

2022 Soil quality monitoring – native vegetation



Contents

- [2022 Soil quality monitoring – native vegetation](#)
 - [Contents](#)
- [Disclaimer](#)
- [Overview](#)
 - [Monitoring sites and indicator breaches](#)
- [Methods](#)
 - [Analytical methods](#)
 - [Benchmarking](#)
- [Soil chemistry & fertility results](#)
 - [Organic resources](#)
 - [Acidity - soil pH](#)
 - [Fertility - Olsen P](#)
 - [Trace elements](#)
- [Physical condition results](#)
 - [Bulk density](#)
 - [Macroporosity](#)
- [Resources](#)
 - [Useful links for managing soil quality](#)
 - [References](#)
- [Appendix 1: Monitoring site information](#)
- [Appendix 2: Data tables](#)
 - [Total carbon \(C\)](#)
 - [Mineralisable nitrogen \(N\)](#)
 - [Acidity - soil pH](#)
 - [Fertility - Olsen P](#)
 - [Arsenic \(As\)](#)
 - [Cadmium \(Cd\)](#)
 - [Chromium \(Cr\)](#)
 - [Copper \(Cu\)](#)
 - [Lead \(Pb\)](#)
 - [Nickel \(Ni\)](#)
 - [Zinc \(Zn\)](#)
 - [Bulk density](#)
 - [Macroporosity](#)

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For the latest available results go to the [GW environmental data hub](#).

Overview

Greater Wellington (GW) monitors soil quality as part of its State of the Environment programme, to meet the requirements of section 35 of the Resource Management Act (1991) and to provide information to measure Regional Plan policy effectiveness.

The soil quality monitoring programme consists of approximately 100 monitoring sites on a range of soils across the region under different land uses. The frequency of sampling is dependent on the intensity of the land use; dairying, cropping and market garden sites are sampled every 3-4 years, dry stock, horticulture and exotic forestry sites are sampled every 5-7 years, while indigenous vegetation sites are sampled every 10 years. This years' report summarises monitoring results for native vegetation sites.

Monitoring objectives

1. Provide information on the physical, chemical and biological properties of soils;
2. Provide an early-warning system to identify the effects of primary land uses on long-term soil productivity and the environment;
3. Track specific, identified issues relating to the effects of land use on long-term soil productivity;
4. Assist in the detection of spatial and temporal changes in soil quality; and
5. Provide information required to determine the effectiveness of regional policies and plans.

Monitoring indicators

Monitoring indicators are used to assess soil chemistry and fertility, and to understand soil physical condition. The indicators used are as follows:

- [Soil chemistry and fertility](#) - total carbon (C), total nitrogen (N), anaerobic mineralisable nitrogen, soil pH, Olsen phosphorus (P), and total recoverable trace elements.
- [Physical condition](#) - bulk density and macroporosity.

Measured indicator values at each monitoring site are benchmarked against relevant guidelines for monitoring soil health. See the [methods page](#) for more information.

Note: *No guidelines are currently established for soil on native vegetation sites. So, their indicator values are assessed against forestry land use ratings to get a general idea of soil quality. Note also that some 2022 sites are located in small remnants of native vegetation, and their soil quality may be influenced by adjacent land uses (e.g. spray drift from neighbouring properties). These notes will be addressed in the next round of sampling for native vegetation monitoring sites.*

Monitoring sites and indicator breaches

Each monitoring site is shown by the map circles below, with the total number of indicators breached during the 2022 monitoring season displayed by colour of the circle.

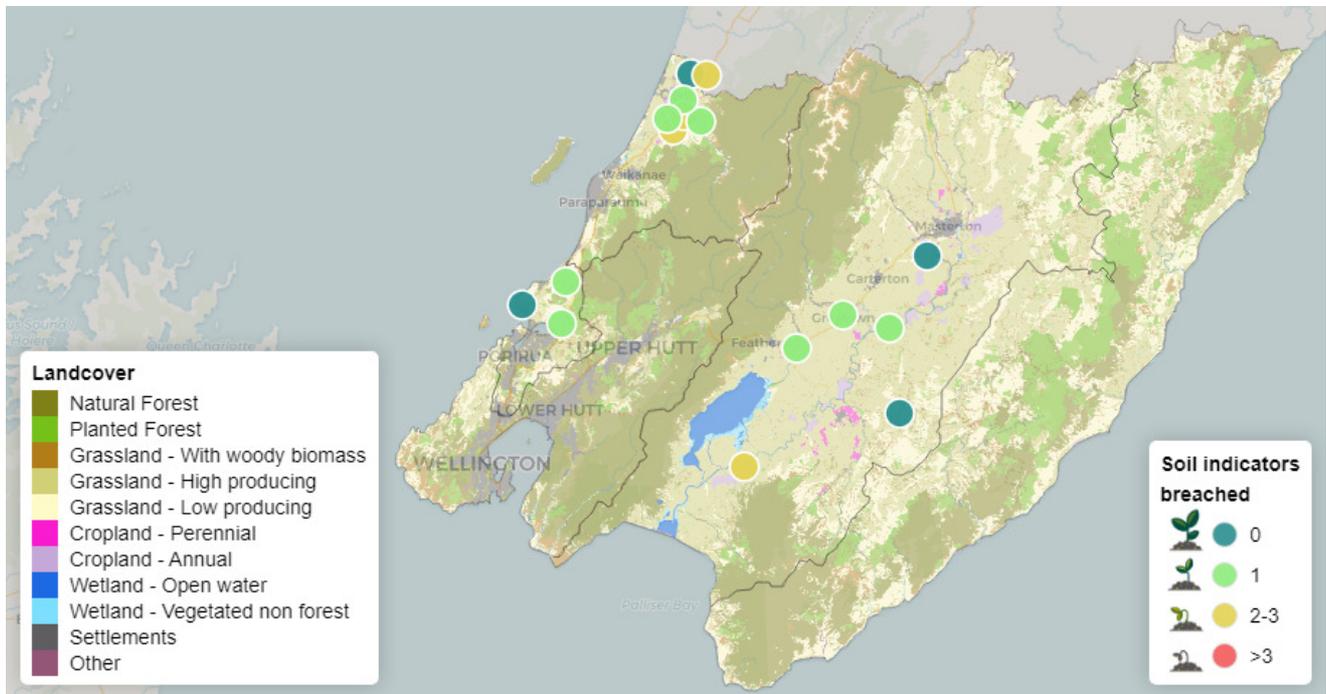


Figure 1: Soil quality monitoring sites rated by the total number of soil quality indicators breached. See the results sections for which indicators were breached, and [LUCAS 16 landcover](#) for more information on the classifications shown. Whaitua (main river catchments) are outlined by thin grey lines.

Note that site coordinates have been moved slightly throughout the report for visualisation and confidentiality purposes.

Proportion of total sites that breached indicators

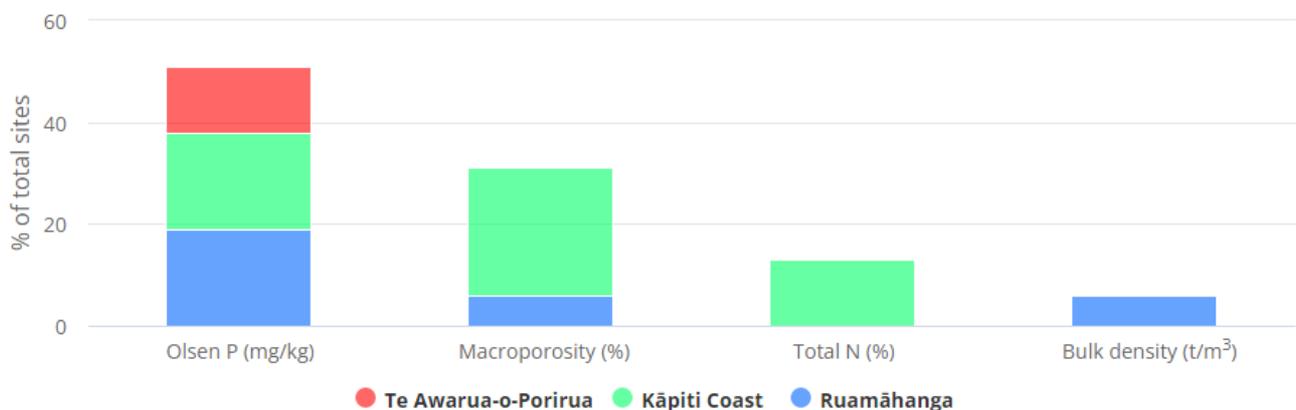


Figure 2: Percentage of total soil quality monitoring sites that breached each soil quality indicator, coloured by Whaitua.

Methods

Analytical methods

Analyses of the soil chemistry and soil physics indicators were completed at the Landcare Research laboratory. Trace element analyses were undertaken at Hill Laboratories in Hamilton. Where necessary, samples were stored at 4°C until analysis.

Soil macroporosity was determined at the Landcare Research soil physics laboratory in Hamilton. The Land Monitoring Forum specifies that macroporosity should be measured at a matric potential of -10 kPa. Macroporosity is the percentage of pores > 30 microns in diameter, when measured at -10 kPa. Ambiguity may arise with other terms (e.g. air-filled porosity) or macroporosity measured at other matric potentials (Drewry et al. 2008; 2015).

Olsen P measurements analysed at Landcare Research were undertaken using a gravimetric (weight) method to avoid the influence of soil bulk density. In New Zealand several large commercial laboratories measure soil received in the laboratory by volume prior to Olsen P chemical extraction. The fertiliser industry guidelines for Olsen P measurement are based on a volumetric method. Further information and explanation is available from Drewry et al. (2013; 2015).

Indicator	Method
Bulk density	Measured on a sub-sampled core dried at 105°C.
Total-C content	Dry combustion method. Using air-dried, finely ground soils using a Leco 2000 CNS analyser.
Total-N content	Dry combustion method. Using air-dried, finely ground soils using a Leco 2000 CNS analyser.
Mineralisable-N	Waterlogged incubation method. Increase in NH_4^+ concentration was measured after incubation for 7 days at 40°C and extraction in 2M KCl.
Soil pH	Measured in water using glass electrodes and a 2.5:1 water-to-soil ratio.
Olsen P	Bicarbonate extraction method. Extracting <2mm air dried soils for 30 minutes with 0.5M NaHCO_3 at pH 8.5 and measuring the PO_4^{3-} concentration by the molybdenum blue method.
Trace elements	Total recoverable digestion. Nitric/hydrochloric acid digestion, USEPA 2002.

Benchmarking

Green shaded columns indicate **soil quality target ranges**, follow the referenced links for more information. See the [note in the overview section](#) about using forestry rating ranges for native vegetation sites.

Bulk density (t/m³)

Table 1: Target range is 'Loose' to 'Compact' ([Hill and Sparling, 2009](#)).

Soil order	Very loose	Loose	Adequate	Compact	Very compact
Semi-arid, pallic and recent	≤0.40	>0.40-0.90	>0.90-1.25	>1.25-1.40	>1.40
Allophanic	≤0.30	>0.30-0.60	>0.60-0.90	>0.90-1.30	>1.30
Organic	≤0.20	>0.20-0.40	>0.40-0.60	>0.60-1.00	>1.00
All other	≤0.70	>0.70-0.80	>0.80-1.20	>1.20-1.40	>1.40

Macroporosity (% v/v at -10kPa)

Table 2: Target range is 'Adequate' ([Hill and Sparling, 2009](#)).

