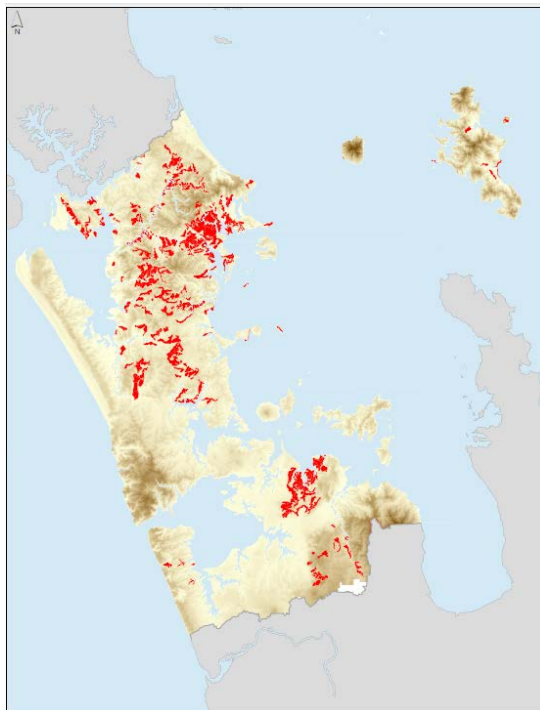
| | |
|-----|--|
| Brm | Brookby mottled clay loam (Whangaripo variant) |
| Br | Brookby clay loam (Warkworth variant) |
| Brs | Brookby sandy clay loam (Matakana variant) |

Local series names have been retained on Auckland Council's farm-scale maps for continuity with published nomenclature, except that the soil previously identified by DSIR mappers as a brown variant of Warkworth clay loam (but not separately labelled on the DSIR's maps) has been given an informal series name, Matakana sandy clay loam.

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

Throughout eastern parts of the Auckland region, from its northern boundary at Te Hana through the urban area to the southern boundary at Ararimu.



Location of Whangaripo and related soils

Whangaripo and related soils are mapped on 33,800 hectares (7% of Auckland region.) About 20,200 hectares (60% of the area mapped) are in agriculture or forestry (estimated from overlay of Agribase 2010 on Fundamental Soils Layer).

<http://intermaps.arc.govt/AucklandCouncilViewer/>



Whangaripo clay loam and related soils occur on stable sites where alternating beds of sedimentary rock dip gently through the landscape, forming low-angle slopes (foreground) Photo: D. Hicks

5.1 On what landform

Rolling to moderate hillslopes with clay regolith weathered from Waitemata Group marine sediments (inter-bedded siltstone, sandstone and tuffaceous sandstone).

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

Whangaripo and related soils weathered from sandstone or siltstone have enough sand and silt in their topsoil to be cultivable on easy slopes, unlike Aponga and related soils weathered from mudstone which contain very little, so are difficult to cultivate. Their clay-rich subsoil resembles Aponga and related soils in appearance, though still has enough sand and silt or silt grains to give it somewhat better structure and permeability, so root penetration by fruit trees or vines is possible. The same properties render them good soils for pasture growth. Unlike the associated Mahurangi series, Whangaripo, Warkworth and Matakana soil have not yet developed an eluvial horizon in lower topsoil, or a perch-gley horizon in upper subsoil.

Sourced from: Wilson, A.D. and Cox, J.E., Soils of Rodney County, Unpublished report, Soil Bureau DSIR

6 Classifications

NZ genetic (NZG):

Northern yellow-brown earth

NZ soil (NZSC):

Typic yellow ultic or mottled yellow ultic

http://soils.landcareresearch.co.nz/contents/SoilNames_NZSoilClassification_SoilOrders.aspx

Soil Taxonomy (USDA):

Typic or aquic haplohumult

http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051544.pdf

World Soils (FAO):

