Land Use Capability classification assessment

Lot 2 DP 567678 + Part Lot 1 DP 21055 + Lot 2 DP 21055 + Part Lot 3 DPS 14362, Station Road, Matamata 3472

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Contents

1. Introduction

An on-site Land Use Capability (LUC) classification assessment of 172 Station Road (13.5 ha: Lot 2 DP 567678, hereafter Area 1) and 247 Station Road (70 ha: Part Lot 1 DP 21055 + Lot 2 DP 21055 + Part Lot 3 DPS 14362, hereafter Area 2), Matamata 3472, totalling 83.5 ha (**Figure 1**), was undertaken in order to confirm the LUC units at property scale and the site's suitability for the productive use including the proposed solar farm.

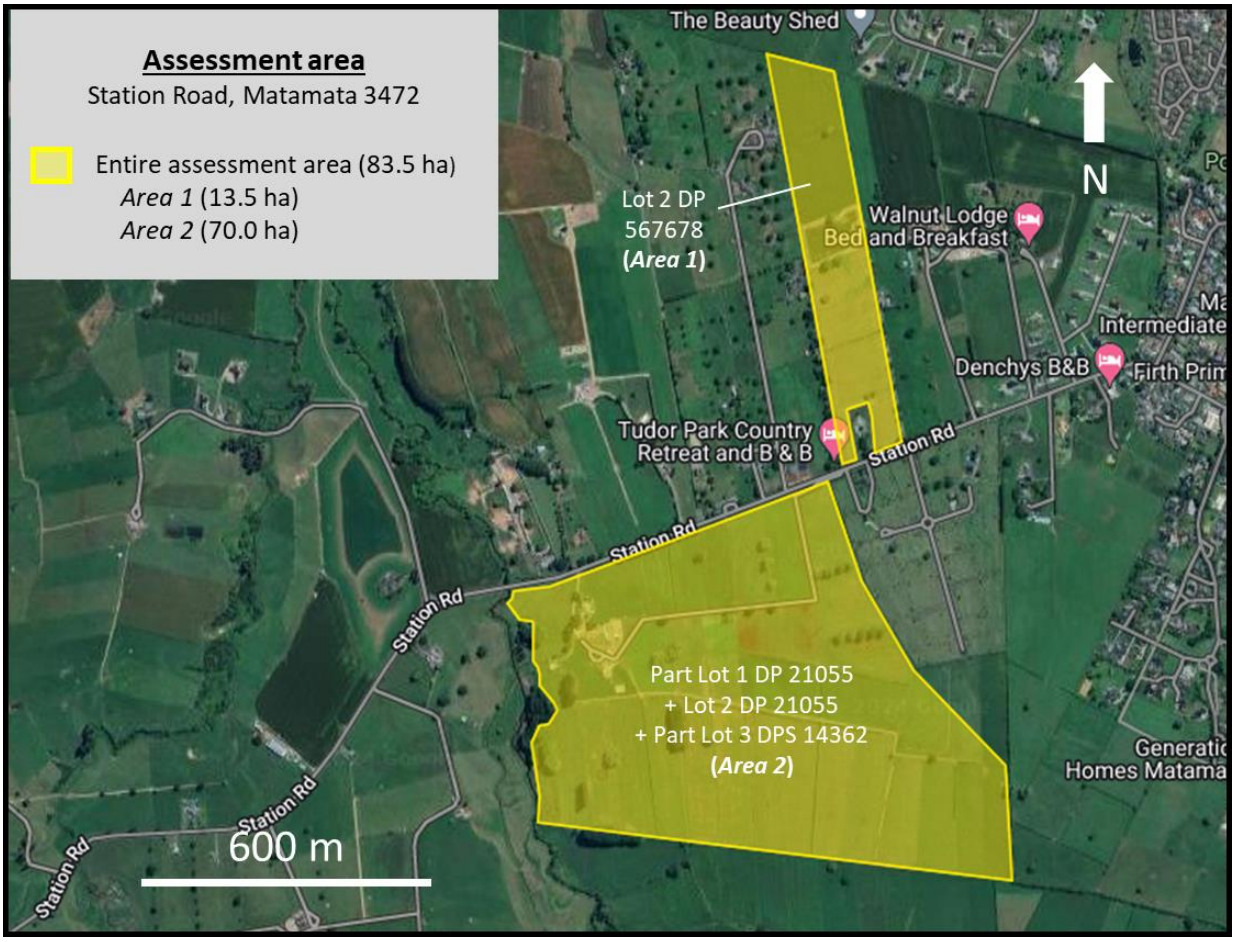


***Figure 1**. Assessment areas 1 and 2, Station Road, Matamata 3472.*

2. LUC background

LUC classification is the common method for assessing land in New Zealand; it uses the Land Use Capability System, which is part of the New Zealand Land Resource Inventory (NZLRI) as produced by the Water and Soil Division of the Ministry of Works, for the National Water and Soil Conservation Organization during the 1970s. In 2009 the 3rd Edition of the LUC Survey Handbook[1] was published and has been used for this assessment. The LUC uses a systematic arrangement of different kinds of land according to those properties that determine its capacity for permanent sustained production, where the word "capability" is used in the sense of "suitability for productive use" after taking into account the physical limitations the land may have.

[1] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand.

The LUC classification is specifically designed to provide an index of versatility. There are eight LUC classes (**Figure 2**) arranged in order of increasing degree of limitation or hazard to use; and a decreasing order of use, from Class 1 to 8.

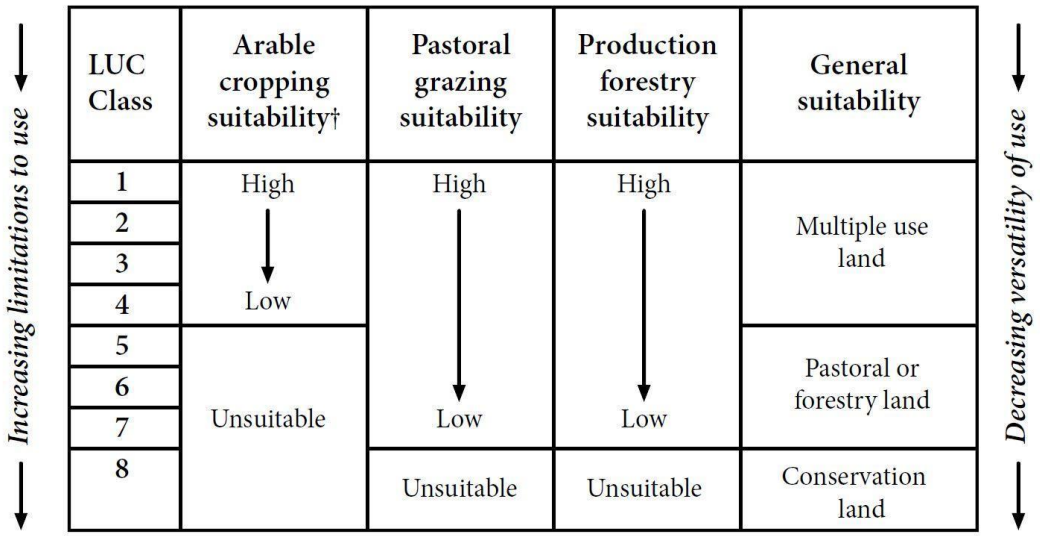


***Figure 2**. Increasing limitations to use and decreasing versatility of use from LUC Class 1-8.*

Within each LUC Class the land is assigned a subclass according to the kind of limitation (e = Erodibility, w = Wetness, s = Soil limitations within the rooting zone, c = Climate). At the most detailed level LUC groups together those inventory units which respond similarly to the same management, and which are suitable for the same kinds of crops, pasture, or forest species with the same potential yield and which require the application of the same conservation measures.

The LUC worksheets were compiled from all relevant databases of land resource documents available at the time, consequently some sheets suffered from a lack of information that only detailed soil and geological surveys could have provided. Therefore, there are **scale limitations**, which need to be considered, especially when interpretation is required at the individual property scale.

The LUC units displayed on the 1970s worksheets remain reasonably robust but are subject to change. For example, the second edition (1993) Northland region worksheets were mapped at the more detailed scale of 1:50 000, replacing the earlier first edition 1:63,360 maps. In the first edition, 69 LUC units were defined compared with 91 LUC units in the second edition - about 60 of the first edition classification units changed.

The average area for a map unit is 125 ha, however, at the 1:50 000 scale of mapping it is theoretically possible to delineate an unhooked inventory map unit (no vinculum) area of 60 ha (60 ha = 600 m by 1000 m) provided the geology, soil, vegetation, erosion and slope are uniform.

The **purpose of this background information** is to illustrate and emphasise that the NZLRI information provides excellent physical base data for planners (a planning tool) but is not fit for purpose as a plan (map) unless undertaken at the correct scale. This assessment fulfils that purpose.

3. Non-productive land and modified areas

For an accurate assessment of LUC classification for a property, the assessment should be based on the current condition of the area (i.e. mapped in current state). This is important because some land management practices (e.g. the placement of tracks, excavation of drains, and general earthworks) result in irreversible changes to the soil (i.e. changes other than those that can be remediated by management practices and return the soil to its intrinsic state). These areas are referred to as non-productive land. Examples of non-productive land include native vegetation, wetlands and riparian areas, tracks, buildings and curtilage.

Non-productive land can include areas where the soil has been modified by truncation, placement of fill or extensive mixing. Where these areas do not resemble a functioning soil, the areas are not considered productive land (i.e. they are non-productive land). Where these areas do resemble a functioning soil (such as the reinstatement of a soil profile following gravel extraction) the land can be assigned a LUC classification.

For this assessment the productive area of the site (to which the LUC classification can be applied) is the site area excluding the non-productive land area.

4. National Policy Statement for Highly Productive Land 2022

The National Policy Statement for Highly Productive Land 2022[2] (NPS-HPL) came into force on the 17th of October 2022 (clause 1.2(1)).

"Highly productive land" is defined as:

> means land that has been mapped in accordance with clause 3.4 and is included in an operative regional policy statement as required by clause 3.5 (but see clause 3.5(7) for what is treated as highly productive land before the maps are included in an operative regional policy statement and clause 3.5(6) for when land is rezoned and therefore ceases to be highly productive land).

Our understanding is that NPS-HPL clause 3.5(7) applies because maps produced in accordance with clause 3.4 have not yet been included in an operative regional policy statement as required by clause 3.5. Clause 3.5(7) says:

> (7) Until a regional policy statement containing maps of highly productive land in the region is operative, each relevant territorial authority and consent authority must apply this National Policy Statement as if references to highly productive land were references to land that, at the commencement date:
>
> (a) is
>
> (i) zoned general rural or rural production; and
>
> (ii) LUC 1, 2, or 3 land; but
>
> (b) is not:
>
> (i) identified for future urban development; or
>
> (ii) subject to a Council initiated, or an adopted, notified plan change to rezone it from general rural or rural production to urban or rural lifestyle.

The NPS-HPL includes the following definition of LUC 1, 2, or 3 land:

> **"LUC 1, 2, or 3 land** means land identified as Land Use Capability Class 1, 2, or 3, as mapped by the New Zealand Land Resource Inventory or by any more detailed mapping that uses the Land Use Capability classification".

The estimates of highly productive land in the assessment are based on Land Use Capability Class 1, 2, or 3, as mapped by the New Zealand Land Resource Inventory.

The on-site LUC assessment follows the Land Use Capability (LUC) classification criteria as prescribed by the Land Use Capability Survey Handbook (LUC Handbook)[3].