Land use	Very low	Low	Adequate	High
Pastures, cropping and horticulture	≤6	>6-10	>10-30	>30
Forestry	≤8	>8-10	>10-30	>30

Total Carbon (% w/w)

Table 3: Target range is 'Depleted' to 'Ample' (modified from [Hill and Sparling, 2009](#) to have no upper bound on the ample category). *Organic soils excluded as by definition these soils have ample total carbon content.

Soil order	Very depleted	Depleted	Normal	Ample
Semi-arid, pallic and recent	≤2	>2-3	>3-5	>5
Allophanic	≤3	>3-4	>4-9	>9
Organic*				
All other	≤3	>3-4	>4-7	>7

Total nitrogen (% w/w)

Table 4: Target range is 'Depleted' to 'Ample', ([Hill and Sparling, 2009](#)). *Cropping and horticulture excluded as ranges would depend on specific crops grown.

Land use	Very depleted	Depleted	Normal	Ample	High
Pasture	≤0.25	>0.25-0.35	>0.35-0.65	>0.65-0.70	>0.70
Forestry	≤0.10	>0.10-0.20	>0.20-0.60	>0.60-0.70	>0.70

Mineralisable nitrogen (mg/kg)

Table 5: Target range is 'Low' to 'High' ([Hill and Sparling 2009](#)).

Land use	Very low	Low	Adequate	Ample	High	Excessive
Pasture	≤50	>50-100	>100-200	>200-200	>200-250	>250
Cropping and horticulture	≤20	>20-100	>100-150	>150-150	>150-200	>200
Forestry	≤20	>20-40	>40-120	>120-150	>150-175	>175

Soil pH

Table 6: Target range is 'Slightly-acidic' to 'Optimal' ([Hill and Sparling, 2009](#)). *Forestry on organic soils excluded as this combination is unlikely in real life due to windthrow.

Land use & soil order	Very acidic	Slightly acidic	Optimal	Sub-optimal	Very alkaline
Pastures on all except Organic	>4-5	>5-6	>6-6	>6-7	>7-9
Pastures on Organic	>4-5	>5-5	>5-6	>6-7	>7
Cropping & horticulture on all except Organic	>4-5	>5-6	>6-7	>7-8	>8-9
Cropping & horticulture on Organic	>4-5	>5-5	>5-7	>7-8	>8
Forestry on all except Organic	≤4	>4-4	>4-7	>7-8	>8
Forestry on organic soils*					

Olsen P (mg/kg)

Table 7: Target ranges are set for different land use and soil orders ([McKay et al 2013](#)). Note: the reference range of 5-50 mg/kg for forestry is usually applied as 5-30 mg/kg (Gordon 2018, Drewry et al. 2021), so this report also uses the upper limit of 30 mg/kg to maintain reporting consistency. Sedimentary soil includes all other soil orders except Allophanic (volcanic ash), Pumice, Organic, and Recent (AgResearch classification system).

Land use	Soil order	Range
Forestry	All soils	>5-30
Pastures, cropping and horticulture	Volcanic	>20-50
Pastures, cropping and horticulture	Sedimentary and organic	>20-40
Pastures, cropping and horticulture	Raw sands and podzols with low AEC	>5
Pastures, cropping and horticulture	Raw sands and podzols with medium and above AEC	>15-25
Pastures, cropping and horticulture	Other	>20-45
Pastures, cropping and horticulture	Hill country	>15-20

Trace elements - draft eco-soil guidelines (mg/kg)

Table 8: Target range is less than the soil guideline value ([Cavanagh, 2019](#)). Note: Other values may apply for non-agricultural land uses, soils and circumstances.

Trace element	Guideline (mg/kg)	Soil orders rated
Arsenic (mg/kg)	<20	All soil
Cadmium (mg/kg)	<1.5	All soil
Chromium (mg/kg)	<300	All soil
Copper (mg/kg)	<150	Sensitive soil
Copper (mg/kg)	<340	Tolerant soil
Copper (mg/kg)	<220	Typical soil
Lead (mg/kg)	<530	All soil
Nickel (Ni)	Not determined	
Zinc (mg/kg)	<130	Sensitive soil
Zinc (mg/kg)	<265	Tolerant soil
Zinc (mg/kg)	<190	Typical soil

Trace elements - adapted from NZWWA (mg/kg)

Table 9: Target range is less the the soil limit value ([NZWWA, 2003](#)). Note: the suggested values by [Alloway \(2008\)](#) suggested for copper deficiency (≤ 5 mg/kg) and zinc deficiency (≤ 10 mg/kg) may be of interest depending on circumstances and type of farm production.

Trace element	Soil limit (mg/kg)
Arsenic (mg/kg)	<20
Cadmium (mg/kg)	<1
Chromium (mg/kg)	<600
Copper (mg/kg)	<100
Lead (mg/kg)	<300
Nickel (mg/kg)	<60
Zinc (mg/kg)	<300

Cadmium - Tiered Fertiliser Management System (mg/kg)

Table 10: Target ranges depend on the choice and rate of phosphate fertiliser application, see the [Fertiliser Association Tiered Fertiliser Management System for Soil Cadmium](#) for more detail.

Tier	Concentration (mg/kg)
0	>0.0-0.6
1	>0.6-1.0
2	>1.0-1.4
3	>1.4-1.8
4	>1.8

Total nitrogen (N)

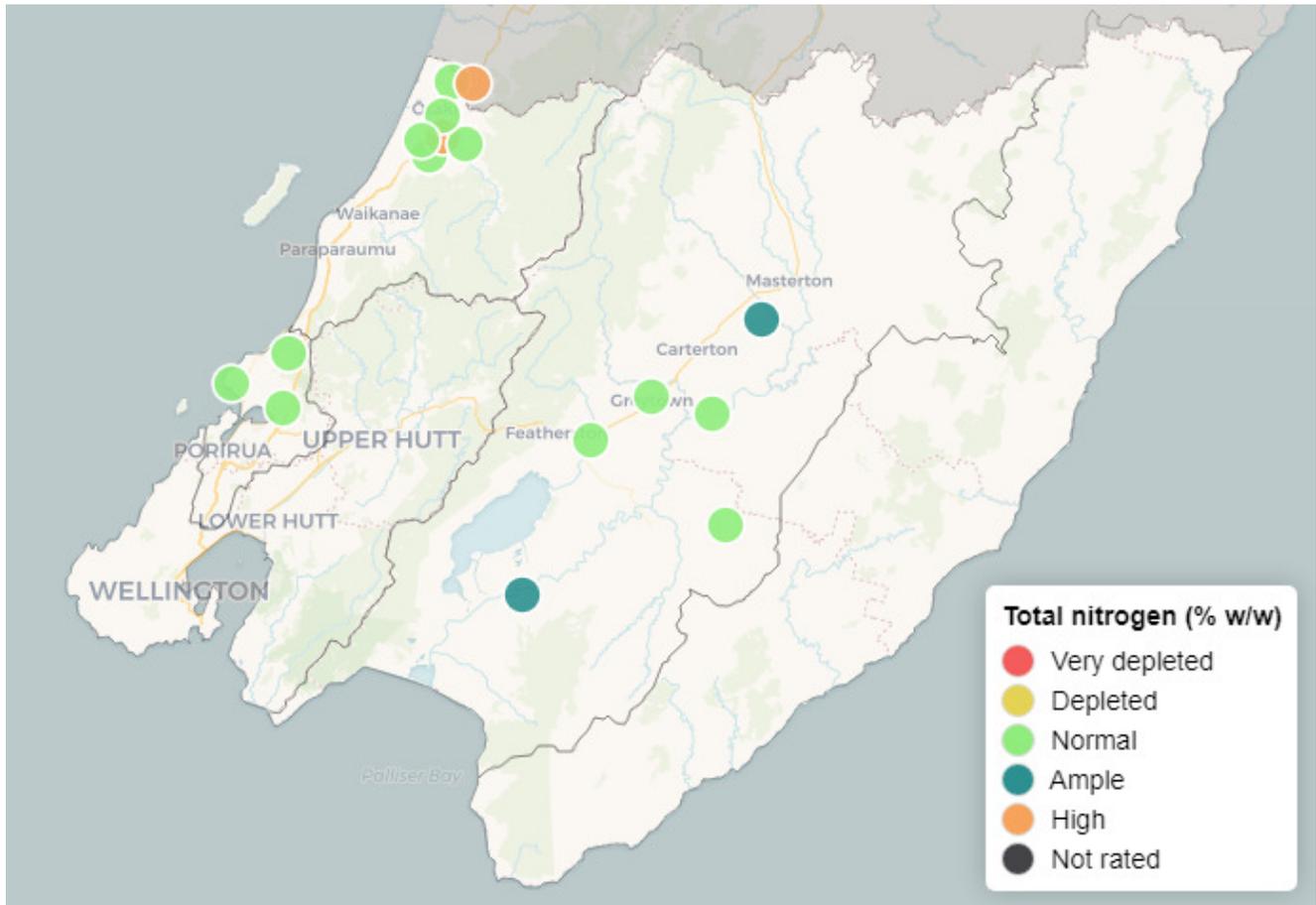


Figure 4: Most nitrogen in soil is present within the organic matter fraction, and total nitrogen gives a measure of those reserves. It also provides an indication for the potential of nitrogen to leach into underlying groundwater. The target range is **‘Depleted’ to ‘Ample’**, see [benchmarking](#) for more information.

Mineralisable nitrogen (N)