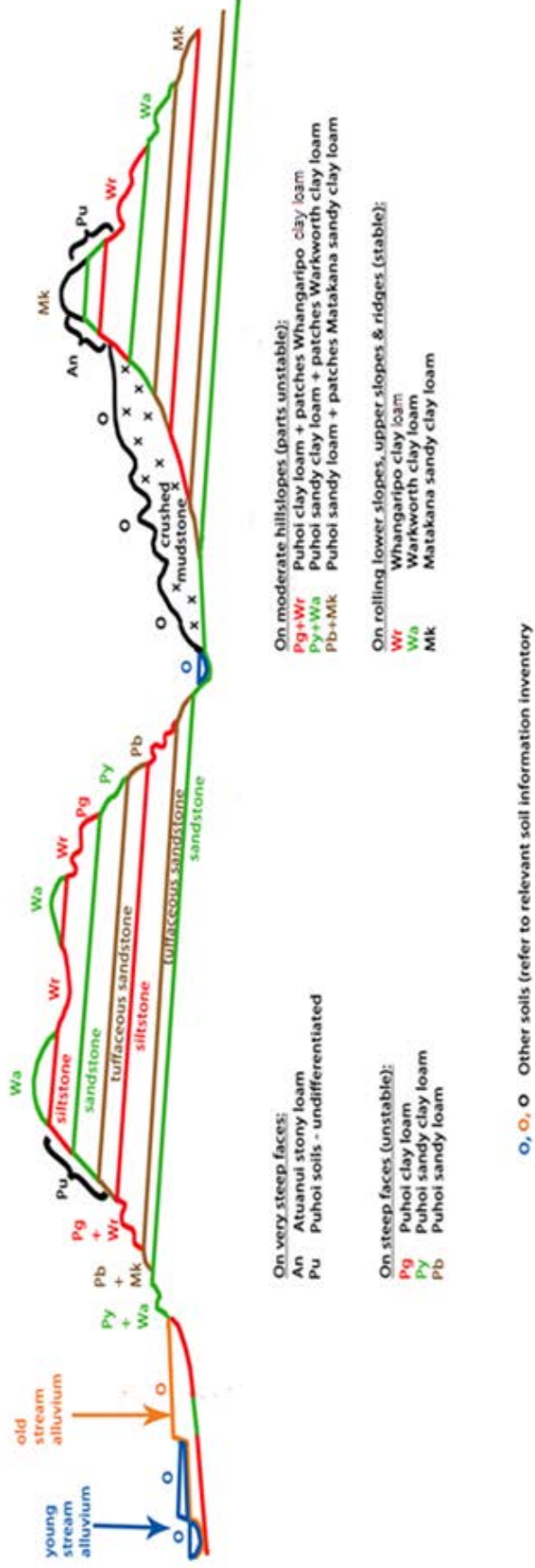
Nitisol or cambisol

<http://www.fao.org/3/a-i3794e.pdf>

DSIR replaced the New Zealand genetic classification dating from 1930s with the New Zealand 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.

Soil information inventory 27: Whangaripo and related soils.

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



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

7 Soil profile descriptions



Topsoil (A and Af)

Upper subsoil (Btf)

Lower subsoil (Cf)

Whangaripo clay loam *Photo: D Hicks*

There is confusion about identity of the type profile for Whangaripo series. It appears in Soil Bureau Bulletin 26 (Soils of New Zealand) as Whangaripo clay. On DSIR's unpublished type profile description, hand-written annotations state, "Only a limited type description available for WRe so the related soil below is included" and "This seems to have been chosen as a WR site but turned out on particle size and perhaps base saturation to be more of a WRe site. Shown on map as WR + WRH".