5. Regional scale soil and LUC map information (1:50,000 scale)

An initial desktop LUC assessment was undertaken for the entire assessment area. Available map information, soil reports and geospatial data included:

[2] National Policy Statement for Highly Productive Land 2022. September 2022. Effective from the 17th of October 2022.
[3] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand.

- New Zealand Land Resource Inventory (NZLRI) layers, including the New Zealand Fundamental Soil Layer (NZFSL) and Land Use Capability Layer (providing map units of dominant soil type and LUC unit)[4]
- McLeod (1992) soil map of the Matamata District[5]
- S-Map Online (providing map units of Soil Siblings)[6]

Of the available map information sources, the S-Map Online soil map information, McLeod soil map, NZFSL and NZLRI map information are at a regional scale (approximately 1:50,000 scale).

NZLRI (1:50,000 scale) soil and LUC classification

Based on the available NZLRI and NZFSL map information the soils and LUC units in the assessment area are mapped as shown in **Figure 3**. Available NZLRI map information maps the property[7] as predominantly the Waihou sandy loam-Te Puninga silt loam complex on flat to undulating slopes. The parent material of these soils is the Hinuera Formation, namely, rhyolitic alluvial deposits deposited by the Ancestral Waikato River[8].

Area 1 contains 100% well drained to imperfectly drained Waihou sandy loam-Te Puninga silt loam complex (Allophanic Soil) on flat to gently undulating slopes (0-3°) with an LUC classification of LUC 2s1.

The larger **Area 2** is also dominated by Waihou sandy loam-Te Puninga silt loam complex (greater than 99% of the area), occurring on flat to gently undulating slopes (0-3°) in the central and northeast of Area 2; and on flat to undulating slopes (0-7°) in the west and south of the Area 2. Both of these map units have a LUC classification of LUC 2s1. There is a very small pocket of imperfect to poorly drained Ohinemuri silt loam (Recent Soil) in the southwest corner on flat to gently undulating slopes with a LUC classification of 3w1 (**Table 1**).

The approximate % cover of these regional NZLRI derived LUC units is shown in **Table 1**. The estimates were made using Google MyMaps.

***Table 1**. Approximate % cover of regional NZLRI derived LUC units (estimated from **Figure 3**) in Area 1 and Area 2 and NPS-HPL highly productive land.*

LUC unit	NPS - HPL	Area of Area 1 (%)*	Area of Area 2 (%)*	Area of total assessment area ha (%)*
2s1	HPL	100	>99	83.50 (>99)
3w1	HPL	-	<1	0.02 (<1)

*% areas rounded to whole number.

[4] https://lris.scinfo.org.nz/layer/48076-nzlri-land-use-capability-2021/
[5] McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand, available via LRIS: https://lris.scinfo.org.nz/layer/48177-soil-survey-of-part-northern-matamata-county/
[6] https://smap.landcareresearch.co.nz/maps-and-tools/app/
[7] https://lris.scinfo.org.nz/layer/48134-nzlri-north-island-edition-2-all-attributes/
[8] McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand. DSIR Land Resources Scientific Report No. 18.

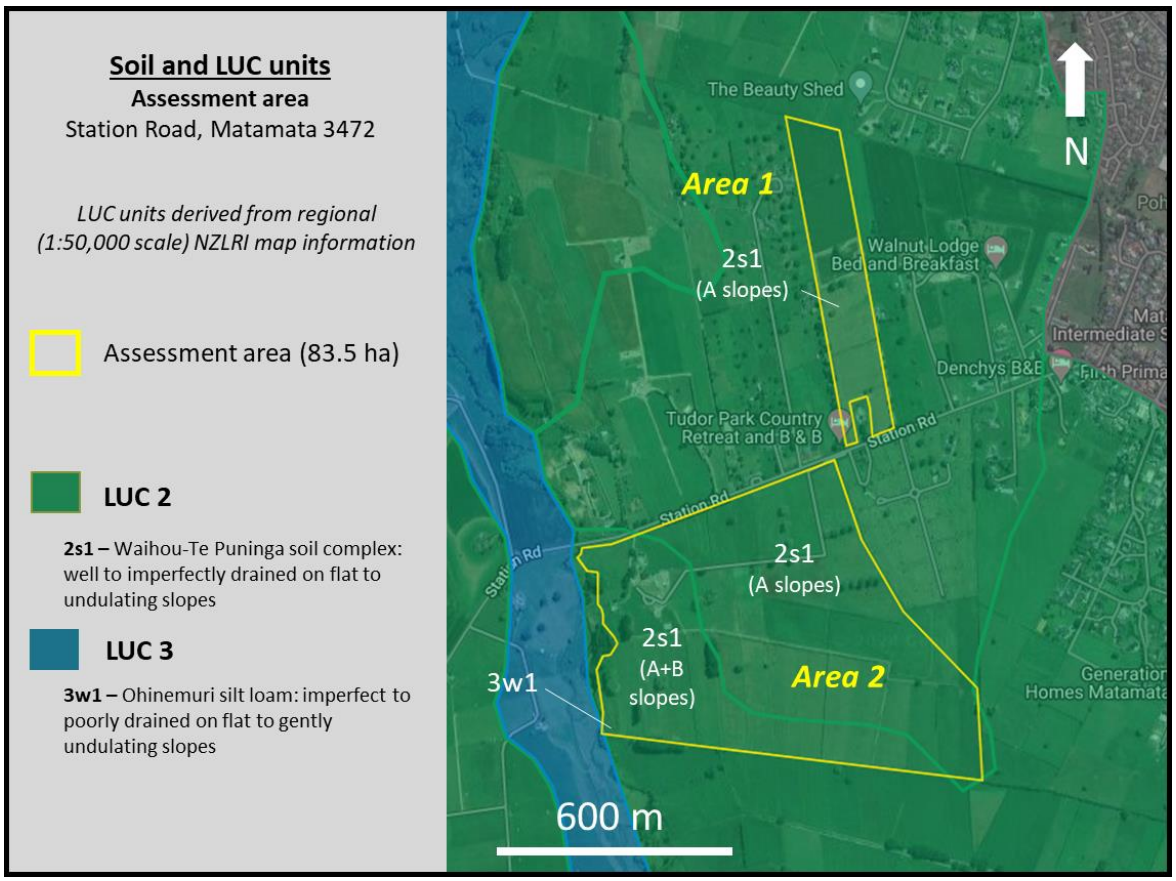


***Figure 3**. LUC units for the assessment Area 1 and 2, derived from available regional scale NZLRI map information.*

Based on the available NZLRI and NZFSL map information the majority of the assessment area is a mosaic of well drained to imperfectly drained Waihou-Te Puninga soil complex, on flat to undulating slopes and classified as LUC 2s1 (greater than 99% of the assessment area); with a very small area of imperfectly to poorly drained Ohinemuri silt loam on the southwestern boundary, classified as LUC 3w1 (less than 1% of the assessment area) (**Table 1**).

Based on the available 1:50,000 scale NZLRI information and applying the NPS-HPL, LUC units 2s1 and 3w1 land are considered highly productive land.

McLeod (1992) soil map

The McLeod (1992) soil map was produced at a scale accurate to 1:50,000. The soil map units for the assessment area are shown in **Figure 4**.

The soils identified by McLeod (1992) provide a more spatially detailed representation of the soils on the site than the NZLRI 1:50,000 soil map information. Soil complex map units are delineated out into individual soils, and as such the NZLRI 1:50,000 scale LUC 2s1 map unit is separated into separate soil polygons of the Te Puninga silt loam, Waitoa silt loam, Piarere silt loam, and Waihou silt loam soils (**Figure 4**). Subsequently, wetter areas of poorly drained Waitoa silt loam are shown in the north and eastern parts of assessment Area 1 and northeast of Area 2. An expanse of a peat soil, the Motumaoho peaty loam, is shown on the McLeod (1992) map, comprising more than a third of Area 2, but is absent in the NZLRI 1:50,000 scale map (**Figure 3**).

Due to the absence of land characteristics information (e.g. slope) in the McLeod (1992) soil map, there is currently no direct correlation with LUC units. Therefore, detailed on-site mapping was required to identify limitations that may affect the productivity of the site and determine an accurate LUC classification.

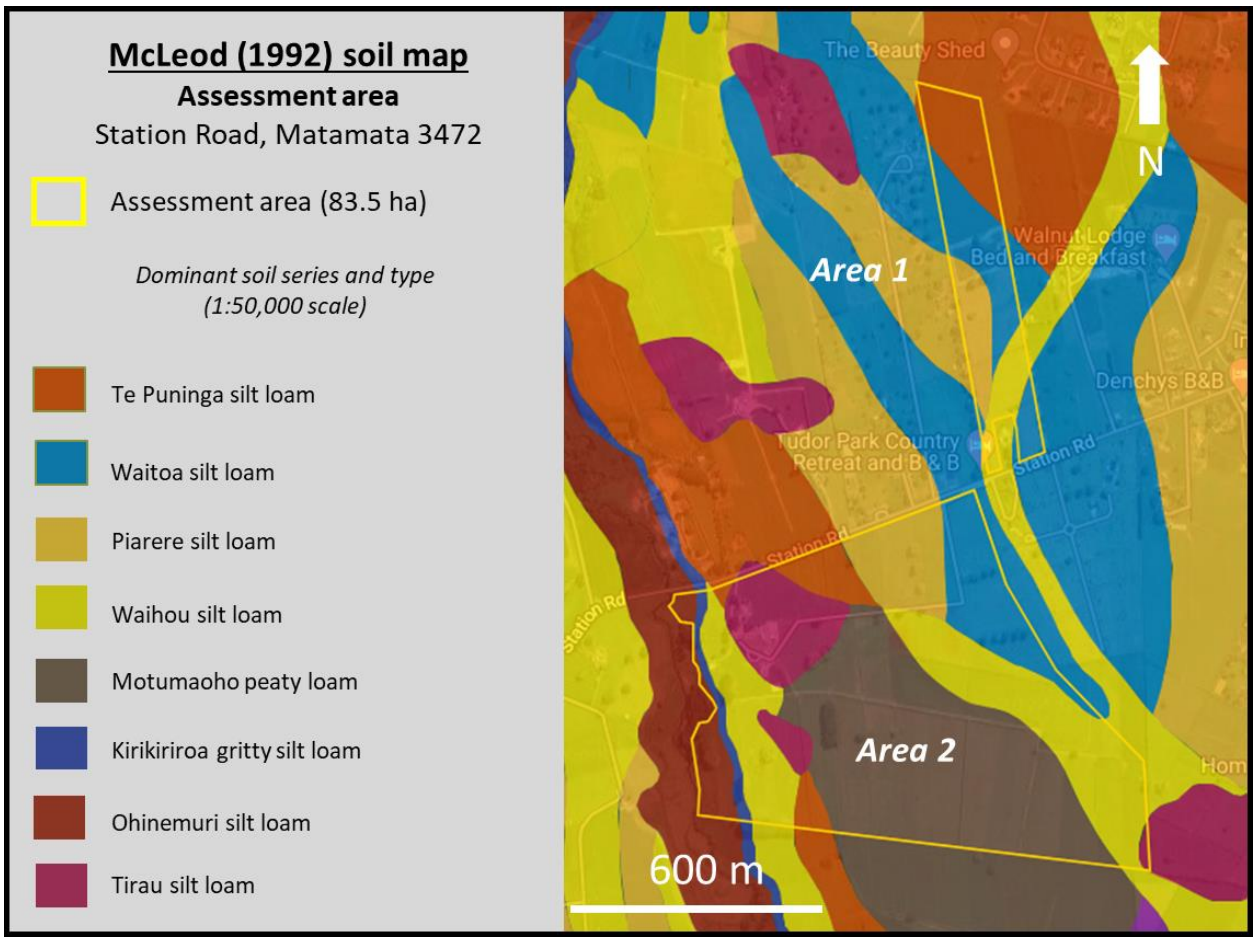


***Figure 4**. McLeod (1992) soil map units for the assessment area, Station Road, Matamata.*

S-Map Online

The S-Map soil map information is sourced from S-Map Online and is mapped at 1:50,000 scale. S-Map soil polygons are only available on the S-Map Online website. The soil names for each map unit are "soil siblings", with a probability of occurrence (%) and certainty rating provided for each soil sibling in a map unit. S-Map Online identified the majority of the soils in the assessment areas as Allophanic Soils, followed by Gley Soils, some Brown Soil and Recent Soils (**Figure 5A** and **6A** and **Table 2** and **3**). S-Map Online identified a higher proportion of well drained to imperfectly drained soils in assessment areas 1 and 2, with some areas of poorly drained soils (**Figure 5B** and **6B** and **Table 2** and **3**).