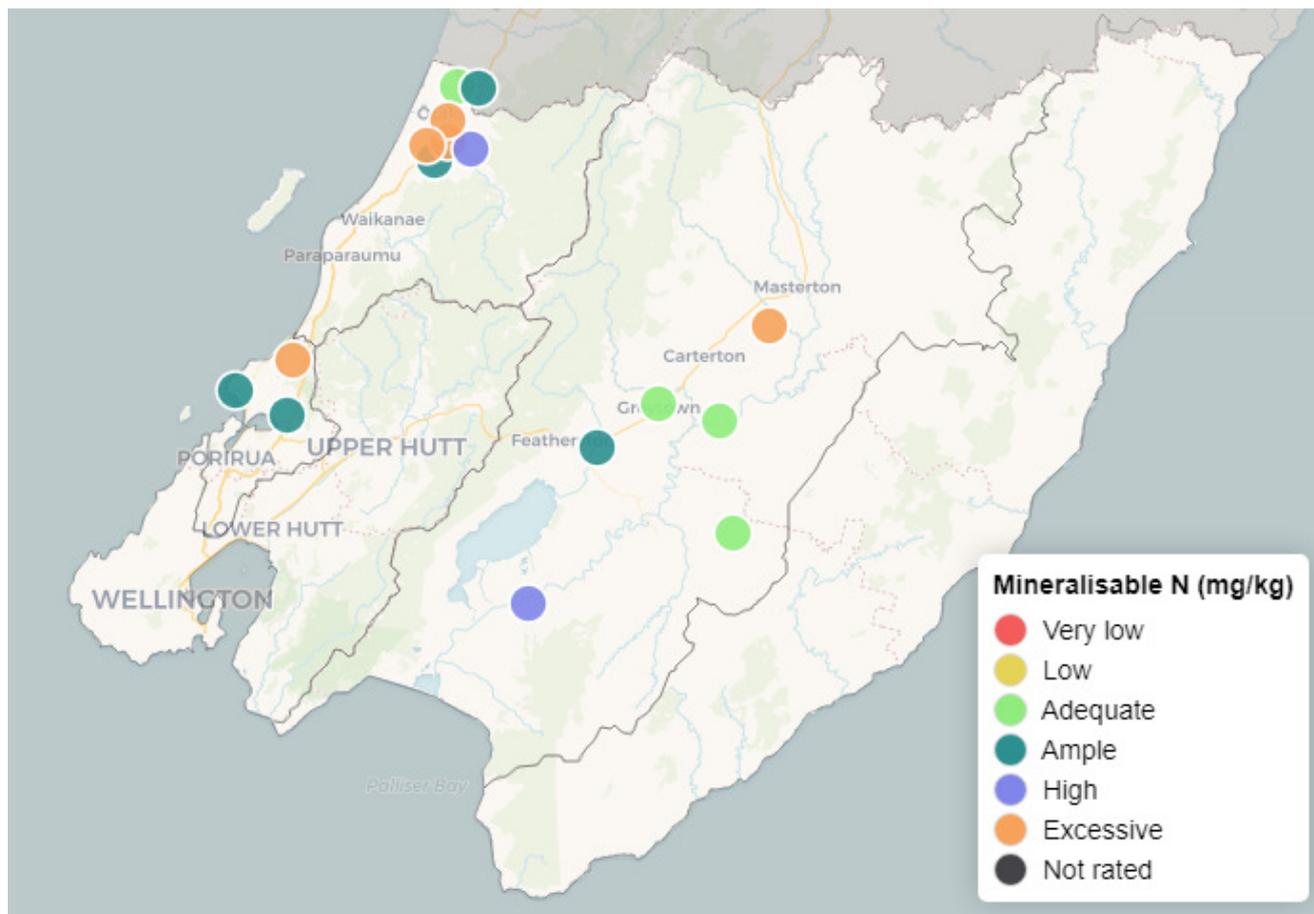


Figure 5: Not all nitrogen can be used by plants; soil organisms change nitrogen to forms that plants can use. Mineralisable N gives a measure of how much organic nitrogen is available to plants, and the potential for nitrogen leaching at times of low plant demand. Mineralisable nitrogen is also used as a surrogate measure of the microbial biomass. The target range is ‘**Low**’ to ‘**High**’, see [benchmarking](#) for more information.

Acidity - soil pH

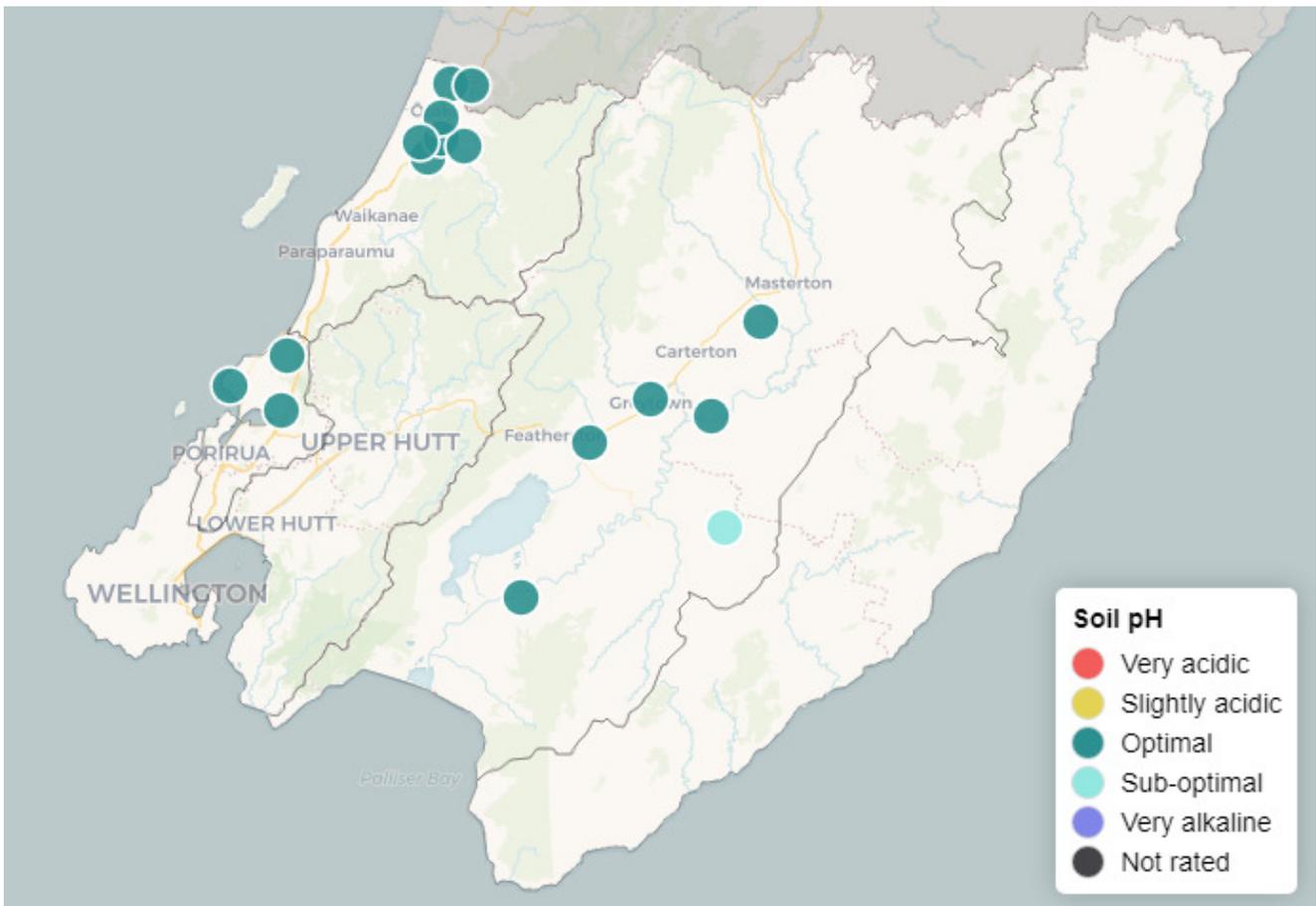


Figure 6: Most plants have an optimal pH range for growth. The pH of a soil influences the availability of many nutrients to plants and the solubility of some trace elements. Soil pH is influenced by the application of lime and some fertilisers. The target range is ‘**Slightly-acidic**’ to ‘**Optimal**’, see [benchmarking](#) for more information.

Fertility - Olsen P

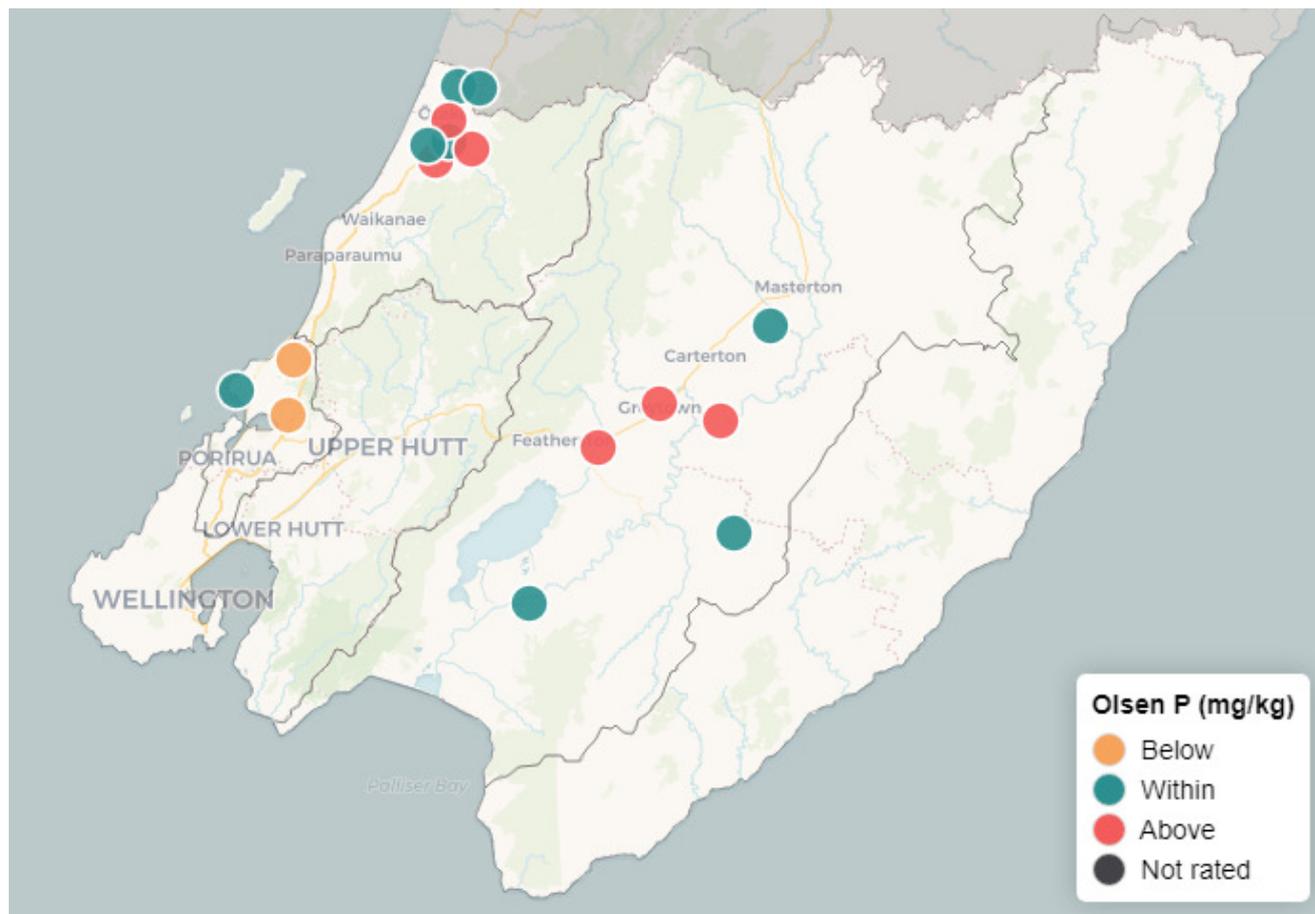


Figure 7: Phosphorus (P) is an essential nutrient for plants and animals. Olsen P is a measure of the amount of phosphorus that is available to plants. Levels of P greater than agronomic requirements can increase P losses to waterways, and therefore contribute to eutrophication (nutrient enrichment). The target range for forest land is **5-30 mg/kg**, see [benchmarking](#) for more information.

Trace elements

Some trace elements are essential micro-nutrients for plants and animals. Both essential and non-essential trace elements can become toxic at high concentrations. Trace elements can accumulate in the soil from various common agricultural and horticultural land use practices.