The DSIR's type profile is:

Whangaripo clay loam or clay

| Horizon | Depth (cm) | Description |
|---------|------------|--|
| A | 0-8 | Dark grey and grey-brown (10 YR 3/1 and 3/2) clay loam; friable; subrounded and subangular polyhedral structure. |
| A(f) | 8-21 | Yellow (10YR 8/6), pale brown (10YR 6/3) and light brownish grey (10YR 6/2) clay; faint to distinct reddish brown (5YR 4/4) mottles; firm; slightly firm subangular polyhedral structure. |
| Bt(f)1 | 21-46 | Yellowish brown (10YR 6/4) clay; faint to distinct reddish brown (5YR 4/4) mottles, fine coatings along root channels; firm; coarse to medium subangular polyhedral structure which breaks to fine polyhedral; grey clay skins along fissures and on aggregates. |
| Bt(f)2 | 46-91 | Brownish yellow (10YR 6/8) and pale brown (10YR 6/3) clay; faint to distinct yellow-red (5YR 5/8) mottles; firm; coarse, medium and fine subangular polyhedral structure which breaks to very fine; grey clay skins along fissures and on aggregates. |
| C(f) | 91-121 | Reddish yellow (7.5 YR 7/6), yellow (10YR 7/6), red (2.5 YR 5/6) and reddish brown (5 YR 5/4) clay; massive and firm; medium to fine subangular polyhedral structure, crumbles when disturbed. |
| CR | on | Light red (7.5 R 6/6) to red (10 R 4/6) sandy parent material; massive and firm; brown, yellow and black coatings along fractures and fissures. |

When mapping at farm scale, soil within polygons labelled as WR or WRe on published maps differs from the type profile in several respects. The B horizon contains distinct grey mottles (not red-brown). The C horizon is typically grey clay, less often yellow sandy clay with grey mottles, rarely red sandy clay with yellow or brown mottles. Notes attached to the type profile indicate that DSIR mappers recorded Whangaripo clay loam or clay on "massive deeply weathered brownish-grey banded sandstones which in places appear to be pre-red weathered". Field observations by local mappers confirm that Whangaripo series (as mapped by the DSIR pedologists) coincides with thick siltstone beds interspersed by thin beds of sandstone or volcanic grit. At farm scale, soils on the sandstone and grit beds are separable as Warkworth clay loam or Matakana sandy clay loam.

DSIR mappers recorded Warkworth series on "strongly weathered massive sandstones and some red grits, belonging to the upper Waitemata beds". A local mapper (DLH) comments that the type profile description accords with soil within polygons labelled as WA, except that A horizon texture is clay loam, B horizon contains faint grey mottles at imperfectly draining sites e.g. undulating ridges and footslopes; and C horizon has visible sand dispersed through the clay. A mottled phase (no profile description) mapped in hollows is similar to Karaka silt loam except that B and C horizons have many red and few grey mottles. A few grey and red mottles are found in topsoil in places. A sandy phase is

also observed when identifying soils for sampling, and when mapping at farm scale. It has a sandy loam topsoil and sandy clay upper subsoil, better-structured though shallower than Karaka silt loam's B horizon.



Topsoil (A)

Upper subsoil (Bwf)

Lower subsoil (C)

Warkworth clay loam Photo: D Hicks

The DSIR's unpublished type profile description is:

Warkworth clay loam

| Horizon | Depth (cm) | Description |
|---------|------------|--|
| A | 0-13 | Dark greyish brown (10YR 4/2) clay; slightly sticky when wet; hard (when dry); medium and fine subangular polyhedral structure; sharp boundary. |
| Bw(f)1 | 13-33 | Yellowish brown (10YR 5/4) clay; faint reddish brown mottles; slightly sticky when wet, very firm when dry; coarse subangular polyhedral structure which breaks to fine; diffuse boundary. |
| Bw(f)2 | 33-61 | Yellowish brown (10 YR 5/6) clay; distinct yellowish red mottles; sticky when wet; firm when dry; coarse subangular polyhedral structure which breaks to fine; diffuse boundary. |
| C | on | Yellowish brown (10 YR 5/6) clay; sticky when wet, firm (when dry); coarse to medium subangular polyhedral structure breaking to fine. |

Soil information inventory 27: Whangaripo and related soils

DSIR mappers noted “within the Waitemata beds are strongly weathered red volcanic grits from which the soils are dark brown” but did not define them as a series. Their properties are so different from Whangaripo or Warkworth, that the dark brown soils are labelled as Matakana sandy clay loam by local mappers at farm scale.