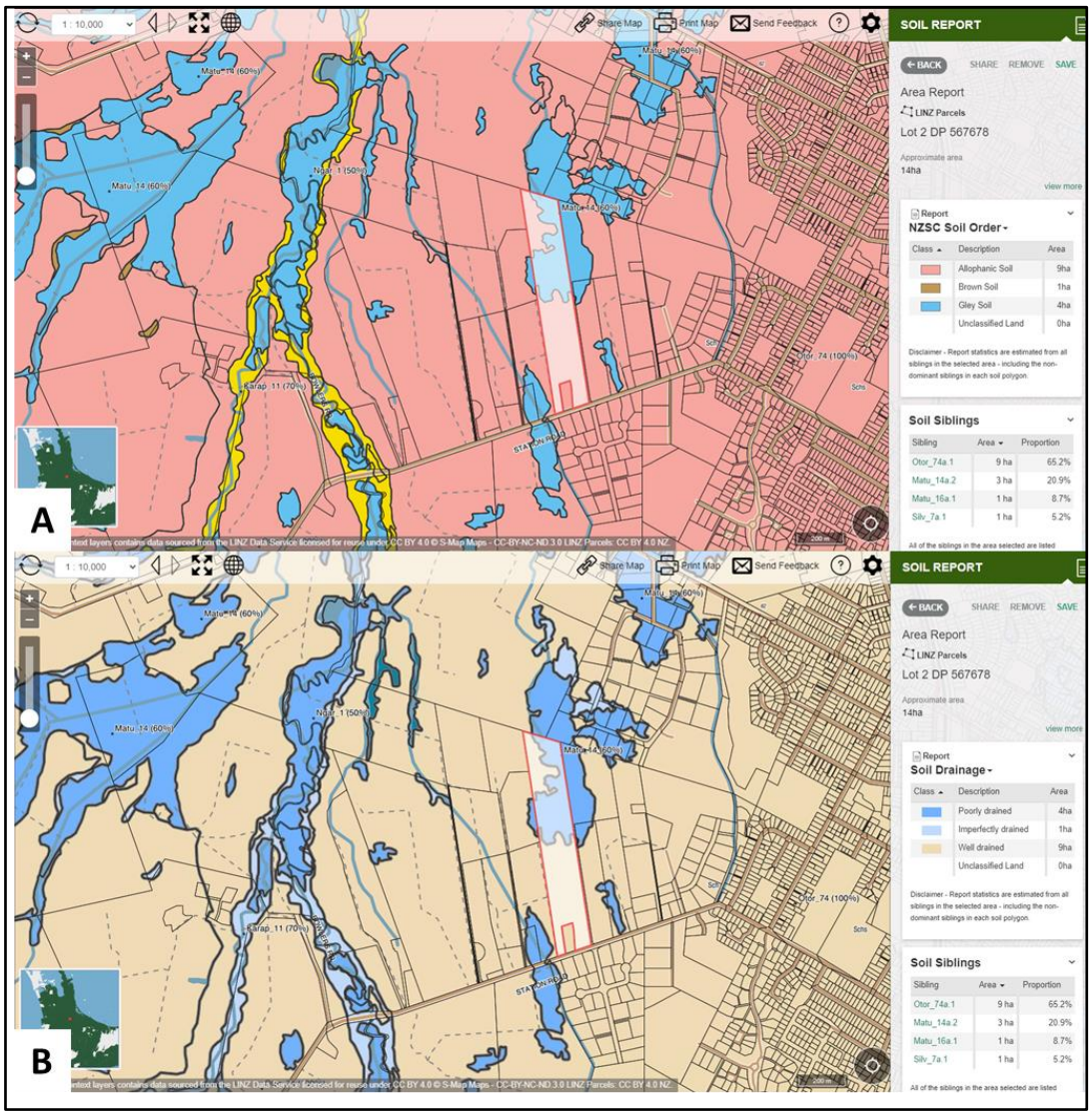


Figure 5. *A) S-Map soil (Soil Order and soil sibling) distributions; and B) S-Map soil drainage characteristics for assessment* ***Area 1****, Station Road, Matamata.*

Table 2 and **Table 3** provide a summary of the S-Map soil sibling map unit characteristics, including S-Map Family, S-Map Sibling, correlating Soil Series name, NZSC Soil Order, soil drainage, and their approximate proportions, for assessment **Area 1** and **Area 2**. All soils are deep (> 100 cm), have either silt loam or clay loam textures, with variable drainage. This information is derived from S-Map Online factsheets and can be sourced from the S-Map Online website[9]

[9] https://smap.landcareresearch.co.nz/maps-and-tools/app/

***Table 2**. S-Map soil sibling map unit characteristics for assessment Area 1, Station Road, Matamata.*

S-Map Family	S-Map Sibling	Soil Series name	NZSC (Soil Order)	Soil depth	Soil drainage	Proportion (%)
Otorohanga	Otor_74a.1	Waihou	Allophanic (LOT)	Deep (> 1m)	Well drained	65.2
Matuku	Matu_14a.2	Waitoa	Gley (GOA)	Deep (> 1m)	Poorly drained	20.9
Matuku	Matu_16a.1	Waitoa	Gley (GOA)	Deep (> 1m)	Poorly drained	8.7
Silverdale	Silv_7a.1	Bruntwood	Brown (BOM)	Deep (> 1m)	Imperfectly drained	5.2

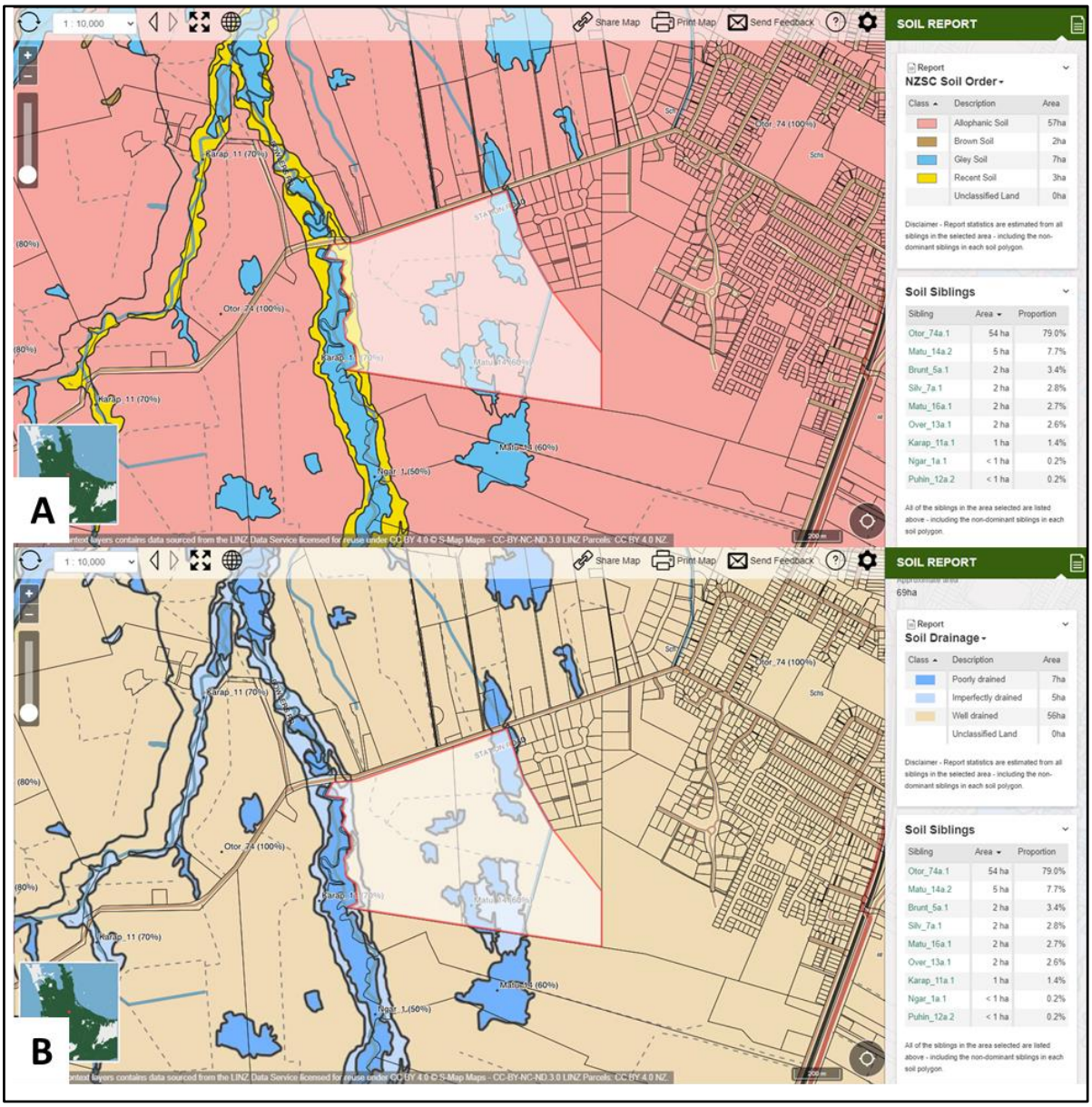


***Figure 6**. A) S-Map soil (Soil Order and soil sibling) distributions; and B) S-Map soil drainage characteristics for assessment **Area 2**, Station Road, Matamata.*

***Table 3**. S-Map soil sibling map unit characteristics for assessment Area 2, Station Road, Matamata.*

S-Map Family	S-Map Sibling	Soil Series name	NZSC (Soil Order)	Soil depth	Soil drainage	Proportion (%)
Otorohanga	Otor_74a.1	Waihou	Allophanic (LOT)	Deep (> 1m)	Well drained	79.0
Matuku	Matu_14a.2	Waitoa	Gley (GOA)	Deep (> 1m)	Poorly drained	7.7
Bruntwood	Brunt_5a.1	Te Puninga	Allophanic (LOM)	Deep (> 1m)	Imperfectly drained	3.4
Silverdale	Silv_7a.1	Bruntwood	Brown (BOM)	Deep (> 1m)	Imperfectly drained	2.8
Matuku	Matu_16a.1	Waitoa	Gley (GOA)	Deep (> 1m)	Poorly drained	2.7
Overlea	Over_13a.1	Ohinemuri	Recent (RFT)	Deep (> 1m)	Well drained	2.6
Karapoti	Karap_11a.1	Ohinemuri	RFM (Recent)	Deep (> 1m)	Imperfectly drained	1.4
Ngarua	Ngar_1a.a	Ohinemuri	Gley (GRT)	Deep (> 1m)	Poorly drained	0.2
Pukehina	Puhin_12a.2	-	Gley (GOT)	Deep (> 1m)	Poorly drained	0.2

The S-Map soil map information provides a more spatially detailed representation of the soils on the site than the NZLRI 1:50,000 soil map information. However, because of the absence of land characteristics information (e.g. slope) for the soil map units, there is currently no direct correlation with LUC units. Some, but not all, of the S-Map soil map units correlate to the soil series identified by the NZLRI map information. In this report, we have retained the DSIR's soil nomenclature (e.g. soil type and series names) in preference to the S-Map soil sibling nomenclature to allow for direct correlation of the soils with the LUC units provided by the NZLRI map information and associated NZLRI Extended Legends.