Arsenic (As)

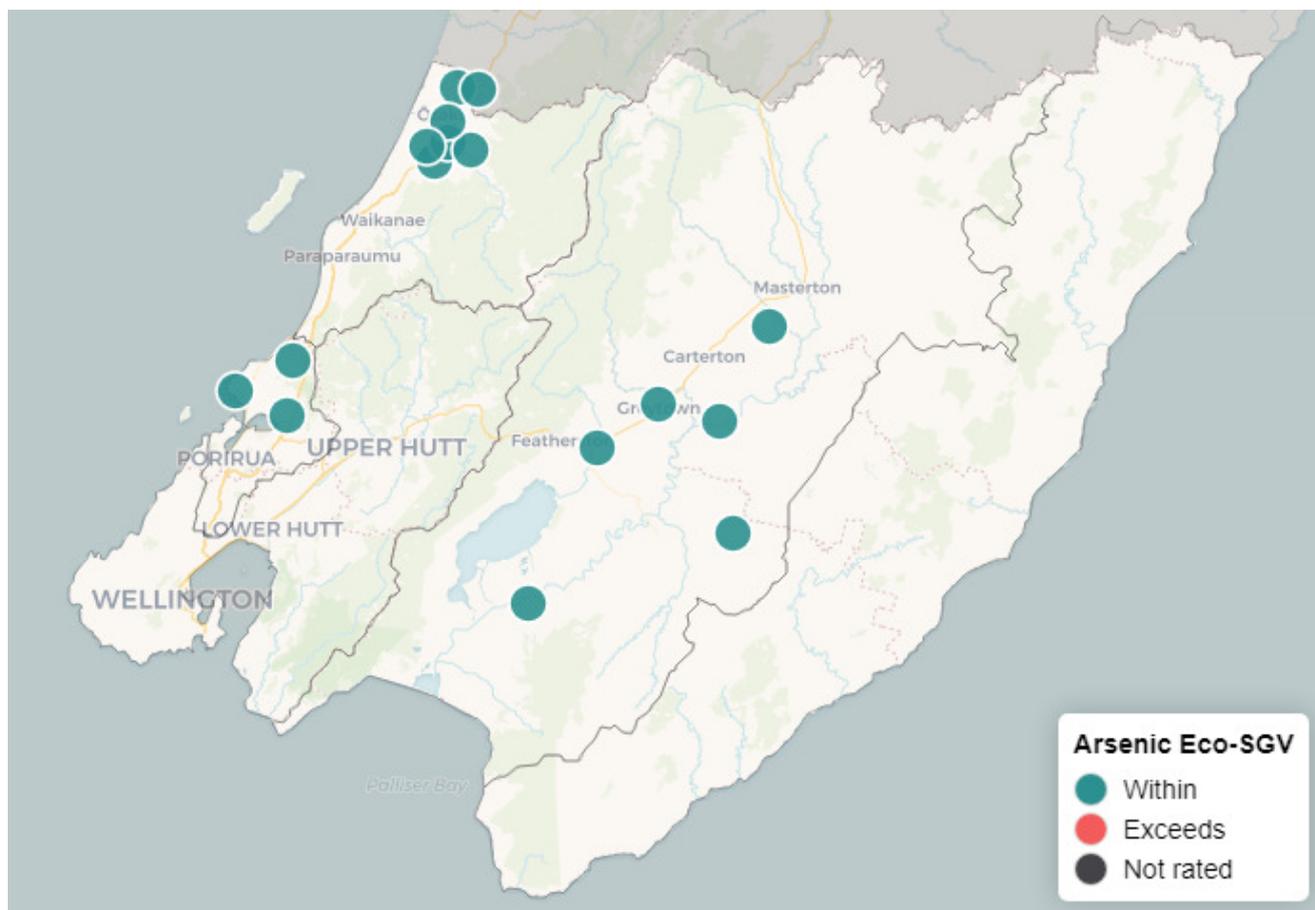


Figure 8: Arsenic results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Cadmium (Cd)

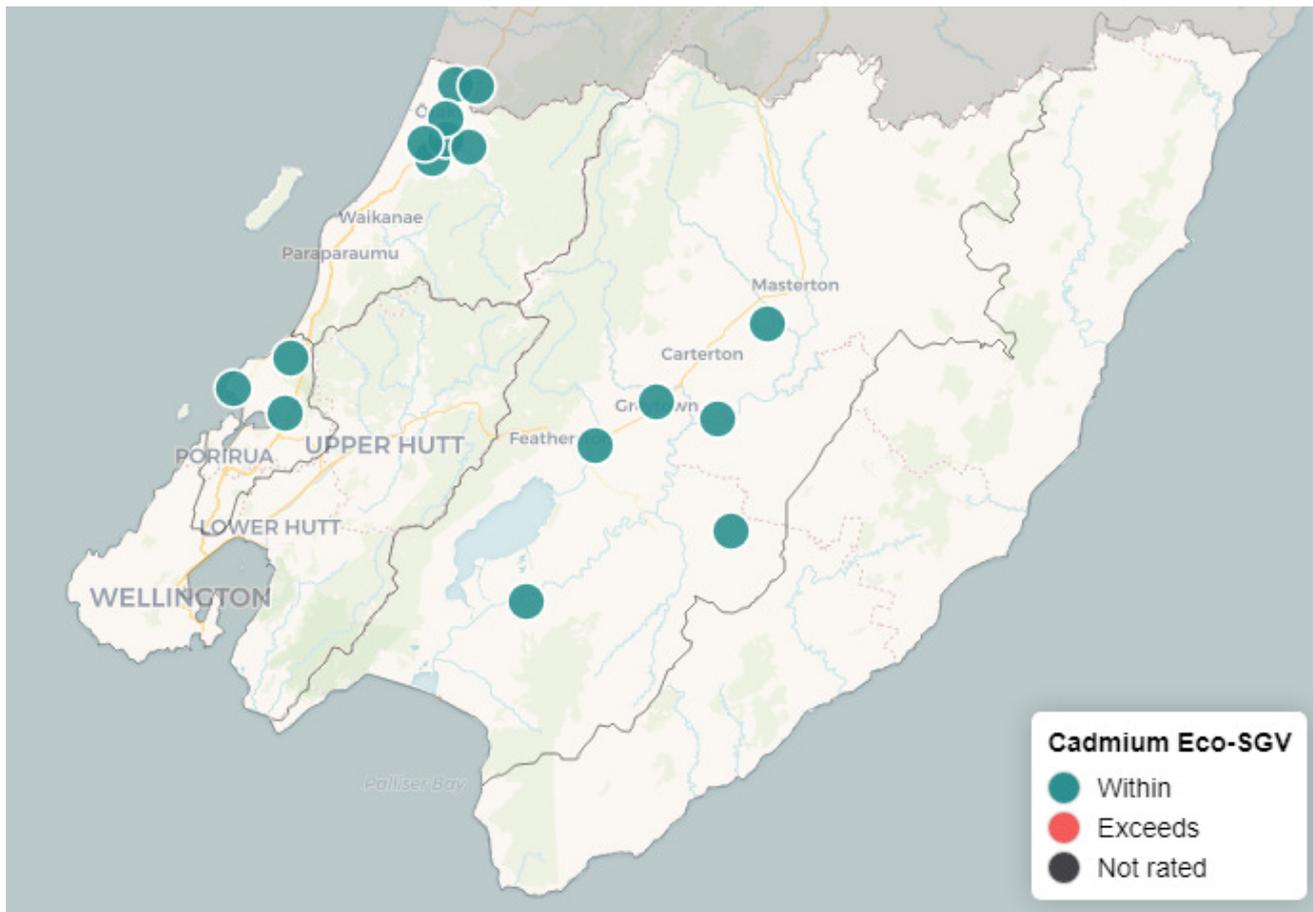


Figure 9: Cadmium results are compared against draft eco-soil guideline values (Eco-SGVs) on the map and trigger values from the tiered fertiliser management system (TFMS) also in the table, see [benchmarking](#) for more information.

Chromium (Cr)

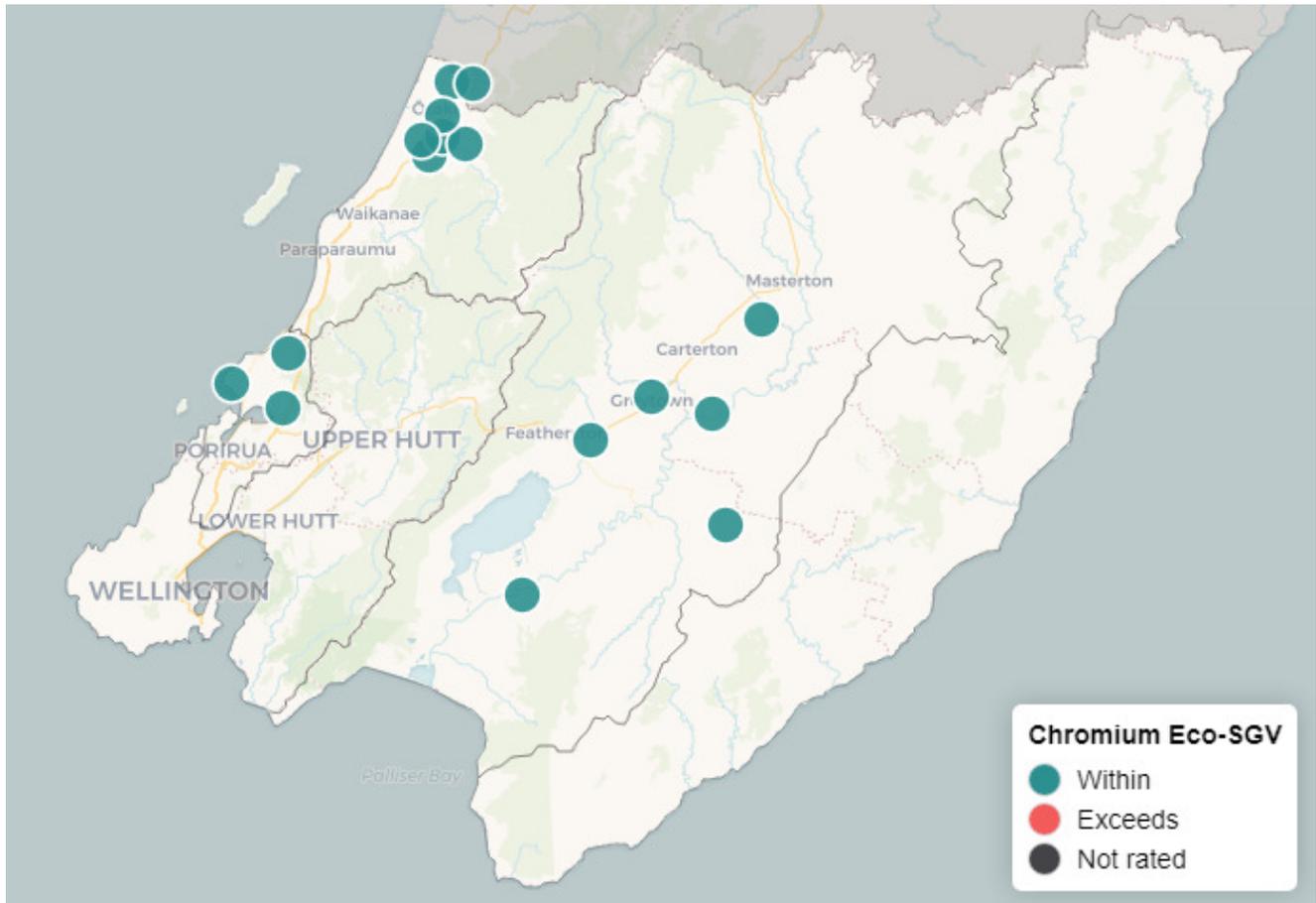


Figure 10: Chromium results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Copper (Cu)

