Appendix 10: Land and Water Science Soil Classification Report

Land and Water Science Ltd.
231 Dee Street
Invercargill 9810
New Zealand

www.landwaterscience.co.nz

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Attention: Christine McMillian, Bonish, on behalf of Tulloch Ltd

Soil Assessment at 805, 815 and 819 North Road

1 Introduction

Bonish on behalf of Tulloch Ltd, has requested a soil assessment at 805, 815, and 819 North road, Invercargill, to support an application to rezone the land from rural to industrial zone 1. The soil assessment is to confirm the existing soil type at the site and assess the Land Use Capability class (LUC). The site consists of three properties with a total area of 9.7 hectares. The current land use of the site is a mixture of rural (lifestyle block) and industrial use (wool store). The soil was described at three locations within the area (Figure 1). The following report details the current mapped soil types and soil assessment undertaken at the location to identify the soil and corresponding LUC class.



Figure 1. Site location. Soil observation pits are numbered 1 to 3.

2 Data Review

The site is predominantly flat to gently rolling with an approximately 7-degree slope to a lower terrace in the east (Figure 2). The elevation change across the property is 13 m above sea level in the west and 7 m above sea level in the east. There are no permanent waterways on the property, which backs on to a drainage ditch on the eastern boundary. There is a swale (ephemeral stream channel) in the northwest of the site that drains to the west.

Soil information at the location is available from two datasets, Fundamental Soils Layer (FSL) and Topoclimate South (2002) (Figure 2). The LUC classification is mapped according to the FSL.



Figure 2. Elevation of the property showing an upper terrace in the west and lower terrace in the east. Soil maps for the site are shown as outlines with Fundamental Soils Layer indicated in blue and Topoclimate South indicated in red.

2.1 Soil Classification

The soil according to the Fundamental Soils Layer, the upper terrace to the west is mapped as a Waikiwi Soil Series which is classified as a Typic Firm Brown; stoneless; silty soil according to the New Zealand Soil Classification (NZSC). Waikiwi soils form in wind-deposited silt (loess). They are typically well drained, deep and have silt loam textures.

More recently the soils were mapped by Topoclimate South soil survey in 2002. The western upper terrace is in an area identifying Mokotua, Waikiwi, and Woodlands soil series (MtU1 + WiU1 + Wdu1). The dominant soil, Mokotua is classified as Mottled-acidic Orthic Brown; stoneless; silty soil according to the NZSC. Mokotua soils are found on high terraces and are formed in deep wind-deposited loess. They are strongly mottled, have imperfect to poor drainage, and silt loam textures. Secondary soils include Waikiwi and Woodlands (Mottled Firm Brown; stoneless; silty).

In the east of the site, both FSL and Topoclimate South map the soil as Dacre which is classified as an Acidic Recent Gley; stoneless; silty soil in the NZSC. Dacre soils are located on floodplains of minor streams formed in fine alluvium from rewashed loess. They are deep to moderately deep, poorly drained, and have silty textures. The Topoclimate South soil map also identifies Titipua as a secondary soil. Titipua soils are classified as Peaty Orthic Gley; stoneless; clayey over silty. They are

located on flood plains and the margins of peat swamps. The soils are moderately deep and poorly drained and have silty to silty clay textures.

2.2 LUC Class

The upper terrace in the west of the property is described in the LUC as “flat to undulating loess mantled alluvial terraces and recent floodplains below 300m asl with moderately deep Brown (lowland yellow brown earth) and Recent soils in cool, moderate (800-1600 mm) rainfall inland districts.” The LUC class is identified as Class 2 (2c 2) which is defined as land with slight climate limitations for arable use, whilst suitable for cultivated crops, pasture or forestry. Climate limitations such as coldness, frost frequency, and salt-laden onshore winds limits production.

The rock type is undifferentiated floodplain alluvium. The soil is mapped as 33 (Waikiwi series). The slope class is A (0-3 degrees is flat to gently undulating). The erosion class is 0 with a potential 0-1 Sb (slight streambank erosion). The vegetation cover is P1 and P3 (high producing pasture and short tussock grassland).

The lower terrace in the east of the property is flat to gently undulating floodplains and low terraces with Gley or Recent Gley (gley and recent) soils with moderately high water tables in cool, moderate to high (800 to >1600 mm) rainfall districts. The LUC class is identified as Class 3 (3w 3) which identifies it as land with moderate wetness limitation for arable use and suitable for cultivated crops, pasture or forestry. Soil wetness resulting from poor drainage or a high water table, or from frequent overflow limits production.