6. Regional scale map information limitations

The LUC classification can be applied (mapped) at any scale and regional scale LUC map units can differ from those identified at property scale. Property scale mapping is typically mapped at a scale between 1:5,000 and 1:15,000, while catchment and regional maps are generally mapped at 1:50,000 scale. The LUC Handbook sets out recommended mapping scales for inventory surveys and LUC mapping (p100).

Mapping LUC at a property scale can identify different LUC units (and map units) than depicted by regional scale LUC mapping. This is because property scale mapping includes more observations compared with regional scale mapping.

Soil and LUC maps are usually drawn at a specific scale depending on the smallest area of interest for a particular use and the density of field observations. For example, a 1:5,000 scale map requires on average four observations/ha while a 1:50,000 scale map requires 0.04 observations/ha (or four observations per 100 ha). With GIS tools and geospatial databases, it has become easy to manipulate maps, creating the temptation to rescale a map beyond its original scale of collection. Enlarging maps from their original scale will not provide the same accuracy or contain more detail than a coarse scale map. This is because they are not based on sufficient field observations to delineate soil map units at the finer scales portrayed. For the regional scale LUC map information, map unit boundaries may not align with the topography (slope) and other geographic features (such as rivers or terraces). Therefore, to correctly identify and map the LUC units at property scale, assessment using the LUC classification criteria described in the LUC Handbook is required.

7. On-site LUC classification assessment

Method

Landsystems undertook an on-site property scale LUC assessment of the 83.5 ha assessment area, Station Road, Matamata 3472, according to standard methods (Milne et al., 1993[10] and Lynn et al., 2009[9]). The on-site assessment was undertaken on Monday 29th of July, Friday 2nd of August, and Tuesday 6th of August 2024.

The on-site mapping does not constitute a detailed soil survey rather the focus is on characterisation of soil and land properties to apply the Land Use Capability classification, in turn used to determine the extend off NPS-HPL highly productive land on the site. However, recorded soil properties are used to identify limitations that may affect the productivity of the site.

The on-site assessment included soil observations by hand auger across the site using a free survey approach. Approximately 240 soil auger observations (excluding additional observations for checking boundaries) were used to determine the LUC map units. A higher proportion of observations were undertaken on the site area with potential highly productive land.

Observations of slope angle, topography and soil parent material were made over the relevant area. Soil augering up to 100 cm depth was used to assess soil properties such as soil horizons, drainage, plant root depths, depth to gravels, soil texture, structure, and colour.

All soils were assessed in current condition and areas with modified soils and areas considered to be non-productive land were identified and mapped. Soil series and types have been used for this report (as opposed to S-Map soil siblings) to provided clearer correlation with LUC units provided by the regional NZLRI LUC map information. LUC classification was assigned based on the criteria provided in Lynn et al. (2009). LUC units were assigned based on the closest fitting LUC unit provided by the regional NZLRI LUC map information.

Mapping scale

The number of soil auger observations across the 83.5 ha site equated to an observation density of 2.9 observations per hectare (or one observation per 0.35 ha). Considering the site area as a whole, this density of observations (using conventional mapping techniques) is sufficient to support a map scale of between 1:8,000 to 1:10,000.[11]

8. On-site LUC assessment

A generalised physiographic distribution of soils within the assessment area is shown below in **Figure 7**. The main landform units and soils of the assessment area include soils formed on high terrace plains (Waihou-Waitoa soil complex), soils formed on low terraces which are regularly inundated by floodwater (Ohinemuri Series), and soils formed on gully sides where streams have incised alluvial deposits (Kirikiriroa Steepland soils) (**Figure 7**).

[10] Milne JDG, Clayden B, Singleton P.L, Wilson AD. 1995. Soil Description Handbook. Lincoln, New Zealand, Manaaki Whenua Press. 157p.

[11] Page 12 - Grealish G. 2017. New Zealand soil mapping protocols and guidelines. Envirolink Grant: C09X1606. Manaaki Whenua –Landcare Research.

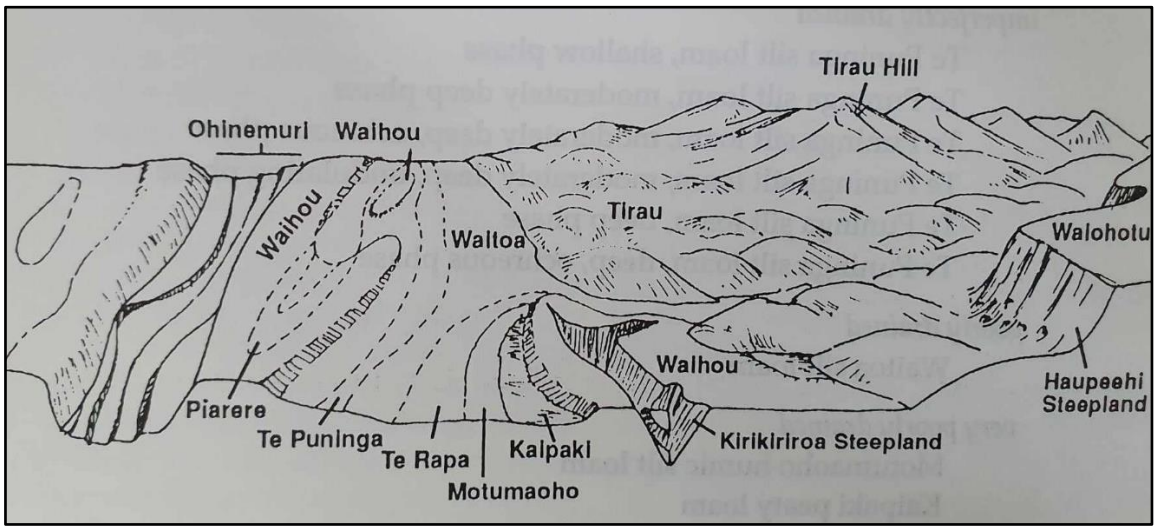


***Figure 7**. Schematic showing the distribution of soils across the Matamata district in relation to their physiographic position (from McLeod, 1992[12])*

A summary of the soils and LUC units identified in the assessment area are provided in **Table 4**. The main soils observed and examples of non-productive land in the assessment area are shown in **Figures 8-10**. The soil profiles should be considered example soil profiles for each soil as the profile for actual soil observed in the field at any given point may differ slightly from the example shown.

[12] Page 12 – McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand. DSIR Land Resources Scientific Report No. 18.

Table 4. *Soils and dominant LUC units identified for the assessment areas, Station Road, Matamata (in order of increasing limitations).*

Soil type (DSIR code+NZSC Soil Order)	Parent material	Texture profile	Slope class	Soil depth	Soil drainage	Dominant LUC unit (limitation)
Waihou silt loam (Allophanic Soil)	Rhyolitic alluvial deposits of the Hinuera Formation	Silt loam over silt or sand	A+B (0 -6°)	Deep (100+ cm)	Well drained	1s1 (soil)
Waihou-Te Puninga complex, *Waihou silt loam dominant* (Allophanic Soil)	Rhyolitic alluvial deposits of the Hinuera Formation	Silt loam over silt or sand	A+B (0 -6°)	Deep (100+ cm)	Well to imperfectly drained	2s1 (soil)
Waihou-Te Puninga complex, *Te Puninga silt loam dominant* (Allophanic Soil)	Rhyolitic alluvial deposits of the Hinuera Formation	Silt loam over silt or sand	A+B (0 -6°)	Deep (100+ cm)	Imperfectly to well drained	2s1 (soil)
Te Rapa peaty silt loam (Organic Soil, drained)	Decomposed peat on rhyolitic alluvial deposits of the Hinuera Formation	Peaty silt loam over sandy loam over silty clay loam	A (0 -3°)	Deep (100+ cm)	Moderately well drained	2w2 (wetness)
Motumaoho peaty silt loam (Organic Soil, drained)	Decomposed peat on rhyolitic alluvial deposits of the Hinuera Formation	Peaty silt loam over silt	A (0 -3°)	Deep (100+ cm)	Moderately well to imperfectly drained	2w2 (wetness)
Waitoa-Te Puninga complex, *Te Puninga silt loam dominant* (Gley Soil + Allophanic Soil)	Rhyolitic alluvial deposits of the Hinuera Formation	Silt loam over silt or sand	A (0 -3°)	Deep (100+ cm)	Imperfectly to poorly drained	2w3 (wetness)
Waitoa-Te Puninga complex, *Waitoa silt loam dominant* (Gley Soil + Allophanic Soil)	Rhyolitic alluvial deposits of the Hinuera Formation	Silt loam over silt or sand	A (0 -3°)	Deep (100+ cm)	Poorly to imperfectly drained	2w3 (wetness)
Motumaoho peaty silt loam (Organic Soil, drained)	Decomposed peat on rhyolitic alluvial deposits of the Hinuera Formation	Peaty silt loam over silt	A (0 -3°)	Deep (100+ cm)	Poorly drained	3w1 (wetness)
Waitoa silt loam (Gley Soil)	Rhyolitic alluvial deposits of the Hinuera Formation	Silt loam over silt or sand	A (0 -3°)	Deep (100+ cm)	Poorly drained	3w3* (wetness)
Ohinemuri sandy loam +Kirikiriroa Steepland soil association (Recent Soil)	Rhyolitic alluvial deposits of the Hinuera Formation, including sands and gravels, and reworked flood deposits	Sandy loam over sand *or* Gritty silt loam over sandy loam over sand	A to C (0-13°)	Deep (100+ cm)	Poorly to well drained	3w1+3e5 (wetness + slope)
Ohinemuri sandy loam (Recent Soil)	Rhyolitic alluvial deposits of the Hinuera Formation, and reworked flood deposits	Sandy loam over sand	A (0 -3°)	Deep (100+ cm)	Poorly drained	4w1 (wetness)
Modified soil / non-productive land	Dairy shed and infrastructure, existing houses and curtilage, farm races, drains, gravelled storage areas, ponds, deposited fill areas					-

*Jessen, MR. 1992. Waikato LUC units correlated. Unpublished file note, Land Resources Division, Department of Scientific and Industrial Research