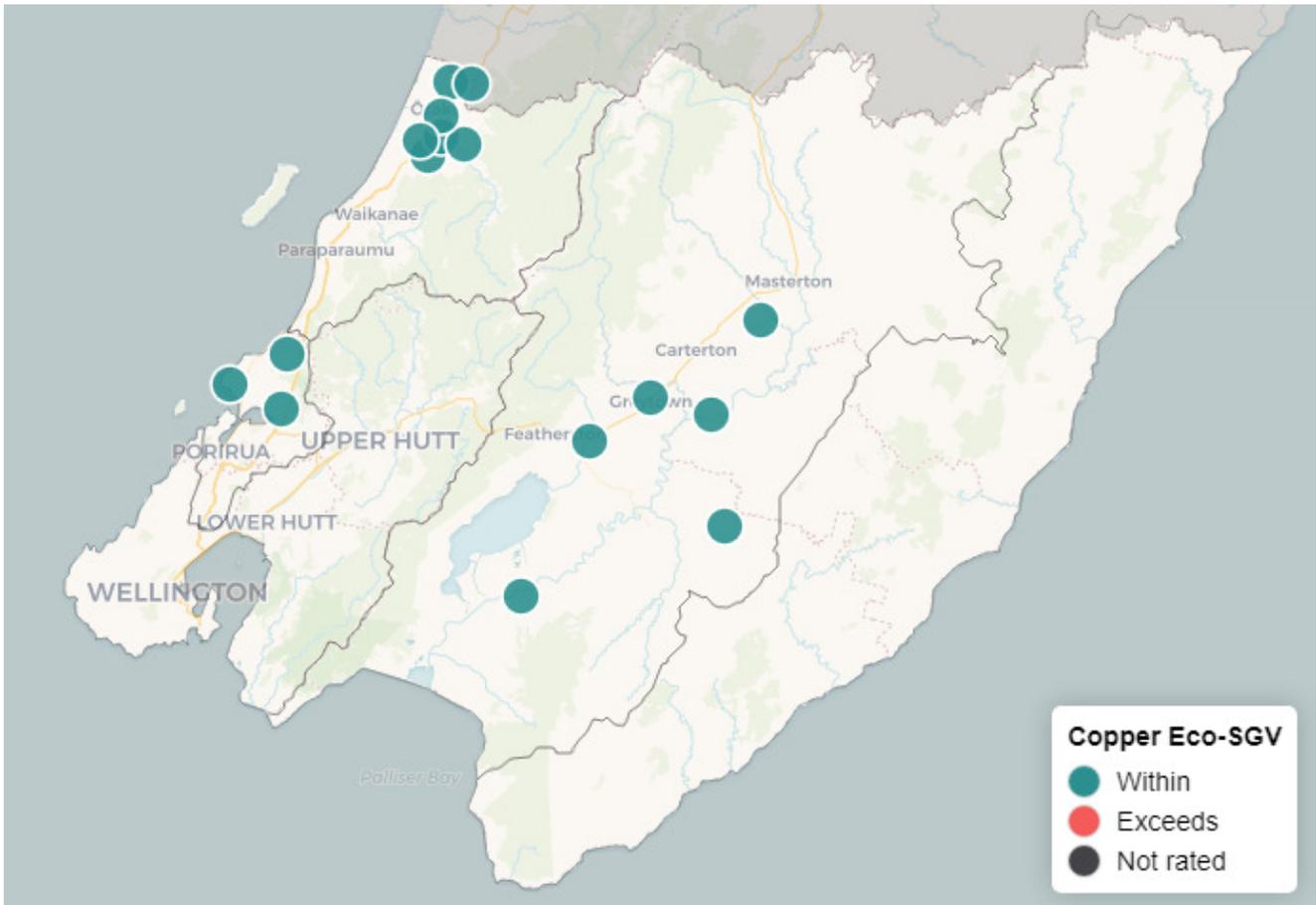


Figure 11: Copper results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Lead (Pb)

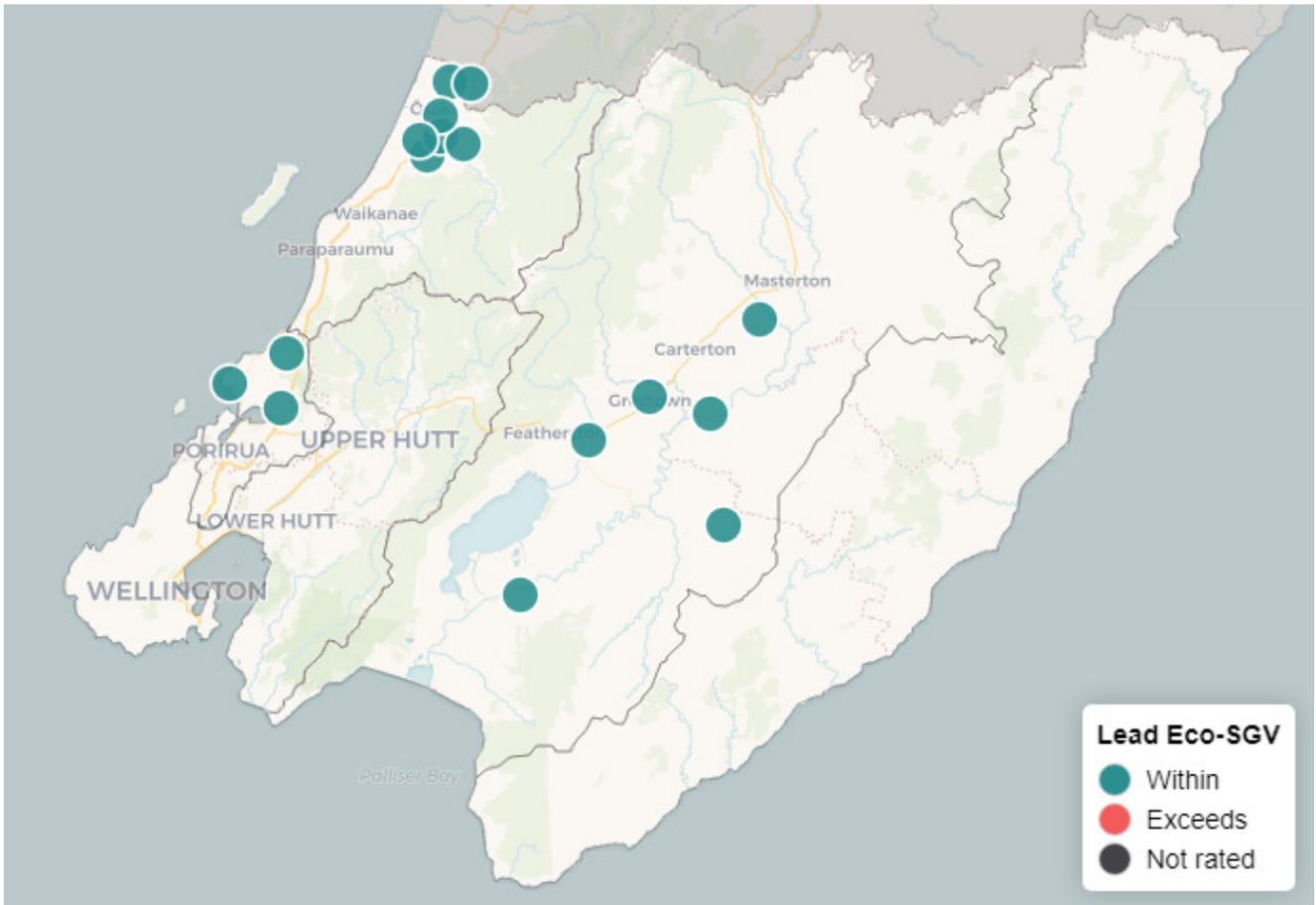


Figure 12: Lead results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Nickel (Ni)

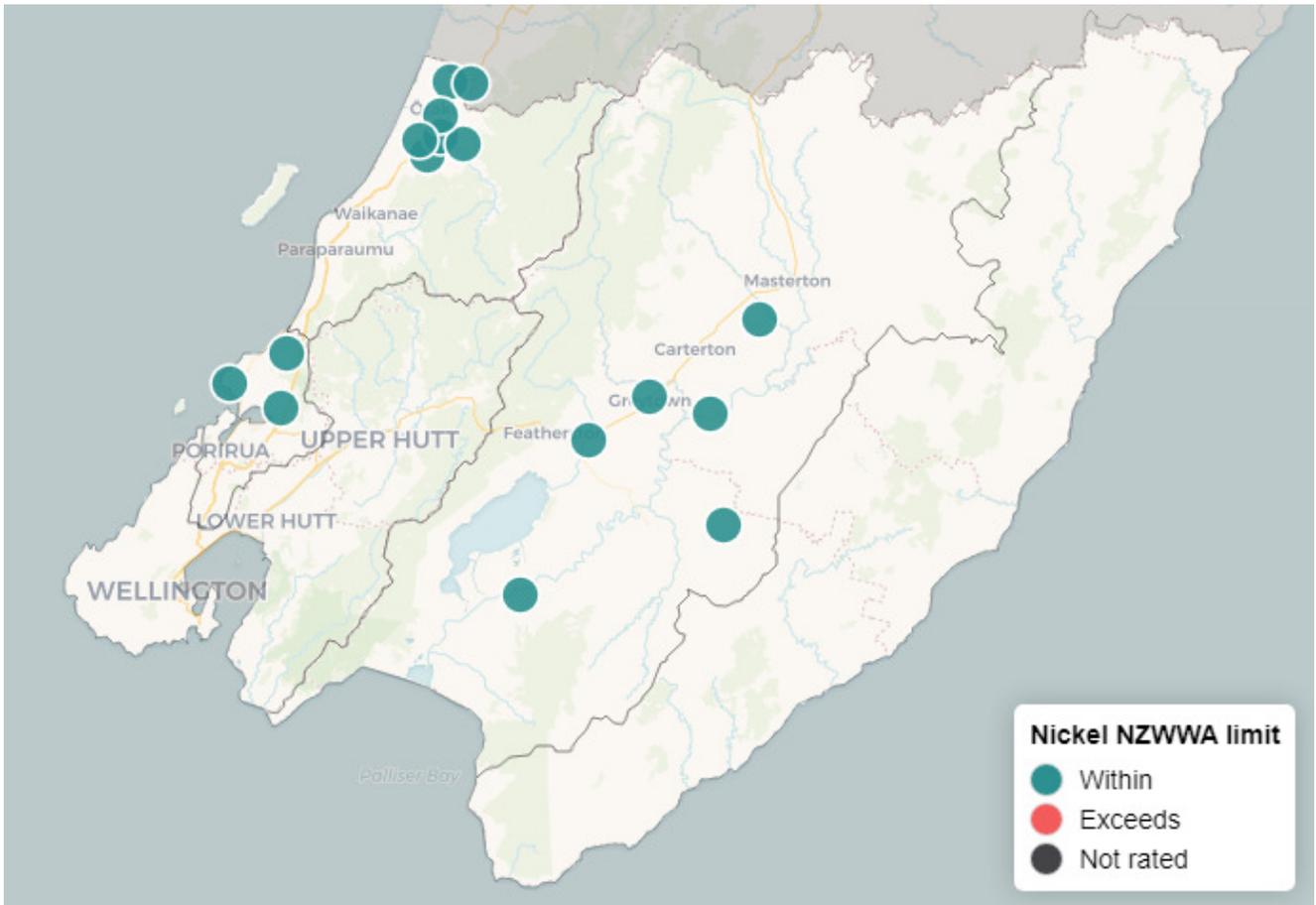


Figure 13: Nickel results are compared against New Zealand Water and Wastes Association (NZWWA) limits, see [benchmarking](#) for more information.