Topsoil (A and A/B)

Upper subsoil (Bw)

Lower subsoil (C)

Matakana sandy clay loam *Photo: D Hicks*

Matakana sandy clay loam

| Horizon | Depth (cm) | Description |
|---------|------------|--|
| A | 0-20 | Dark grey to black sandy clay loam; firm when dry, friable when moist; earthy structure. |
| A/B | 20-35 | Brown sandy clay loam; firm when dry, friable when moist; earthy to subrounded polyhedral structure; mixed with topsoil washed down root channels and fissures. |
| Bw | 35-65 | Brown sandy clay; few reddish brown mottles flecked with white (weathered) volcanic grit; hard when dry, friable when moist; subrounded and subangular polyhedral structure. |
| C | over | Reddish brown sandy clay contains numerous white (weathered) to black (unweathered) volcanic grit particles |

Brookby series

Type profile descriptions for Brookby series (on published and unpublished maps south of Auckland) can be matched with Whangaripo, Warkworth and Matakana soils respectively.

Soil information inventory 27: Whangaripo and related soils

The three are differentiable by attaching an appropriate texture description (clay, clay loam or sandy clay loam) to the local series name (Brookby) when mapping at farm scale south of Auckland.

Sourced from:

Sutherland C.F., Cox, J.E., various dates, Type profile descriptions for North Auckland Soil Survey, Unpublished documents, Soil Bureau, DSIR

Purdie, B. et al 1982 Type profile descriptions for Manukau Soil Survey. Unpublished documents, Soil Bureau, DSIR

8 Properties of typical profile

Properties of typical profiles are best indicated by laboratory analyses for the type profiles i.e. sites where Whangaripo and Warkworth clay loams were defined and described. Data for any other site on either soil will vary from the type profile, though not greatly. Properties of the related Matakana sandy clay loam may differ considerably.

8.1 Chemical

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

Whangaripo clay loam or clay

| Property | Topsoil | Subsoil | Units |
|--------------------------|-----------|-----------|-------|
| Acidity | 5.3-5.8 | 5.0-5.2 | pH |
| Total carbon | 2.8-6.1 | 0.8-1.7 | % |
| Total nitrogen | 0.21-0.32 | 0.07-0.12 | % |
| Available phosphorus | 3 | 1-2 | % |
| P retention | 45 | 59-61 | % |
| Available sulphur | 2-3 | 6-10 | µ/ug |
| Cation exchange capacity | 15.9-27.8 | 16.2-18.9 | me % |
| Base saturation | 23-59 | 7-12 | % |
| Calcium | 1.6-9.6 | 0.7-1.1 | me % |
| Magnesium | 1.9-6.3 | 0.8-1.1 | me % |
| Potassium | 0.27-0.65 | 0.14-0.20 | me % |
| Sodium | 0.1-0.3 | .01-.02 | me % |

Sourced from laboratory analysis SB07653, DSIR Soil Bureau

Warkworth clay loam

| Property | Topsoil | Subsoil | Units |
|--------------------------|---------|---------|-------|
| Acidity | 5.4 | 5.5 | pH |
| Total carbon | 6.2 | - | % |
| Total nitrogen | 0.39 | - | % |
| Available phosphorus | 0.003 | 0.002 | % |
| P retention | - | - | % |
| Available sulphur | - | - | µ/µg |
| Cation exchange capacity | 34.6 | 28.6 | me % |
| Base saturation | 39 | 33 | % |

| Property | Topsoil | Subsoil | Units |
|-----------|---------|---------|-------|
| Calcium | 7.6 | 5.1 | me % |
| Magnesium | 5.3 | 4.0 | me % |
| Potassium | - | - | me % |
| Sodium | - | - | me % |