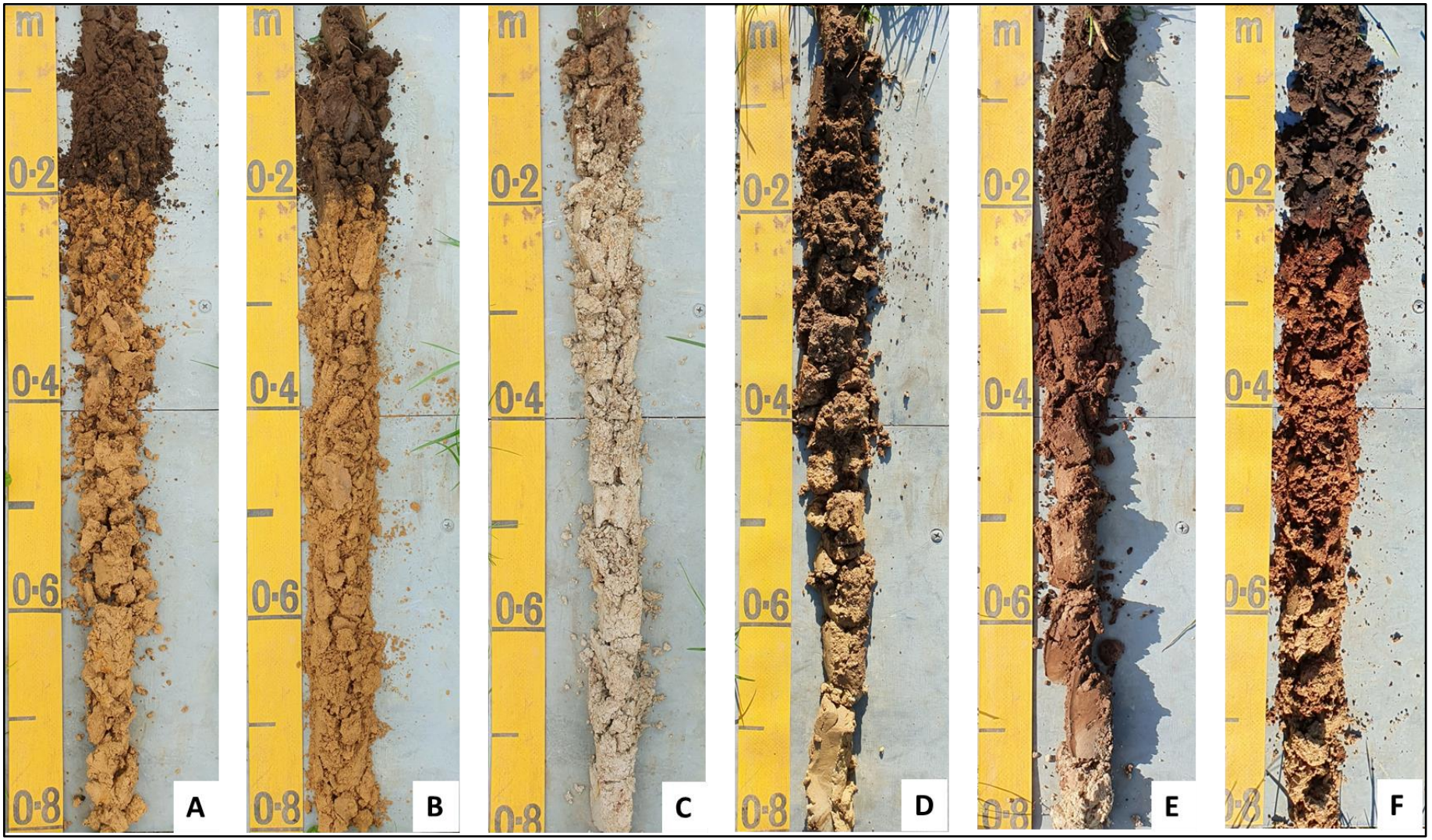


Figure 8. *Example soil profiles of the dominant soils identified in assessment area. A) Te Puninga silt loam, LUC 2s1 on A+B slopes; B) Waihou silt loam, LUC 2s1 on A+B slopes; C) Waitoa silt loam, LUC 3w1 on A slopes; D) Ohinemuri sandy loam, LUC 3w1 on A slopes; E) Motumaoho peaty silt loam, LUC 2w2 on A slopes; F) Te Rapa peaty silt loam, LUC 2w2 on A slopes.*

Figure 9. *Example non-productive land and poor drainage identified in assessment Area 2. A) Dairy sheds and modified soil; B) Gravelled storage areas; C) Gravelled farm race; D) Series of ponds along western boundary; E) Drains near peat soil; F) Drain and free-standing/ponded surface water within LUC 4w1 area on western boundary.*

The detailed on-site assessment confirmed the assessment Area 1 and 2 is the alluvial surface of the Hinuera Formation, left by the ancestral Waikato River, which although relatively flat, contains ridges and swales of old levees and channels. Soils formed on this Hinuera Formation within the Matamata district are known as the Waihou-Waitoa soil complex[13], a complex of poorly drained Waitoa soil series to imperfectly drained Te Puninga soil series to well drained Waihou soil series, often found in close proximity to one another.

Area 1: The flat to gently undulating slopes in the northern and central parts of assessment Area 1 comprised poorly drained to imperfectly drained, deep, Waitoa-Te Puninga complex (Waitoa silt loam dominant) (**Figure 8C** and **Figure 10**) (Waitoa silt loam is a Gley Soil within the New Zealand Soil Classification[14]), assigned an LUC classification 2w3. Within this soil complex there are areas of imperfectly drained Te Puninga silt loam (Allophanic Soil) (**Figure 8A** and **Figure 10**). In the central and southern part of Area 1 on flat to undulating slopes, the imperfectly drained to well drained, deep, Waihou-Te Puninga complex (Te Puninga silt loam dominated) was observed (**Figure 8A** and **Figure 10**) and assigned an LUC of 2s1. A band of well drained, deep, Waihou silt loam (Allophanic Soil) was observed in the south of Area 1, which was assigned a LUC classification of 1s1 (**Figure 8B** and **Figure 10**).

Area 2: Much of Area 2 was dominated by a mosaic of well to imperfectly drained ridges and imperfectly to poorly drained swales, typical of soils formed on the Hinuera surface. The slightly elevated areas (ridges) contained the well to imperfectly drained, deep, Waihou-Te Puninga soil complex (Waihou silt loam dominated) (**Figure 8A** and **8B**) and assigned LUC 2s1. Lower lying areas (swales) between ridges were occupied by poorly drained to imperfectly drained Waitoa silt loam and Te Puninga silt loam soils (Waitoa-Te Puninga soil complex). These were assigned a LUC classification of 2w3 (**Figure 10**).

Drained Organic Soils (Motumaoho series and Te Rapa series) were observed in the southcentral and southeast of Area 2 (**Figure 10**). These organic soils formed after transport and deposition of material by the ancient braided river system (Ancestral Waikato River) dammed valleys, forming areas of high water table in which peat was able to develop[15]. The Motumaoho peaty silt loam is an organic soil of 40 to 100 cm black decomposed silty peaty on peaty silt (**Figure 8E**). In its natural state they are poorly drained, however, these have been artificially drained to lower the high water table and consequently are moderately well to imperfectly drained. The Motumaoho peaty silt loam has a LUC classification of 2w2. The Te Rapa peaty silt loam forms in backswamp areas on plains and has a completely decomposed peaty top less than 40 cm thick, with a dark reddish brown humic layer occurring immediately below the topsoil (**Figure 8F**). A thin layer of coarse pumice sand is common at about 20 cm depth. In its natural state the Te Rapa peaty silt loam is poorly drained, but with artificial drainage, these soils are moderately well drained with a LUC classification of 2w2 (**Figure 10**). Due to artificial drainage of both the Te Rapa and Motumaoho soils, some soil boundaries were dictated by paddock drains.

On the western boundary of Area 2 the Waihou-Te Puninga complex (Waihou silt loam dominant) on the high terraces (LUC 2s1) is observed, and moving westwards towards the stream, Kirikiriroa series have developed on the steeper sides of gullies and occur in conjunction with the Ohinemuri series as a soil association (**Figure 8D** and **Figure 10**). The Kirikiriroa Steepland soils are a well drained sandy loam, often containing gravels of the Hinuera Formation, and within Area 2 occur on rolling slopes (LUC 3e5). The Ohinemuri sandy loam is found at the base of the gully and is developed on the flood plain of the nearby stream. The Ohinemuri-Kirikiriroa association was assigned a LUC classification of 3w1+3e5 (**Figure 10**). On the floodplain where the

[13] McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand. DSIR Land Resources Scientific Report No. 18

[14] Hewitt AE. 2010. New Zealand Soil Classification. 3rd ed. Landcare Research Science Series No. 1. Lincoln, Manaaki Whenua Press.

[15] Singleton P. 1991. Soils of Ruakura – a window on the Waikato. DSIR Land Resources Scientific Report No. 5.

Ohinemuri series experiences regular flooding, the soils are poorly to very poorly drained and the land had extensive areas of ponded surface water (after drainage) and assigned LUC 4w1 (**Figure 9F** and **Figure 10**).

There were also areas of non-productive land within the assessment Area 1 and 2 (**Figure 9** and **Figure 10**), including farm dairy shed and infrastructure (**Figure 9A**), existing houses and curtilage, gravelled storage areas (**Figure 9B**), gravelled farm races (**Figure 9C** and **9E**), ponds and drains (**Figure 9D, 9E** and **9F**).

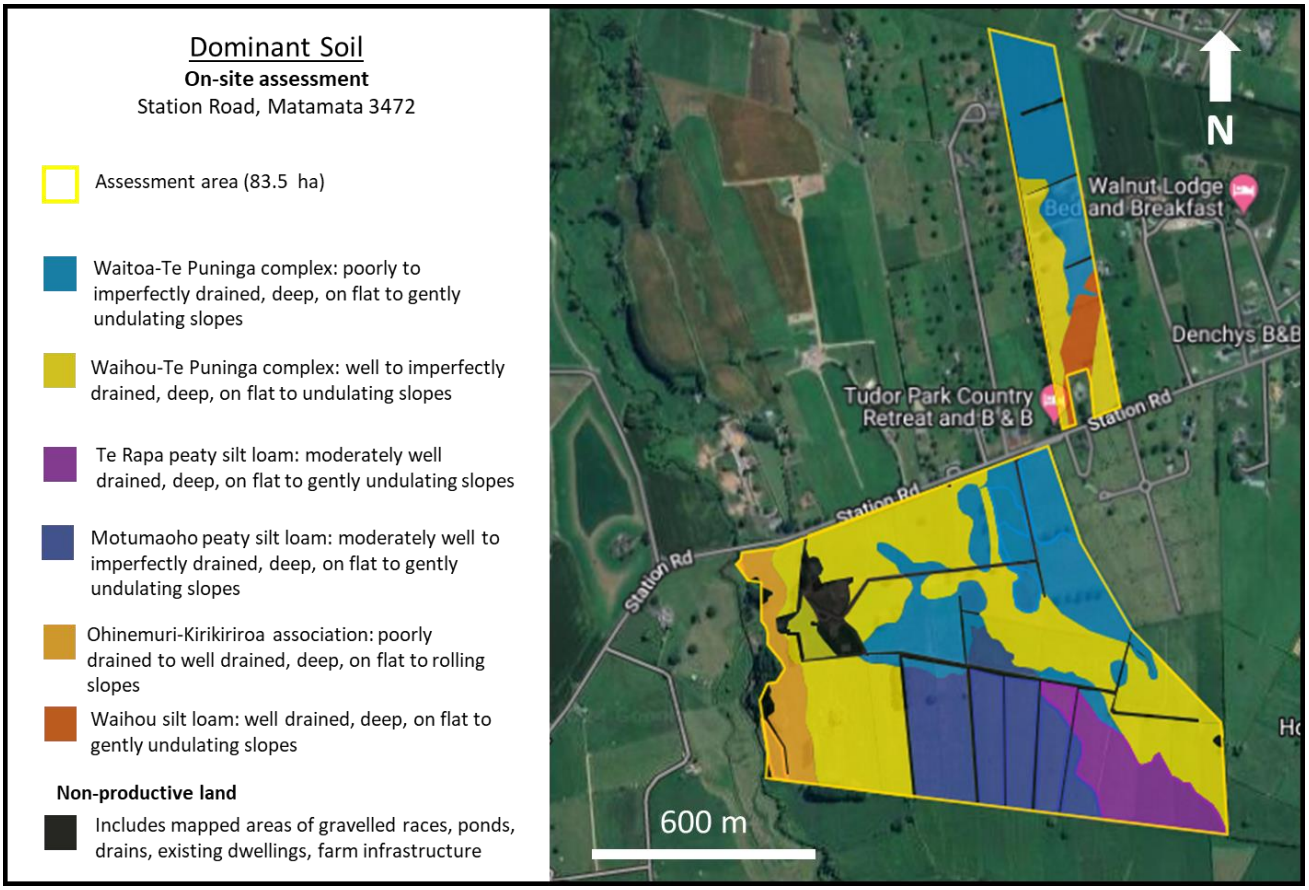


Figure 10. *The distribution of dominant soils for the entire assessment area, Station Road, Matamata.*

The estimated distribution of dominant soils, LUC classes and LUC units are given in **Figures 11-13** (larger maps are provided at the end of the report).