Zinc (Zn)

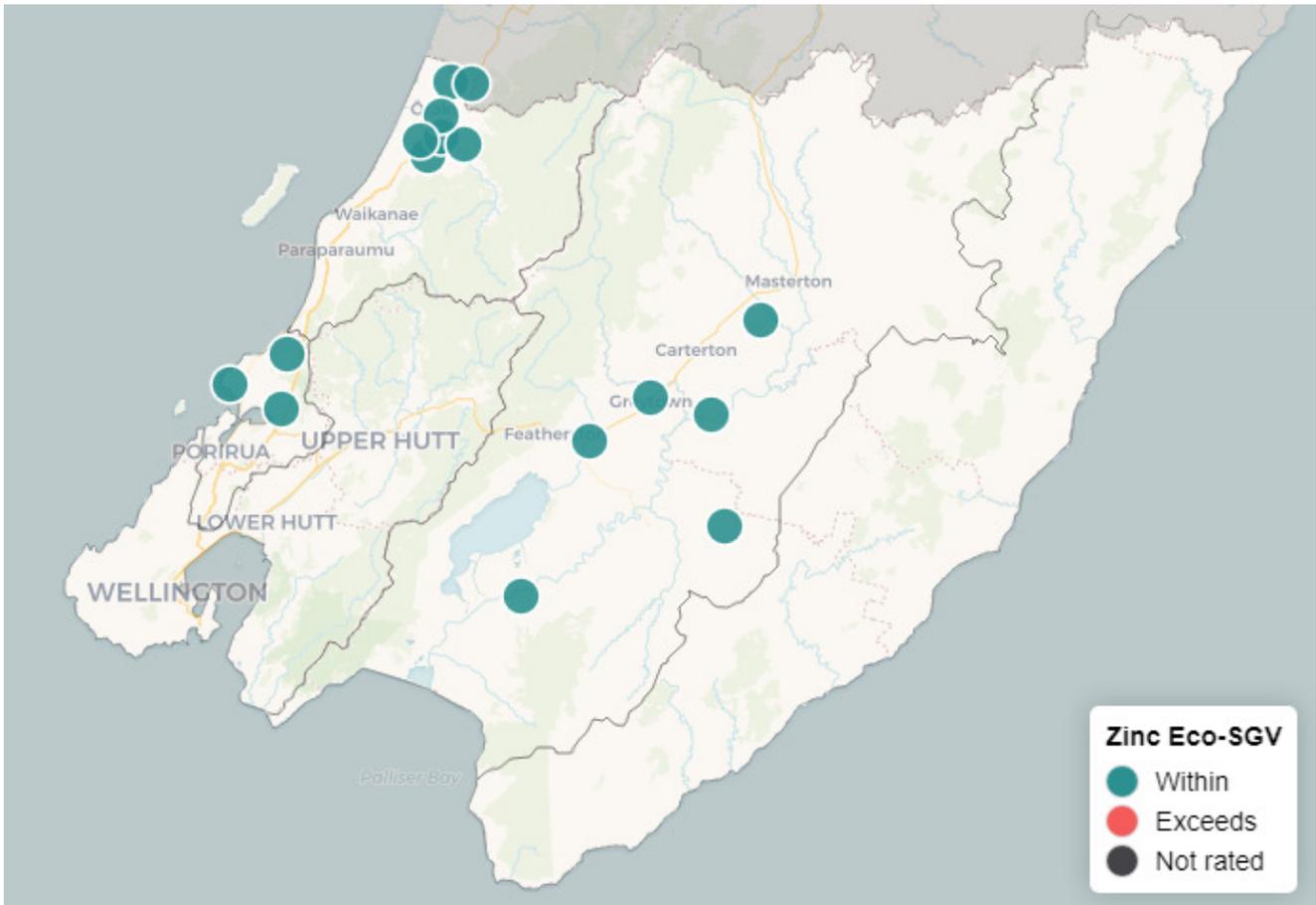


Figure 14: Zinc results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Physical condition results

The following sections present maps of soil quality monitoring results benchmarked against relevant indicator guidelines, see Appendix 2: Data tables for tabulated results.

Bulk density

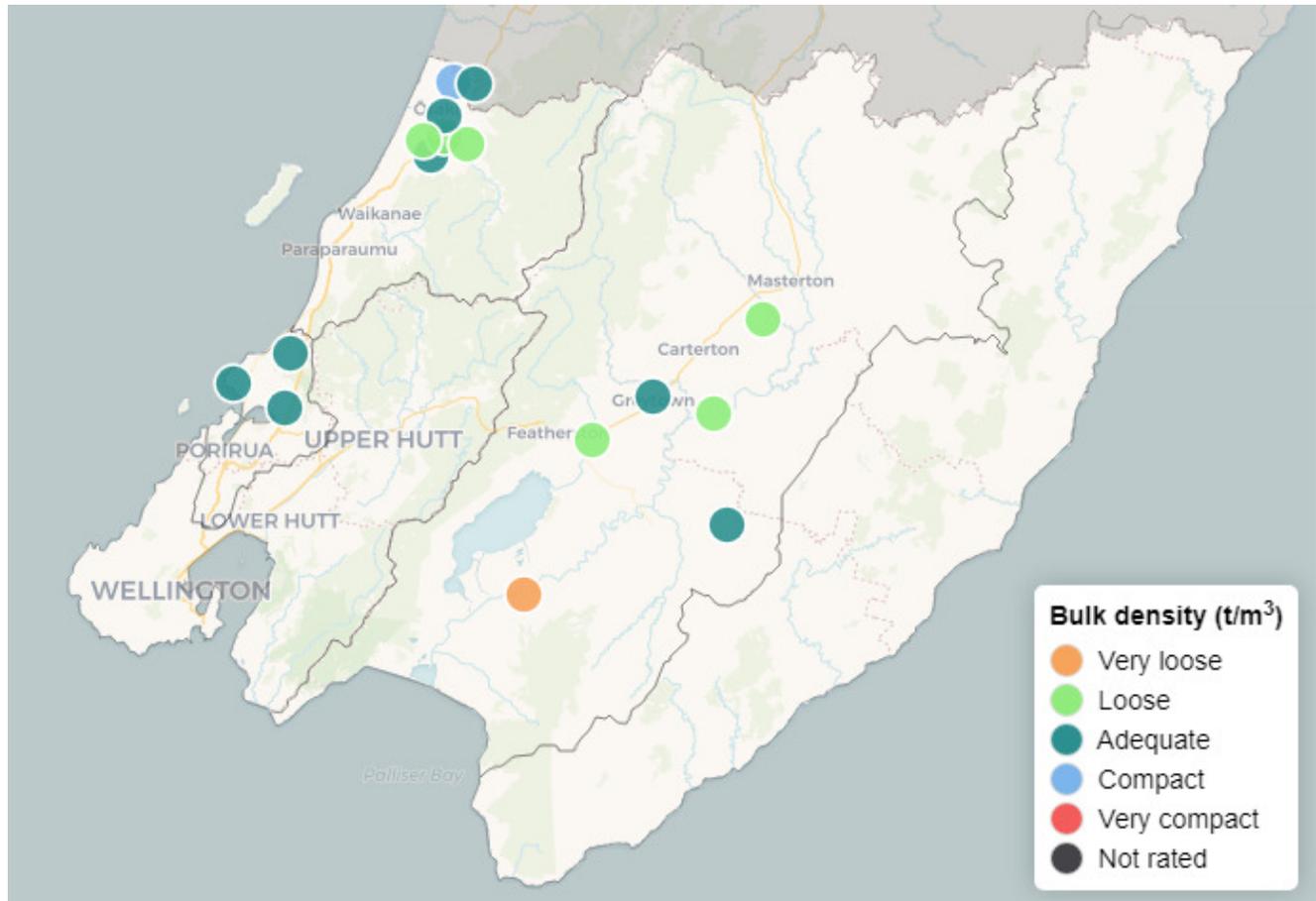


Figure 15: Bulk density is a measure of soil density. A high bulk density indicates a compacted or dense soil. Movement of water and air through soil pores is reduced in compacted soils. High soil bulk density can restrict root growth and adversely affect plant growth. There is also potential for increased run-off and nutrient loss to surface waters in compacted soils. The target range is 'Loose' to 'Compact', see benchmarking for more information.

Macroporosity

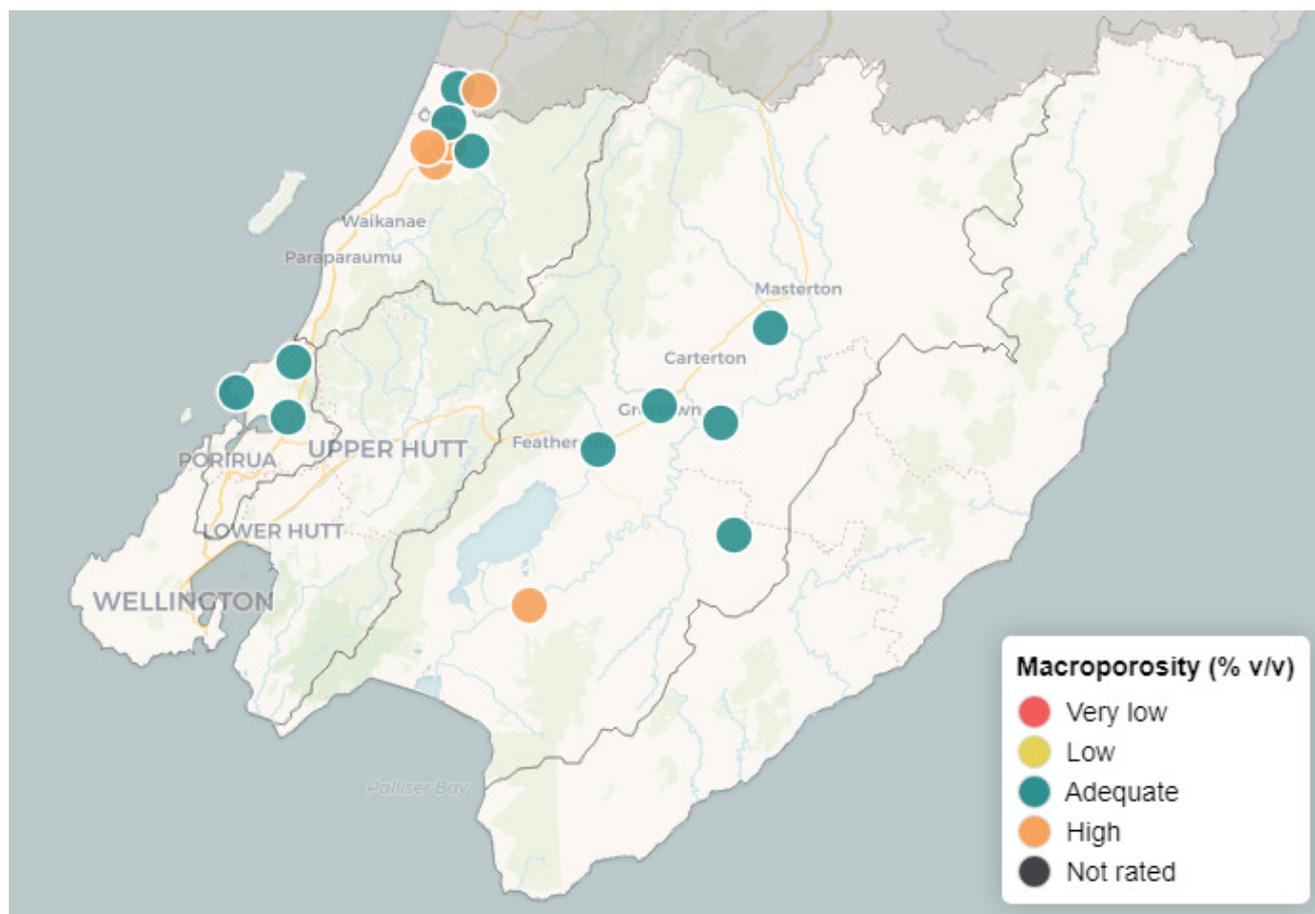


Figure 16: Macropores are important for soil air movement and drainage. Large soil pores are the most susceptible to collapse when soil is compacted. Low macroporosity adversely affects plant growth due to poor root environment, restricted air movement and N-fixation by clover roots. It also infers poor drainage and infiltration. The target is 'Adequate', see [benchmarking](#) for more information.