Sourced from laboratory analysis SB00807 DSIR Soil Bureau

8.2 Physical

<http://soils.tfrec.wsu.edu/mq/chemical.htm>

An incomplete physical analysis appears in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 26 (for Whangaripo clay loam) and the Fundamental Soils Layer (FSL) plus estimates from an S-map factsheet (for Warkworth clay loam):

Whangaripo clay loam or clay

| Property | Topsoil | Subsoil | Units |
|------------------|---------|-----------|-------------------|
| Stones | 0 | 0 | % |
| Sand | 13-30 | 14-19 | % |
| Silt | 26-28 | 23-28 | % |
| Clay | 44-59 | 53-63 | % |
| Dry bulk density | 0.90 | 1.14-1.15 | g/cm ³ |
| Total porosity | - | - | % |
| Macroporosity | - | - | % |

Sourced from laboratory analysis SB07653, DSIR Soil Bureau

Warkworth clay loam

| Property | Topsoil | Subsoil | Units |
|------------------|---------|---------|-------------------|
| Stones | 0 | 0 | % |
| Sand | 10 | - | % |
| Silt | 40 | - | % |
| Clay | 50 | 59 | % |
| Dry bulk density | 1.08 | 1.26 | g/cm ³ |
| Total porosity | - | - | % |
| Macroporosity | - | - | % |

Sourced from FSL table and S-map factsheet, Landcare Research

8.3 Irrigation and drainage

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

There is no soil moisture analysis in the online version of National Soils Database (NSD). The following data are sourced from Soil Bureau Bulletin 26 (for Whangaripo clay loam) together with estimates from an FSL table and S-map factsheet (for Warkworth clay loam):

Whangaripo clay loam or clay

| Property | Topsoil | Subsoil | Units |
|---------------------------------|---------|---------|-------|
| Field capacity | 63 | 47-55 | % w/w |
| Wilting point | 31 | 32-36 | % w/w |
| Plant-available water | 29 | 17-21 | % v/v |
| Plant-available water | 43 | 40 | mm |
| Depth to slowly permeable layer | - | 0.4-0.6 | m |
| Perm. at slowly permeable layer | - | <4 | mm/hr |

Sourced from laboratory analysis SB07653, DSIR Soil Bureau and S-map factsheet, Landcare Research

Warkworth clay loam

| Property | Topsoil | Subsoil | Units |
|---------------------------------|---------|---------|-------|
| Field capacity | 46 | 49 | % w/w |
| Wilting point | 31 | 36 | % w/w |
| Plant-available water | - | - | % v/v |
| Plant-available water | 45 | 37 | mm |
| Depth to slowly permeable layer | - | 0.8-1.0 | m |
| Perm. at slowly permeable layer | - | <4 | mm/hr |

Sourced from FSL table and S-map factsheet, 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 Karaka and related 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.

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

Also: *Soil Quality for Horticultural Sites in the Auckland Region 2013*, *Soil Quality of Dairy Sites in the Auckland Region in 2009*, *Soil Quality of Drystock Sites in the Auckland Region in 2010*, *Soil Quality of Plantation Forestry Sites in the Auckland Region in 2011*, *Soil Quality of Indigenous Sites in the Auckland Region in 2012*