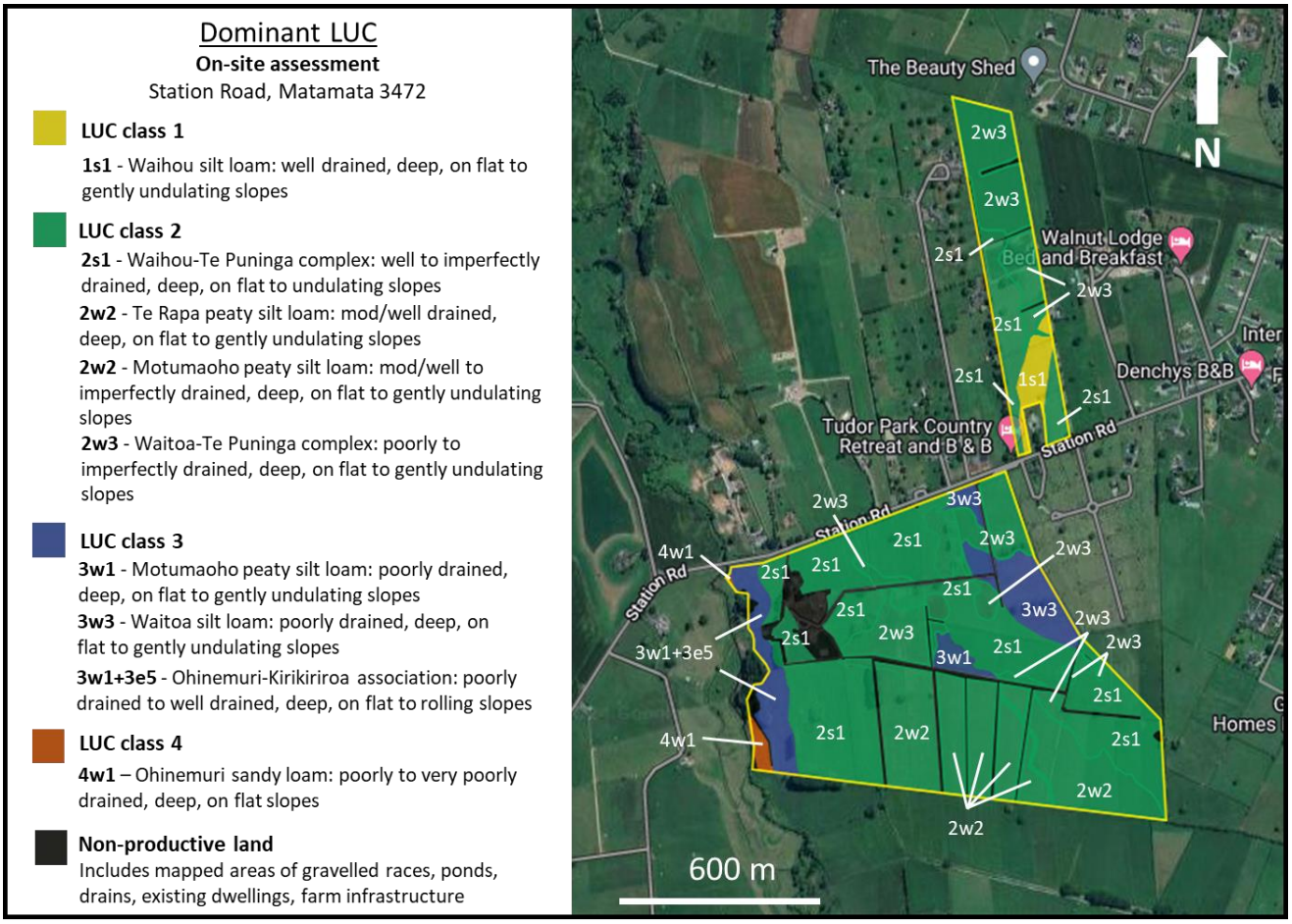


Figure 11. *The distribution of dominant soils, LUC classes and units for the entire assessment area, Station Road, Matamata.*

Figure 12. *The distribution of dominant soils, LUC classes and units for Area 1, Station Road, Matamata.*

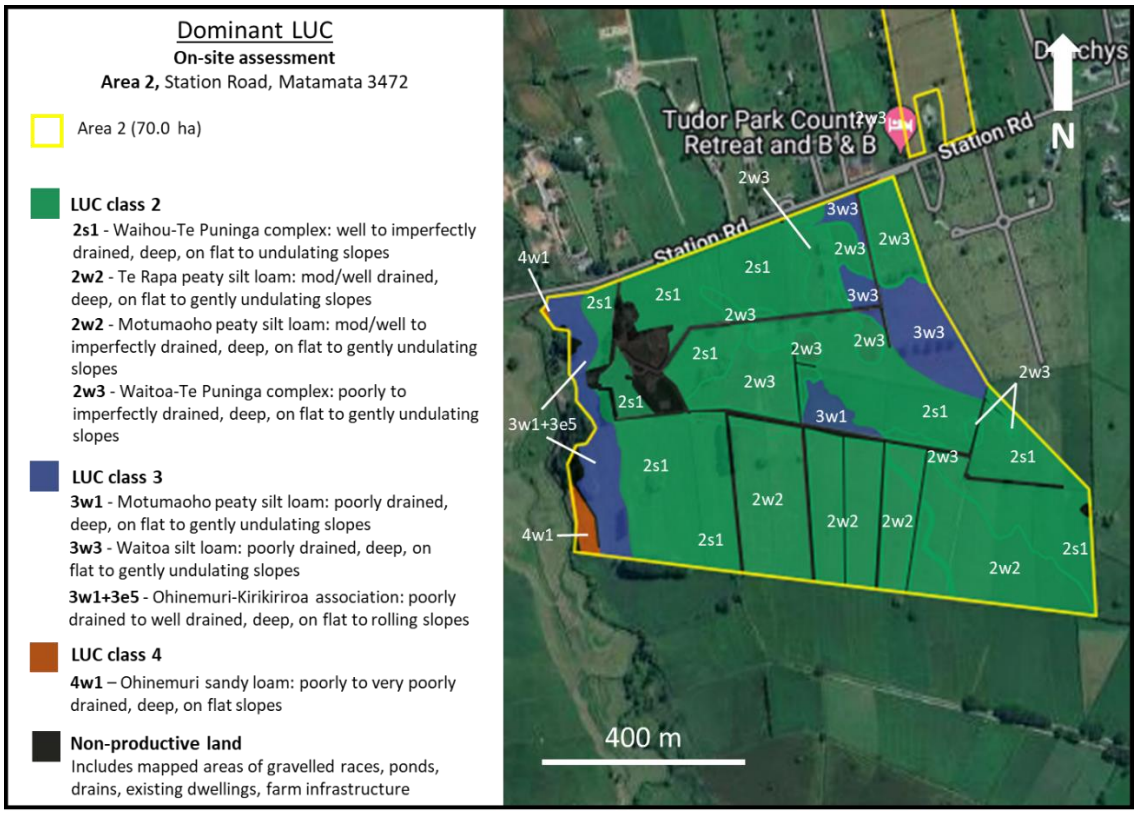


Figure 13. *The distribution of dominant soils, LUC classes and units for Area 2, Station Road, Matamata.*

9. Revised LUC classification

Based on the on-site assessment, aerial photographs of the assessment area and surrounding areas and soil auger observations, the original NZLRI delineated LUC map units differ from the LUC map units identified and mapped in the on-site assessment.

Based on the regional scale NZLRI and NZFSL map information (shown in **Figure 3**), more than 99% of the total assessment area was mapped as LUC 2s1 (well drained to imperfectly drained Waihou-Te Puninga soil complex on flat to undulating slopes), and less than 1% of the assessment area as imperfectly to poorly drained Ohinemuri silt loam on the southwestern boundary, classified as LUC 3w1.

However, detailed on-site mapping showed discrepancies in the extent of LUC class 2 and 3 land and drainage characteristics across the assessment areas (refer **Table 5** and **Figures 11-13**). Regional scale map information showed more than 99% of the entire assessment area as LUC class 2 land, however detailed field mapping showed 10% of the entire assessment area was LUC class 3 land, and 1% LUC class 4 land. Furthermore, of the 80% LUC class 2 land mapped, there was a greater proportion of imperfectly to poorly drained LUC 2w3 land (21% of the entire assessment area), and only 38% was LUC unit 2s1 (imperfectly to well drained) (**Table 5**).

Specific comments on individual areas are as follows:

Area 1 is 13.5 ha in size and of that area 100% was mapped at LUC 2s1 at a regional scale. Detailed LUC mapping showed this to be an overestimation of LUC 2s1 land, with 30% of the area LUC 2s1, 53% LUC 2w3 (imperfectly to poorly drained), 13% LUC 1s1, and the balance, 4% as non-productive land (gravelled races and drains) (**Figures 11** and **12**).

Area 2 is 70.0 ha in size and at a regional scale more than 99% of this area is mapped as LUC 2s1, with a small pocket of LUC 3w1 land in the southwest. Again, detailed LUC mapping showed an overestimation of LUC class 2 land, with the area of LUC class 2 land approximately 55.5 ha (79% of Area 2), and the balance, 12% LUC class 3 land, 1% LUC class 4 land, and 8%, land not available for production (non-productive land), including existing dwellings, gravelled farm races, drains, farm sheds, gravelled storage areas, etc (**Figures 11** and **13**).

Although LUC class 2 land still dominates Area 2, of the 79% of land mapped as LUC class 2 land, there is a greater proportion of imperfectly to poorly drained Waitoa-Te Puninga complex (LUC 2w3, 15%) (**Table 5**). Furthermore, of LUC class 2 land, 24% of the land is occupied by drained organic soils (Te Rapa peaty silt loam and Motumaoho peaty silt loam, both LUC 2w2). These organic soils were not shown on the regional scale NZLRI map information. Poorly drained Waitoa silt loam (LUC 3w3), very poorly drained Motumaoho peaty silt loam (LUC 3w1) and poorly to very poorly drained Ohinemuri sandy loam (LUC 4w1), make up 13% of Area 2, and were also missing from regional scale maps (**Table 5**).