Resources

Useful links for managing soil quality

- [Reducing the impacts of winter grazing on soil and water quality](#)
- [Soil compaction and pugging on farms](#)
- [Limiting Pugging and Compaction Damage](#)
- [Soil Fertility for Pasture](#)
- [Nitrogen Fertiliser](#)
- [Nutrient Management](#)
- [Beef and Lamb - Successful soil and fertiliser management](#)
- [Soil Characteristics Important to Management](#)
- [Managing our soils](#)
- [New Zealand Landcare Trust](#)
- [Soil Quality Indicators - A web-based tool designed to help you interpret the quality or health of a soil you have sampled](#)

References

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Appendix 1: Monitoring site information

Table A1.1: 2022 native vegetation monitoring sites with [LUCAS 16](#) landcover classifications.

Whaitua	Site code	Land use	Soil order	Soil subgroup	Soil type	Landcover
Kāpiti Coast	GW007	Native forest	Brown	Mottled Orthic Brown	Te Horo silt loam	Grassland - With woody biomass
Kāpiti Coast	GW009	Native bush	Brown	Acidic Allophanic Brown	Kawhatau stony silt loam	Grassland - High producing
Kāpiti Coast	GW011	Native forest	Recent	Mottled Fluvial Recent	Rangitikei silt loam	Natural Forest
Ruamāhanga	GW014	Native forest	Gley	Typic Recent Gley	Ahikouka silt loam	Grassland - High producing
Ruamāhanga	GW020	Native forest	Pallic	Argillic-fragic Perch-gley Pallic	Kokotau silt loam	Natural Forest
Ruamāhanga	GW029	Native bush	Pallic	Argillic-fragic Perch-gley Pallic	Bideford silt loam	Natural Forest
Ruamāhanga	GW039	Native forest	Recent	Mottled Fluvial Recent	Rangitikei loamy silt	Grassland - With woody biomass
Kāpiti Coast	GW045	Native forest and bush	Brown	Mottled Orthic Brown	Rahui silt loam.	Grassland - High producing
Kāpiti Coast	GW049	Native forest and bush	Recent	Typic Fluvial Recent.	Manawatu silt loam.	Grassland - With woody biomass
Te Awarua-o-Porirua	GW052	Native bush	Brown	Pallic Orthic Brown	Paramata hill soils	Other
Te Awarua-o-Porirua	GW057	Native bush	Brown	Typic Firm Brown	Korokoro hill soils	Natural Forest
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Typic Orthic Recent	Tairawhiti steepland soils	Natural Forest
Ruamāhanga	GW102	Native forest	Recent	Weathered Orthic Recent	Greytown silt loam	Grassland - With woody biomass
Ruamāhanga	GW104	Native forest and bush	Pallic	Typic Immature Pallic	Tauherenikau silt loam	Natural Forest
Kāpiti Coast	GW110	Native forest and bush	Brown	Typic Orthic Brown	Ashhurst stony silt loam	Natural Forest
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Typic Orthic Allophanic	Kawhatau silt loam	Grassland - High producing

Appendix 2: Data tables

Total carbon (C)

Table A2.1: Total carbon results benchmarked against the target range of ‘**Depleted**’ to ‘**Ample**’, see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Rating	Total carbon (%)
Kāpiti Coast	GW007	Native forest	Allophanic	Normal	6.83
Kāpiti Coast	GW009	Native bush	Allophanic	Ample	13.75
Kāpiti Coast	GW011	Native forest	Semi-arid, pallic and recent	Ample	5.96
Ruamāhanga	GW014	Native forest	All other	Ample	8.59
Ruamāhanga	GW020	Native forest	Semi-arid, pallic and recent	Ample	7.79
Ruamāhanga	GW029	Native bush	Semi-arid, pallic and recent	Ample	5.59
Ruamāhanga	GW039	Native forest	Semi-arid, pallic and recent	Ample	5.91
Kāpiti Coast	GW045	Native forest and bush	Allophanic	Depleted	3.88
Kāpiti Coast	GW049	Native forest and bush	Semi-arid, pallic and recent	Ample	5.88
Te Awarua-o-Porirua	GW052	Native bush	Allophanic	Normal	5.88
Te Awarua-o-Porirua	GW057	Native bush	Allophanic	Normal	8.68
Te Awarua-o-Porirua	GW059	Native bush/scrub	Semi-arid, pallic and recent	Normal	3.63
Ruamāhanga	GW102	Native forest	Semi-arid, pallic and recent	Ample	6.66
Ruamāhanga	GW104	Native forest and bush	Semi-arid, pallic and recent	Ample	6.08
Kāpiti Coast	GW110	Native forest and bush	Allophanic	Normal	6.86
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Ample	16.37

Mineralisable nitrogen (N)

Table A2.2: Mineralisable nitrogen results benchmarked against the target range of ‘Low’ to ‘High’, see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Rating land use	Rating	Mineralisable N (mg/kg)
Kāpiti Coast	GW007	Native forest	Forestry	Ample	136.3
Kāpiti Coast	GW009	Native bush	Forestry	Excessive	215.2
Kāpiti Coast	GW011	Native forest	Forestry	High	151.3
Ruamāhanga	GW014	Native forest	Forestry	High	166.8
Ruamāhanga	GW020	Native forest	Forestry	Excessive	175.4
Ruamāhanga	GW029	Native bush	Forestry	Adequate	89.3
Ruamāhanga	GW039	Native forest	Forestry	Adequate	112.6
Kāpiti Coast	GW045	Native forest and bush	Forestry	Adequate	101.5
Kāpiti Coast	GW049	Native forest and bush	Forestry	Excessive	197.4
Te Awarua-o-Porirua	GW052	Native bush	Forestry	Ample	130.7
Te Awarua-o-Porirua	GW057	Native bush	Forestry	Excessive	193.5
Te Awarua-o-Porirua	GW059	Native bush/scrub	Forestry	Ample	120.1
Ruamāhanga	GW102	Native forest	Forestry	Adequate	110.9
Ruamāhanga	GW104	Native forest and bush	Forestry	Ample	134.4
Kāpiti Coast	GW110	Native forest and bush	Forestry	Excessive	265.9
Kāpiti Coast	GW113	Native forest and bush	Forestry	Ample	142.0

Acidity - soil pH

Table A2.3: Soil pH results benchmarked against the target range of ‘Slightly-acidic’ to ‘Optimal’, see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Land use & soil order	Rating	Soil pH
Kāpiti Coast	GW007	Native forest	Forestry on all except Organic	Optimal	4.96
Kāpiti Coast	GW009	Native bush	Forestry on all except Organic	Optimal	5.42
Kāpiti Coast	GW011	Native forest	Forestry on all except Organic	Optimal	5.61
Ruamāhanga	GW014	Native forest	Forestry on all except Organic	Optimal	6.10
Ruamāhanga	GW020	Native forest	Forestry on all except Organic	Optimal	5.34
Ruamāhanga	GW029	Native bush	Forestry on all except Organic	Sub-optimal	7.32
Ruamāhanga	GW039	Native forest	Forestry on all except Organic	Optimal	5.94
Kāpiti Coast	GW045	Native forest and bush	Forestry on all except Organic	Optimal	5.55
Kāpiti Coast	GW049	Native forest and bush	Forestry on all except Organic	Optimal	6.48
Te Awarua-o-Porirua	GW052	Native bush	Forestry on all except Organic	Optimal	5.73
Te Awarua-o-Porirua	GW057	Native bush	Forestry on all except Organic	Optimal	5.34
Te Awarua-o-Porirua	GW059	Native bush/scrub	Forestry on all except Organic	Optimal	5.94
Ruamāhanga	GW102	Native forest	Forestry on all except Organic	Optimal	5.25
Ruamāhanga	GW104	Native forest and bush	Forestry on all except Organic	Optimal	6.00
Kāpiti Coast	GW110	Native forest and bush	Forestry on all except Organic	Optimal	5.90
Kāpiti Coast	GW113	Native forest and bush	Forestry on all except Organic	Optimal	5.54

Fertility - Olsen P

Table A2.4: Phosphorus (P) results benchmarked against the target range of **5-30** mg/kg, see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Rating land use	Soil order	Rating	Olsen P (mg/kg)
Kāpiti Coast	GW007	Native forest	Forestry	All soils	Above	55.75
Kāpiti Coast	GW009	Native bush	Forestry	All soils	Within	6.10
Kāpiti Coast	GW011	Native forest	Forestry	All soils	Above	79.24
Ruamāhanga	GW014	Native forest	Forestry	All soils	Within	20.29
Ruamāhanga	GW020	Native forest	Forestry	All soils	Within	25.37
Ruamāhanga	GW029	Native bush	Forestry	All soils	Within	6.01
Ruamāhanga	GW039	Native forest	Forestry	All soils	Above	51.22
Kāpiti Coast	GW045	Native forest and bush	Forestry	All soils	Within	10.71
Kāpiti Coast	GW049	Native forest and bush	Forestry	All soils	Above	52.65
Te Awarua-o-Porirua	GW052	Native bush	Forestry	All soils	Below	4.73
Te Awarua-o-Porirua	GW057	Native bush	Forestry	All soils	Below	3.62
Te Awarua-o-Porirua	GW059	Native bush/scrub	Forestry	All soils	Within	6.53
Ruamāhanga	GW102	Native forest	Forestry	All soils	Above	33.05
Ruamāhanga	GW104	Native forest and bush	Forestry	All soils	Above	80.16
Kāpiti Coast	GW110	Native forest and bush	Forestry	All soils	Within	24.21
Kāpiti Coast	GW113	Native forest and bush	Forestry	All soils	Within	8.90

Arsenic (As)