Soil information inventory 27: Whangaripo and related soils

| Land use: | Natural cover | | | Pasture | | | Market Garden Organic | Vineyard Organic | Orchard Organic | Forest | |
|--------------------------|-----------------------|-------|---------|----------|-------|--------|-----------------------|------------------|-----------------|--------|--|
| | Bush | Scrub | Organic | Drystock | Dairy | Mature | | | | Logged | |
| Types: | 98/20 | 96/4 | 00/16 | 96/2 | 98/21 | 00/17 | 00/18 | 00/19 | 96/1 | 96/3 | |
| Sample Number: | | | | | | | | | | | |
| Acidity | pH | 5.5 | 5.3 | 6.4 | 5.9 | 6.8 | 5.8 | 5.8 | 4.7 | 4.9 | |
| Total carbon | % | 5.0 | 6.8 | 5.4 | 6.5 | 6.4 | 4.9 | 5.1 | 4.6 | 5.6 | |
| Total nitrogen | % | 0.3 | 0.4 | 0.4 | 0.6 | 0.6 | 0.4 | 0.4 | 0.3 | 0.3 | |
| Available nitrogen | ug/ cm ³ | 114 | 110 | 207 | 139 | 138 | 153 | 144 | 40 | 55 | |
| Available phosphorus | ug/cm ³ | 6 | 4 | 14 | 4 | 114 | 16 | 17 | 35 | 11 | |
| Cation exchange capacity | cmol/cm ³ | 22.7 | 38.1 | 21.7 | 34.9 | 37.9 | 19.7 | 16.6 | 20.2 | 23.4 | |
| Base saturation | % | 62 | 42 | 73 | 60 | 107 | 82 | 77 | 28 | 24 | |
| Calcium | cmol/ cm ³ | 7.7 | 8.2 | 17.0 | 16.7 | 36.0 | 13.5 | 8.1 | 3.6 | 3.7 | |
| Magnesium | cmol/ cm ³ | 5.5 | 6.4 | 1.2 | 2.0 | 3.2 | 1.8 | 2.7 | 1.3 | 1.1 | |
| Potassium | cmol/ cm ³ | 0.6 | 0.7 | 0.4 | 0.5 | 1.2 | 0.3 | 0.8 | 0.5 | 0.5 | |
| Sodium | cmol/ cm ³ | 0.3 | 0.6 | 0.2 | 0.2 | 0.36 | 0.2 | 0.2 | 0.2 | 0.2 | |
| Bulk density | t/ m ³ | 0.92 | 0.78 | 0.85 | 0.78 | 1.01 | 0.99 | 0.93 | 1.05 | 0.84 | |
| Particle density | t/ m ³ | 2.82 | 2.55 | 2.46 | 2.41 | 2.45 | 2.51 | 2.48 | 2.55 | 2.48 | |
| Aggregate stability | mm mwd | 2.07 | - | - | - | 2.19 | 2.58 | 2.58 | - | - | |
| Total porosity | % | 67 | 69 | 68 | 68 | 59 | 62 | 62 | 59 | 66 | |
| Macroporosity | % | 13 | 10 | 10 | 10 | 7 | 10 | 10 | 13 | 7 | |
| Total available water | % | 23 | 29 | 30 | 30 | 22 | 15 | 35 | 18 | 29 | |
| Readily available water | % | 7 | 7 | 8 | 8 | 6 | 5 | 8 | 7 | 8 | |

9 Land use capability

<http://www.landcareresearch.co.nz/publications/books/luc>

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.

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 1:50,000 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 |
|--|---------------|----------|---|--|
| Undulating footslopes and upper slopes | 3e3, 3e4 | 3e | Moderate sheetwash risk if cultivated | Rotational grain and fodder crops, tree and vine crops, improved pasture |
| Rolling footslopes and upper slopes | 4e5,4e3 | 4t | Severe sheetwash risk if cultivated | Occasional grain and fodder crops, tree and vine crops, improved pasture |
| Strongly rolling spurs and ridges | -.- | 5s | Slope precludes cultivation | Tree and vine crops, improved pasture |
| Moderate slopes, stable | 5e1,5e8, 5e19 | 5g, 5g+u | Slight erosion risk (gullies, landslides, slumps) | 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.

10 Past and present land uses

Pip-fruit orchards were established on Whangaripo and related soils around Warkworth, Wellsford, also the North Shore (now within the urban area) 1870s - 1900s, though most were uprooted after infection by fireblight about 1910. Citrus orchards established 1920s - 1930s suffered a similar fate as there was no market for their produce during the great depression. A few remaining pip-fruit and citrus orchards demonstrate that commercial production is achievable on well-drained easy-contour land. Some of it, particularly pockets of Matakana sandy clay loam, has been planted in small "boutique" vineyards since the 1990s.