***Table 5**. LUC classes, LUC units and dominant soil type within assessment Area 1, Area 2, and the total assessment area, Station Road, Matamata, based on the LUC map units identified by the on-site assessment.*

			Area 1		Area 2		Entire assessment area	
LUC class	Dominant LUC unit	Dominant soil type	LUC unit area, ha, (%)[$]	LUC class area, ha, (%)[$]	LUC unit area, ha, (%)[$]	LUC class area, ha, (%)[$]	LUC unit area, ha, (%)[$]	LUC class area, ha, (%)[$]
1	1s1	Waihou silt loam	1.7 (13)	1.7 (13)	-	-	1.7 (2)	1.7 (2)
2	2s1	Waihou-Te Puninga complex	4.0 (30)	11.2 (83)	27.9 (40)	55.5 (79)	31.9 (38)	66.7 (80)
	2w2	Te Rapa peaty silt loam	-		5.9 (8)		5.9 (7)	
		Motumaoho peaty silt loam			11.1 (16)		11.1 (13)	
	2w3	Waitoa-Te Puninga complex	7.2 (53)		10.6 (15)		17.8 (21)	
3	3w1	Motumaoho peaty silt loam	-	-	0.8 (1)	8.4 (12)	0.8 (1)	8.4 (10)
	3w3	Waitoa silt loam			4.2 (6)		4.2 (5)	
	3w1+3e5	Ohinemuri-Kirikiriroa association			3.4 (5)		3.4 (4)	
4	4w1	Ohinemuri sandy loam	-	-	0.5 (1)	0.5 (1)	0.5 (1)	0.5 (1)
Non-productive land/modified soil			0.6 (4)		5.6 (8)		6.2 (7)	

[$] % areas rounded to whole number

10. LUC classification and land use options

The suitability of land for productive uses, including arable cropping, horticulture, pastoral grazing, forestry production, or solar energy production, is a function of the inherent physical qualities of the land and its physical limitations for sustained production. The main land use limitations are the susceptibility of land to erosion (a function of slope and substrate type), soil wetness (high water table, slow internal drainage, susceptibility to flooding), soil factors (such as pans that may limit rooting depth, stoniness, shallow soil depth, water holding capacity, salinity etc.), and climate[16].

Given all soils within the assessment area were deep (> 1 m) and reside within a favourable mild climate, soil drainage (wetness) and slope class (erosion) are the most limiting factors for productive land use.

Drainage: Detailed on-site mapping showed soils to have a mix of drainage classes, with the dominant drainage class as well drained to imperfectly drained (LUC 1s1 and LUC 2s1) covering 40% of the assessment area, followed by 20% of the entire area being moderately well drained (LUC 2w2, drained organic soils). Of the balance, 21% of the assessment area is imperfectly to poorly drained (LUC 2w3), and 11% poorly to very poorly drained (LUC 3w1, 3w3, 3w1+3e5 and LUC 4w1) (**Table 5**). The soil wetness limitations of LUC 2w3, 3w1 and 3w3 land will restrict year-round cropping (summer months only) and horticultural use. Seasonally high water tables, and days in which soil is inundated by water on LUC 2w3, 3w1, and 3w3 land is likely to affect the yield and/or survival of water sensitive crops[17]. Therefore, these LUC 2w3, 3w1, and 3w3 areas are most suited to pastoral land uses, with no or lighter stocking in wetter months. LUC 4w1 land (less than 1% of the

[16] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand.

[17] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF 2009. Land Use Capability survey handbook – a New Zealand handbook for the classification of land. AgResearch Hamilton; Manaaki Whenua Lincoln; GNS Science Lower Hutt, New Zealand

assessment area), is prone to frequent flooding and is excessively wet after drainage and is not considered productive land. As mentioned, 40% of the assessment area is LUC 1s1 and 2s1 land, which is productive land with slight physical limitations to arable use and is suitable for year-round cropping, pasture, with only slight wetness after drainage.

The LUC 2w2 land within the assessment area (covering 20%) is mapped as the Te Rapa peaty silt loam and Motumaoho peaty silt loam soils, organic soils, which have been artificially drained to increase their versatility. Although these soils are now moderately well to imperfectly drained, if surrounding drains are not well maintained the drainage status can deteriorate. These soils have low bulk density and high porosity in the organic part of their profile, with limitations to trafficability in wetter months due to low bearing strength[18]. This land is best suited to low intensity pastoral systems.

Slope class: Of the potentially productive land within the assessment area, 89% is flat to undulating (0-6°) land (**Table 5**). Four percent of the assessment area was classified as LUC 3w1+3e5 land, with slopes of up to 13 degrees (mapped as the Ohinemuri-Kirikiriroa association). This land has moderate susceptibility to erosion under cultivation and is best suited for pastoral use, conservation planting or production forestry.

Considering both the drainage and slope characteristics of the assessed land, LUC class 1s1 and 2s1 land, well drained to imperfectly drained soil on flat to undulating slopes, is the most versatile land and would be suited to year-round cropping, some horticulture, moderate intensity pastoral use, tree crops, and dual use or agrivoltaics solar farming. The soil wetness limitations of LUC 2w3, 3w1 and 3w3 land will restrict year-round cropping (summer months only) and horticultural use. LUC 2w2 land use is somewhat restricted by the workability of the organic materials within these soils in wetter months and is best suited for pastoral use.

Agrivoltaic solar farming: Flat to undulating land (ideally less than 5 degrees, but up to 15 degrees) which has good exposure to sunlight, is not at risk of flooding or prone to erosion, and does not contain major waterways, wetland areas or significant areas of native vegetation, is best suited to agrivoltaics solar farming[19]. As such, all LUC classes within the assessment area fall within slope classes that would be suitable for solar farming.

There are examples of agrivoltaics enterprises in New Zealand on land with similar soil drainage classes, such as the Kohirā, Kaitaia Solar Farm[20]. Some care should be taken to establish the depth to mineral soil in the LUC 2w2 areas (particularly in the Motumaoho peaty silt loam areas, where peat depth may be up to 100 cm, whereas the Te Rapa peaty silt loam typically has less than 40 cm of decomposed peaty material[21]) to meet foundation requirements in peat soils. Consideration should be given to the placement of infrastructure, such as inverters, in areas of poorly drained soils.

The establishment of solar panels on highly productive land can still allow for primary productive activities (such as pastoral use or potentially inter-row cropping) on the land. Dual use solar farms, with panels positioned with higher ground clearance and careful spacing, allows for small animals such as sheep to graze beneath panels, farm machinery to operate, space for panel repair, and allows sunlight to reach the crops or grass below[22]. Integration of panels can provide numerous benefits, including, 1) shade for animals, protecting livestock against heat stress and adverse winter weather; 2) improving water use efficiency by reducing water

[18] McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand. DSIR Land Resources Scientific Report No. 18

[19] Kereush, D., Perovych, I. 2017. Determining criteria for optimal site selection for solar power plants. https://gll.urk.edu.pl/zasoby/74/GLL-4-4-2017.pdf

[20] Example of solar farm on peat soils: https://lodestoneenergy.co.nz/kaitaia/

[21] McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand. DSIR Land Resources Scientific Report No. 18

[22] Vaughan et al. 2023. Agrivoltaics: Integrating Solar Energy Generation with Livestock Farming in Canterbury. https://ourlandandwater.nz/wp-content/uploads/2023/08/Agrivoltaics_Report_OLW-RPF23.pdf

loss in pasture and crops under partial shade[23]; and 3) reducing soil temperatures which may benefit pasture and crop yield and quality[24,25].

Under an agrivoltaics solar farm system, the productive potential of the soil could continue to be utilised for pasture production and support primary electricity generation activity for the life of the solar farm.

11. LUC classification and proposed solar farms

Figure 14 is Landsystems' understanding of the location of the proposed solar farms. The estimated distribution of dominant soils, LUC classes and LUC units within these proposed solar farm areas is shown in **Figure 15** (larger map shown at the end of the report). **Table 6** gives a summary of the drainage and slope characteristics of these areas.

Figure 14. *The projected locations of proposed solar farms, Station Road, Matamata.*

[23] Vaughan et al. 2023. Agrivoltaics: Integrating Solar Energy Generation with Livestock Farming in Canterbury. https://ourlandandwater.nz/wp-content/uploads/2023/08/Agrivoltaics_Report_OLW-RPF23.pdf

[24] Alyssa C. Andrew, Chad W. Higgins , Mary A. Smallman, Maggie Graham and Serkan Ates (2021). Lamb growth and pasture production in agrivoltaic production system. AIP Conference Proceedings, 2361. doi:10.1063/5.0055889

[25] https://ourlandandwater.nz/wp-content/uploads/2023/08/Agrivoltaics-Booklet_OLW-RPF23.pdf

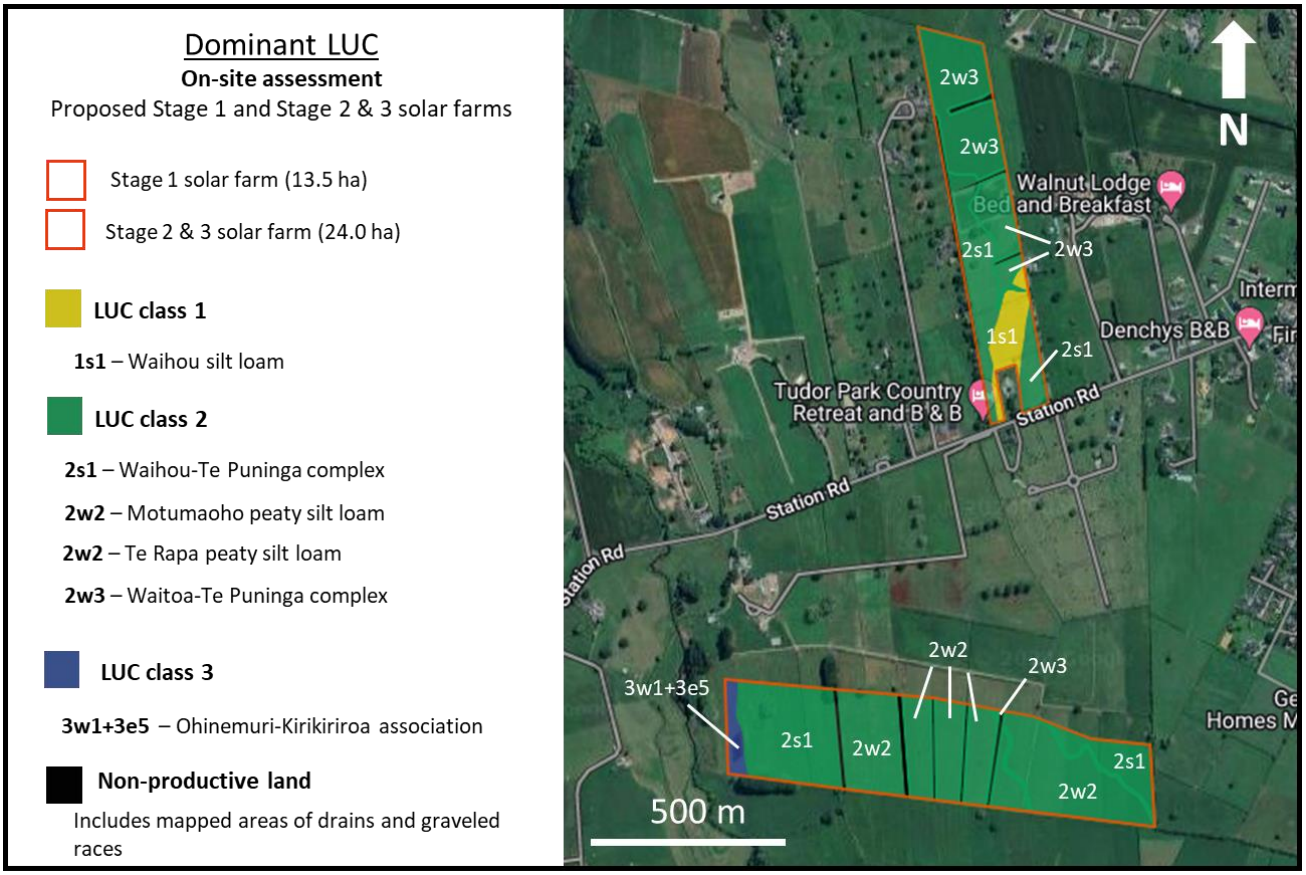


Figure 15. *The distribution of dominant soils, LUC classes and units for the proposed solar farms.*