Table A2.5: Arsenic results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Eco-SGV	Arsenic (mg/kg)
Kāpiti Coast	GW007	Native forest	Brown	Within	1.7
Kāpiti Coast	GW009	Native bush	Brown	Within	2.4
Kāpiti Coast	GW011	Native forest	Recent	Within	8.3
Ruamāhanga	GW014	Native forest	Gley	Within	1.2
Ruamāhanga	GW020	Native forest	Pallic	Within	2.6
Ruamāhanga	GW029	Native bush	Pallic	Within	5.8
Ruamāhanga	GW039	Native forest	Recent	Within	3.8
Kāpiti Coast	GW045	Native forest and bush	Brown	Within	1.3
Kāpiti Coast	GW049	Native forest and bush	Recent	Within	7.0
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within	8.3
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within	3.6
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within	1.6
Ruamāhanga	GW102	Native forest	Recent	Within	5.9
Ruamāhanga	GW104	Native forest and bush	Pallic	Within	6.3
Kāpiti Coast	GW110	Native forest and bush	Brown	Within	5.0
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within	2.2

Cadmium (Cd)

Table A2.6: Cadmium results are compared against draft eco-soil guideline values (Eco-SGVs) on the map and trigger values from the tiered fertiliser management system (TFMS) also in the table, see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Eco-SGV	Cadmium (mg/kg)
Kāpiti Coast	GW007	Native forest	Brown	Within	0.07
Kāpiti Coast	GW009	Native bush	Brown	Within	0.06
Kāpiti Coast	GW011	Native forest	Recent	Within	0.16
Ruamāhanga	GW014	Native forest	Gley	Within	0.10
Ruamāhanga	GW020	Native forest	Pallic	Within	0.15
Ruamāhanga	GW029	Native bush	Pallic	Within	0.06
Ruamāhanga	GW039	Native forest	Recent	Within	0.16
Kāpiti Coast	GW045	Native forest and bush	Brown	Within	0.05
Kāpiti Coast	GW049	Native forest and bush	Recent	Within	0.22
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within	0.02
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within	0.07
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within	0.05
Ruamāhanga	GW102	Native forest	Recent	Within	0.08
Ruamāhanga	GW104	Native forest and bush	Pallic	Within	0.14
Kāpiti Coast	GW110	Native forest and bush	Brown	Within	0.05
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within	0.10

Chromium (Cr)

Table A2.7: Chromium results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Eco-SGV	Chromium (mg/kg)
Kāpiti Coast	GW007	Native forest	Brown	Within	10
Kāpiti Coast	GW009	Native bush	Brown	Within	6
Kāpiti Coast	GW011	Native forest	Recent	Within	16
Ruamāhanga	GW014	Native forest	Gley	Within	8
Ruamāhanga	GW020	Native forest	Pallic	Within	11
Ruamāhanga	GW029	Native bush	Pallic	Within	17
Ruamāhanga	GW039	Native forest	Recent	Within	16
Kāpiti Coast	GW045	Native forest and bush	Brown	Within	7
Kāpiti Coast	GW049	Native forest and bush	Recent	Within	14
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within	16
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within	13
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within	8
Ruamāhanga	GW102	Native forest	Recent	Within	17
Ruamāhanga	GW104	Native forest and bush	Pallic	Within	16
Kāpiti Coast	GW110	Native forest and bush	Brown	Within	6
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within	11

Copper (Cu)

Table A2.8: Copper results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Eco-SGV	Copper (mg/kg)
Kāpiti Coast	GW007	Native forest	Brown	Within sensitive limits	8
Kāpiti Coast	GW009	Native bush	Brown	Within sensitive limits	5
Kāpiti Coast	GW011	Native forest	Recent	Within sensitive limits	18
Ruamāhanga	GW014	Native forest	Gley	Within sensitive limits	9
Ruamāhanga	GW020	Native forest	Pallic	Within sensitive limits	10
Ruamāhanga	GW029	Native bush	Pallic	Within sensitive limits	4
Ruamāhanga	GW039	Native forest	Recent	Within sensitive limits	13
Kāpiti Coast	GW045	Native forest and bush	Brown	Within sensitive limits	4
Kāpiti Coast	GW049	Native forest and bush	Recent	Within sensitive limits	18
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within sensitive limits	18
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within sensitive limits	5
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within sensitive limits	4
Ruamāhanga	GW102	Native forest	Recent	Within sensitive limits	15
Ruamāhanga	GW104	Native forest and bush	Pallic	Within sensitive limits	14
Kāpiti Coast	GW110	Native forest and bush	Brown	Within sensitive limits	5
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within sensitive limits	11

Lead (Pb)

Table A2.9: Lead results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Eco-SGV	Lead (mg/kg)
Kāpiti Coast	GW007	Native forest	Brown	Within	9.4
Kāpiti Coast	GW009	Native bush	Brown	Within	9.5
Kāpiti Coast	GW011	Native forest	Recent	Within	28.0
Ruamāhanga	GW014	Native forest	Gley	Within	11.2
Ruamāhanga	GW020	Native forest	Pallic	Within	12.8
Ruamāhanga	GW029	Native bush	Pallic	Within	9.8
Ruamāhanga	GW039	Native forest	Recent	Within	19.4
Kāpiti Coast	GW045	Native forest and bush	Brown	Within	5.1
Kāpiti Coast	GW049	Native forest and bush	Recent	Within	27.0
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within	20.0
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within	12.7
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within	8.0
Ruamāhanga	GW102	Native forest	Recent	Within	29.0
Ruamāhanga	GW104	Native forest and bush	Pallic	Within	29.0
Kāpiti Coast	GW110	Native forest and bush	Brown	Within	14.4
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within	12.1

Nickel (Ni)

Table A2.10: Nickel results are compared against New Zealand Water and Wastes Association (NZWWA) limits, see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	NZWWA limit	Nickel (mg/kg)
Ruamāhanga	GW014	Native forest	Gley	Within	6.4
Kāpiti Coast	GW007	Native forest	Brown	Within	7.1
Kāpiti Coast	GW009	Native bush	Brown	Within	3.6
Kāpiti Coast	GW011	Native forest	Recent	Within	13.6
Ruamāhanga	GW020	Native forest	Pallic	Within	8.6
Ruamāhanga	GW029	Native bush	Pallic	Within	14.1
Ruamāhanga	GW039	Native forest	Recent	Within	15.5
Kāpiti Coast	GW045	Native forest and bush	Brown	Within	3.5
Kāpiti Coast	GW049	Native forest and bush	Recent	Within	15.3
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within	10.3
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within	5.0
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within	5.0
Ruamāhanga	GW102	Native forest	Recent	Within	13.8
Ruamāhanga	GW104	Native forest and bush	Pallic	Within	16.8
Kāpiti Coast	GW110	Native forest and bush	Brown	Within	3.5
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within	7.4

Zinc (Zn)

Table A2.11: Zinc results are compared against draft eco-soil guideline values (Eco-SGVs), see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Eco-SGV	Zinc (mg/kg)
Kāpiti Coast	GW007	Native forest	Brown	Within sensitive limits	52
Kāpiti Coast	GW009	Native bush	Brown	Within sensitive limits	42
Kāpiti Coast	GW011	Native forest	Recent	Within sensitive limits	98
Ruamāhanga	GW014	Native forest	Gley	Within sensitive limits	52
Ruamāhanga	GW020	Native forest	Pallic	Within sensitive limits	61
Ruamāhanga	GW029	Native bush	Pallic	Within sensitive limits	34
Ruamāhanga	GW039	Native forest	Recent	Within sensitive limits	72
Kāpiti Coast	GW045	Native forest and bush	Brown	Within sensitive limits	24
Kāpiti Coast	GW049	Native forest and bush	Recent	Within sensitive limits	100
Te Awarua-o-Porirua	GW052	Native bush	Brown	Within sensitive limits	57
Te Awarua-o-Porirua	GW057	Native bush	Brown	Within sensitive limits	25
Te Awarua-o-Porirua	GW059	Native bush/scrub	Recent	Within sensitive limits	26
Ruamāhanga	GW102	Native forest	Recent	Within sensitive limits	93
Ruamāhanga	GW104	Native forest and bush	Pallic	Within sensitive limits	101
Kāpiti Coast	GW110	Native forest and bush	Brown	Within sensitive limits	39
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Within sensitive limits	56

Bulk density

Table A2.12: Bulk density results benchmarked against the target range of 'Loose' to 'Compact', see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Soil order	Rating	Bulk density (t/m ³)
Kāpiti Coast	GW007	Native forest	Allophanic	Adequate	0.69
Kāpiti Coast	GW009	Native bush	Allophanic	Loose	0.57
Kāpiti Coast	GW011	Native forest	Semi-arid, pallic and recent	Loose	0.89
Ruamāhanga	GW014	Native forest	All other	Very loose	0.54
Ruamāhanga	GW020	Native forest	Semi-arid, pallic and recent	Loose	0.68
Ruamāhanga	GW029	Native bush	Semi-arid, pallic and recent	Adequate	0.94
Ruamāhanga	GW039	Native forest	Semi-arid, pallic and recent	Loose	0.80
Kāpiti Coast	GW045	Native forest and bush	Allophanic	Compact	1.02
Kāpiti Coast	GW049	Native forest and bush	Semi-arid, pallic and recent	Adequate	0.91
Te Awarua-o-Porirua	GW052	Native bush	Allophanic	Adequate	0.88
Te Awarua-o-Porirua	GW057	Native bush	Allophanic	Adequate	0.70
Te Awarua-o-Porirua	GW059	Native bush/scrub	Semi-arid, pallic and recent	Adequate	1.19
Ruamāhanga	GW102	Native forest	Semi-arid, pallic and recent	Adequate	0.94
Ruamāhanga	GW104	Native forest and bush	Semi-arid, pallic and recent	Loose	0.88
Kāpiti Coast	GW110	Native forest and bush	Allophanic	Loose	0.46
Kāpiti Coast	GW113	Native forest and bush	Allophanic	Adequate	0.67

Macroporosity

Table A2.13: Macroporosity results benchmarked against the target range of 'Adequate', see [benchmarking](#) for more information.

Whaitua	Site code	Land use	Rating land use	Rating	Macroporosity (% v/v)
Kāpiti Coast	GW007	Native forest	Forestry	High	35.0
Kāpiti Coast	GW009	Native bush	Forestry	High	37.9
Kāpiti Coast	GW011	Native forest	Forestry	Adequate	16.0
Ruamāhanga	GW014	Native forest	Forestry	High	34.2
Ruamāhanga	GW020	Native forest	Forestry	Adequate	28.4
Ruamāhanga	GW029	Native bush	Forestry	Adequate	26.0
Ruamāhanga	GW039	Native forest	Forestry	Adequate	19.6
Kāpiti Coast	GW045	Native forest and bush	Forestry	Adequate	20.8
Kāpiti Coast	GW049	Native forest and bush	Forestry	Adequate	23.0
Te Awarua-o-Porirua	GW052	Native bush	Forestry	Adequate	20.7
Te Awarua-o-Porirua	GW057	Native bush	Forestry	Adequate	28.0
Te Awarua-o-Porirua	GW059	Native bush/scrub	Forestry	Adequate	15.3
Ruamāhanga	GW102	Native forest	Forestry	Adequate	16.1
Ruamāhanga	GW104	Native forest and bush	Forestry	Adequate	24.3
Kāpiti Coast	GW110	Native forest and bush	Forestry	High	47.1
Kāpiti Coast	GW113	Native forest and bush	Forestry	High	31.3