The rock type is undifferentiated floodplain alluvium. The soil is mapped as 89f (Dacre series). The slope class is A (0-3 degrees flat to gently undulating). Erosion class is 0 (negligible). The vegetation cover is P1 p2 h2 (high producing pasture, low producing pasture, and rushes and sedges).

3 Site Visit

The site was visited by Dr Lisa Pearson on the 1st of May 2024 (Figure 3). The soils were profiled at 3 locations in soil pits (Figure 1) and a composite soil sample (0-75 mm depth) was collected at approximately 30 random locations across the site for soil chemical analysis. The vegetation at the site is improved pasture, flax, rushes, sedges and poplar trees. The slope is flat to gently rolling (approximately 7 degrees). There is no evidence of visible erosion at the site.





Figure 3. Site photos showing vegetive cover.

3.1 Soil Profile and Site Map

Pits 1 and 2 are located on the upper terrace and Pit 3 on the lower terrace. Pits 1 and 2 have similar soil profiles matching the description of the Mokotua undulating deep soil phase, an imperfectly drained silt loam soil (Table 1 and 2). Pit 1 has a deeper soil profile while Pit 2 is moderately deep with a clay base. The soil at Pit 3 matches the profile description of a Dacre undulating moderately deep soil (Table 3). The water table was shallow at approximately 0.8 m depth.

Table 1. Pit 1 Profile description.

	0 – 20 cm	Light brown silt loam, weak soil strength, moderately developed fine polyhedral peds, abundant roots.
	20 – 34 cm	Light yellow brown silt loam, few orange mottles, weak soil strength, moderately developed polyhedral peds, few roots.
	34 – 74 cm	Yellow brown silt loam with orange mottles, firm soil strength, moderately developed structure, few roots.
	74 cm +	Yellow brown silty clay, firm soil strength, weakly developed structure, no roots.

Table 2. Pit 2 Profile description.

	0 – 30 cm	Light brown silt loam, weak soil strength, moderately developed fine to moderate polyhedral peds, abundant roots.
	30 – 47 cm	Light yellow brown silt loam, common orange mottles, weak soil strength, moderately developed fine polyhedral peds, few roots.
	47 – 110 cm	Yellow brown silt loam, common orange mottles, firm soil strength, weakly developed fine polyhedral peds, no roots.
	110 cm +	Yellow brown silty clay, firm soil strength, weakly developed structure, no roots.

Table 3. Pit 3 Profile description.

	0 – 29 cm	Dark brown silt loam, weak soil strength, moderately developed polyhedral peds, abundant roots.
	29 – 57 cm	Dark brown silt loam, common orange mottles, weak soil strength, moderately developed fine polyhedral peds, few roots.
	57 – 87 cm	Light grey sandy silt with abundant yellow mottles, firm weak structure, dead roots.
	87 – 100 cm	Brown organic material in loose gravel matrix.
	100 cm +	Blue grey rounded gravels in sandy matrix. Strongly anoxic smelling.

3.2 Soil quality

The soil quality was assessed using Manaaki Whenua Landcare Research's online tool for soil quality (https://sindi.landcareresearch.co.nz/). The soil is in the low range for Olsen P (available phosphorus), and optimal for pH, and adequate for Total Carbon, Total Nitrogen, and Mineralisable Nitrogen (Table 4). Bulk density is estimated at approximately 0.76 g/m^3 using Hill Laboratories volume weight method.

Table 4. Soil quality at Tulloch site, North Road.

Soil Quality Indicator	Analysis	Concentration	Range
Acidity	pH	6.0	Optimal
Fertility	Olsen P	18 mg/l	Low
Organic resources	Mineralisable N	149 mg/l	Adequate
	Total C	6.6 %	Normal
	Total N	0.57 %	Adequate
Physical resources	Bulk density	0.76 g/ml	Loose - Adequate

3.3 LUC Class

The LUC classification for the Mokotua soil is Class 3 (3c 2). This means the mapped LUC class of Class 2 on the upper terrace is unlikely at the location given the prevalence of fine textured, slowly permeable, imperfectly drained soils. The slope class is also mixed A + B across the Mototua deep silt loam on the upper terrace (Figure 4). The Mokotua soils will have limited versatility for arable and horticulture due to inadequate aeration during wet periods. Mokotua soils have moderate versatility for intensive pasture due to inadequate aeration during wet periods with a risk of short-term water logging after heavy rain. Soil fertility would also need to be increased at the site to support intensive pasture.

The lower terrace LUC class of Class 3 (3w 3) is consistent with the properties of the Dacre soil. Dacre soils have limited versatility for arable, horticulture and forestry and moderate versatility for intensive pasture due to inadequate aeration during wet periods and the risk of short-term water logging after heavy rain.