Drystock breeding and fattening always has been and remains the largest use by area. When an export market developed in the 1880s, settlers quickly converted their farms to dairy where contour permitted. On rolling downland they found it easier to establish improved pasture on Whangaripo, Warkworth or Matakana, than on poorly structured infertile "gumland" soils adjacent, which usually stayed in rough pasture or scrub. Despite lifestyle subdivision of many properties since the 1980s, dairy farms persist on rolling land. Many drystock farms remain on moderate hill country where the three soils are interspersed with pockets of Puhoi soil.

Farm woodlots though numerous account for little of the area in tree plantations. Most is commercial-scale radiata pine forestry where the three soils form a mosaic with related Puhoi soils on steeper hill country -Dome Hills, Kaipara Hills, Moirs Hill, the hills between Whitford and Clevedon).

No extensive tracts of uncleared bush remain. However, in the course of 160 years farmers have generally given up trying to improve pasture on any unstable or steep land within their paddocks. The end-result is a farm landscape diversified by pockets of scrub and bush at various stages of reversion, from young kanuka and tree fern to second-growth podocarps, tanekaha or kauri.

Suburban housing has also spread onto the three soils, particularly the North Shore and eastern parts of Manukau, plus small-town expansion around Whangaparaoa and Warkworth-Snells Beach-Algies Bay. The soils have a reputation with earthworks contractors as difficult to work, and with builders as problematical for foundations. Their high clay content includes a proportion of smectite (swelling clay) which alters subsoil from hard blocky structure in summer, to sticky and massive in winter. The subsoil is reputed to absorb its own weight in water, and to shrink or swell by 10 - 20%. Soils having high concentrations of swelling clay can under go as much as a 30% volume change due to wetting and drying.

Sourced from Locker, R.H., 2001, Jade River: a history of the Mahurangi, Friends of the Mahurangi Inc.

10.1 Typical fruit, crop, and pasture yields

| Fruit | Yield | Units |
|--------------|--------------|--------------|
| Grapes | ? | t/ha |
| Pip-fruit | ? | bushels/ha |

Source: local growers

| Crop | Yield | Units |
|-----------------|--------------|--------------|
| Maize | ? | t/ha |
| Forage turnips | ? | t/ha |
| Forage brassica | ? | t/ha |

Source: local growers

| Pasture | Yield | Units |
|-----------------------------|--------------|--------------|
| Improved pasture (dairy) | 11.0 | t dm/ha/yr |
| Improved pasture (drystock) | 8.0 | t dm/ha/yr |
| Semi-improved pasture | 6.0 | t dm/ha/yr |
| Un-improved pasture | 4.0 | t dm/ha/yr |

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

11 Information about soil management

Whangaripo and Warkworth soils are not versatile because their high clay content limits cultivation for vegetable or grain crops. Subsoil wetness also restricts root penetration by fruit trees or vines. Matakana soil is somewhat better in this regard due to its sandy clay texture. All three are good soils for pasture and timber tree growth.

Management issues that may arise are:

- Adequate fertiliser to replace grass uptake
- Avoidance of structural deterioration through pugging by stock in winter and spring
- Maintenance of dense sward through dry summers to minimize risk of topsoil loss in runoff when the autumn rains come
- Disposing dairy effluent safely onto paddocks

The soils have similar management needs to other ultic (clay) soils that have weathered from marine sedimentary rocks in the landscape that extends from Northland through Auckland to the northern Waikato. Tips for managing soil structure and nutrients, for controlling erosion, and for applying irrigation water or effluent, 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*
http://www.fertiliser.org.nz/site/code_of_practice/default.aspx *Code of Practice*
- *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
- *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*
- *Streamside planting guide,* *Auckland Council*
- *Riparian zone management* *TP148, Auckland Council*
- *Native forest restoration guide* *Auckland Council*

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