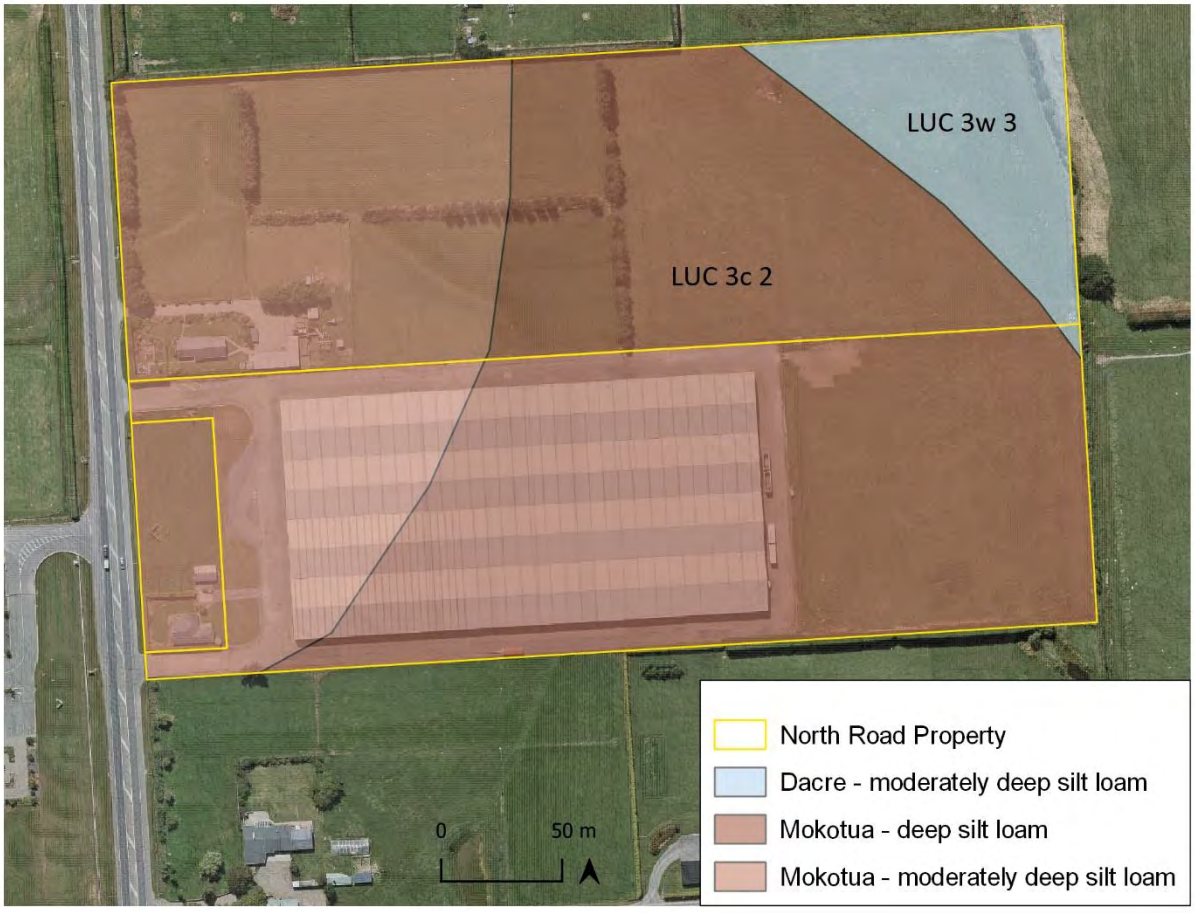


Figure 4. Revised soil map for the North road property. The soils on this property fit the LUC description for Class 3 land.

4 Summary

The soils identified at the site are consistent with the Topoclimate South soil mapping identifying variations of the Mokotua and Dacre soil series. It is noted that the identification of the Mokotua soil series changes the assigned LUC class at the site to Class 3 across the entire property. Soil quality is adequate for the current land use of low intensity pasture grazing, however available P is low for

long term use without the addition of phosphorus fertiliser. The soil at the site is limited by aeration and water logging after heavy rainfall. The size of the pastoral area (< 5 hectares) is also a limiting factor for economic primary production.

If you have any questions regarding the information provided in this letter, please contact Lisa Pearson on 0220199799 or via email at lisa@landwatersci.net.

Yours sincerely



Dr Lisa Pearson
Lead Earth and Environmental Scientist
Land and Water Science

References

Topoclimate South (2002). Topoclimate Southland Soil Technical Data Sheets. Crops for Southland.