Table 6*. LUC units, dominant soil type, drainage and slope characteristics of the proposed solar farm areas.*

Dominant LUC unit	Dominant soil type	Soil drainage	Slope	Area of Stage 1 solar farm ha, (%)*	Area of Stage 2 & 3 solar farm ha, (%)*
1s1	Waihou silt loam	Well drained	Flat to undulating slopes (0 -6°)	1.7 (13)	-
2s1	Waihou-Te Puninga complex	Well drained to imperfectly drained	Flat to undulating slopes (0 -6°)	4.0 (30)	7.6 (32)
2w2	Te Rapa peaty silt loam Motumaoho peaty silt loam	Moderately well to imperfectly drained	Flat to gently undulating slopes (0 -3°)	-	14.9 (62)
2w3	Waitoa-Te Puninga complex	Imperfectly drained to poorly drained	Flat to gently undulating slopes (0 -3°)	7.2 (53)	0.02 (<1)
3w1+3e5	Ohinemuri-Kirikiriroa association	Well drained to poorly drained	Flat to undulating slopes[&] (0-7°)	-	0.8 (3)
NPL^	-	-	-	0.6 (4)	0.6 (3)

*% areas rounded to whole number; ^NPL = Non-productive land/modified soil; [&]southern end is less steep part of larger land unit.

The **Stage 1 solar farm** comprises 53% imperfectly to poorly drained Waitoa-Te Puninga complex on flat to gently undulating slopes with a LUC classification of 2w3. 30% of the area contains well drained to imperfectly drained Waihou-Te Puninga complex on flat to undulating slopes with a LUC of 2s1. The balance of the Stage 1 area is mapped as well drained Waihou silt loam on flat to undulating slopes with a LUC of 1s1. 4% of the area is mapped as non-productive land including drains and gravelled races (**Table 6, Figure 15**).

The **Stage 2 and 3 solar farm** comprises 62% moderately well to imperfectly drained Motumaoho peaty silt loam and Te Rapa peaty silt loam soils on flat to gently undulating slopes, LUC 2w2. 32% of the area comprises well to imperfectly drained Waihou-Te Puninga complex on flat to undulating slopes with a LUC classification of 2s1. Less than 1% of the area was mapped as LUC 2w3, imperfectly to poorly drained Waitoa-Te Puninga complex on flat to gently undulating slopes. Of the balance, 3% of the Stage 2 and 3 solar farm area was mapped as the Ohinemuri-Kirikiriroa association, well drained to poorly drained on flat to rolling slopes with a LUC classification of 3w1+3e5; and 3% was mapped as non-productive land, namely drains (**Table 6, Figure 15**).

The drainage and slope characteristics of the proposed Stage 1, 2 and 3 solar farm areas are likely suitable for dual use solar farming and sheep grazing.

12.Summary

Based on NZLRI LUC map information the land on the site is classified as highly productive land when applying NPS-HPL clause 3.5(7).

The detailed on-site assessment showed soils across the assessment area consisted of Waihou-Te Puninga and Waitoa-Te Puninga soil complex on flat to undulating slopes, an isolated area of Waihou silt loam, pockets of Waitoa silt loam in low-lying swales, Te Rapa peaty silt loam and Motumaoho peaty silt loam on flat to gently undulating slopes, Ohinemuri-Kirikiriroa association on flat to rolling slopes, Ohinemuri sandy loam on flood plains, with some areas of modified soils and non-productive land.

The well drained Waihou silt loam on flat to undulating slopes is classified as LUC 1s1, the well to imperfectly drained Waihou-Te Puninga complex on flat to undulating slopes is classified as 2s1, and the imperfectly to poorly drained Waitoa-Te Puninga complex on flat to gently undulating slopes as 2w3. Moderately well to imperfectly drained Motumaoho and Te Rapa peaty silt loam on flat to gently undulating slopes are classified as LUC 2w2. Small areas of poorly to very poorly drained soils on flat slopes: Waitoa silt loam is classified as LUC 3w3, Motumaoho peaty silt loam as LUC 3w1, and Ohinemuri sandy loam as LUC 4w1. Finally, the soil association of Ohinemuri-Kirikiriroa on flat to rolling slopes is classified as LUC 3w1+3e5.

The modified soil and non-productive land areas (e.g. mapped areas of gravelled races, ponds, drains, existing dwellings, farm infrastructure) are excluded from productive land (i.e. they are non-productive land).

Regional scale NZLRI and NZFSL map information showed more than 99% of the total assessment area was mapped as LUC 2s1 (well drained to imperfectly drained Waihou-Te Puninga soil complex on flat to undulating slopes), and less than 1% of the assessment area as imperfectly to poorly drained Ohinemuri silt loam on the southwestern boundary, classified as LUC 3w1.

Detailed on-site mapping showed discrepancies in the extent of LUC class 2 and 3 land and drainage characteristics across the assessment areas. 10% of the entire assessment area was LUC class 3 land, and 1% LUC class 4 land.

Of the 80% LUC class 2 land mapped, there was a greater proportion of imperfectly to poorly drained LUC 2w3 land (21% of the entire assessment area), only 38% was LUC unit 2s1 (imperfectly to well drained), and 24% of the land is occupied by drained organic soils (Te Rapa peaty silt loam and Motumaoho peaty silt loam, both LUC 2w2). These organic soils were not shown on the regional scale NZLRI map information. Poorly drained Waitoa silt loam (LUC 3w3), very poorly drained Motumaoho peaty silt loam (LUC 3w1) and poorly to very poorly drained Ohinemuri sandy loam (LUC 4w1) and were also missing from regional scale maps.

Discrepancies between regional scale NZLRI delineated LUC maps and detailed field mapping within each assessment area were as follows (% of LUC class in each assessment area in descending order for comparative purposes):

Area 1 (13.5 ha):

Regional scale LRI/LUC: LUC class 2 - 100%

Detailed LUC mapping: LUC class 2 - 83% (53% LUC 2w3, 30% LUC 2s1)
LUC class 1 - 13%
NPL - 4%

Area 2 (70.0 ha):

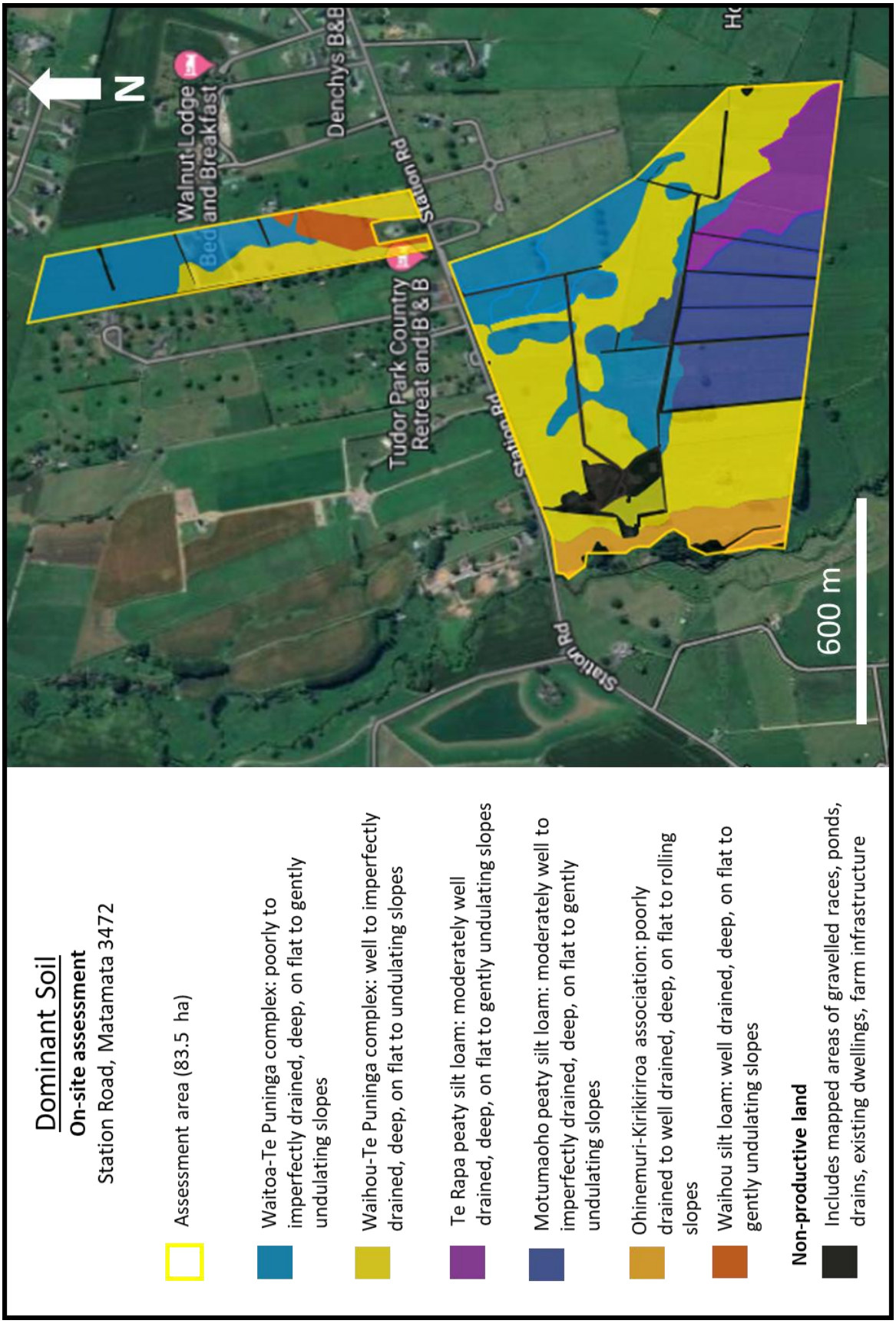
Regional scale LRI/LUC: LUC class 2 - >99%
LUC class 3 - <1%

Detailed LUC mapping: LUC class 2 - 79% (40% LUC 2s1, 24% LUC 2w2, 15% LUC 2w3)
LUC class 3 - 12%
LUC class 4 - 1%
NPL - 8%

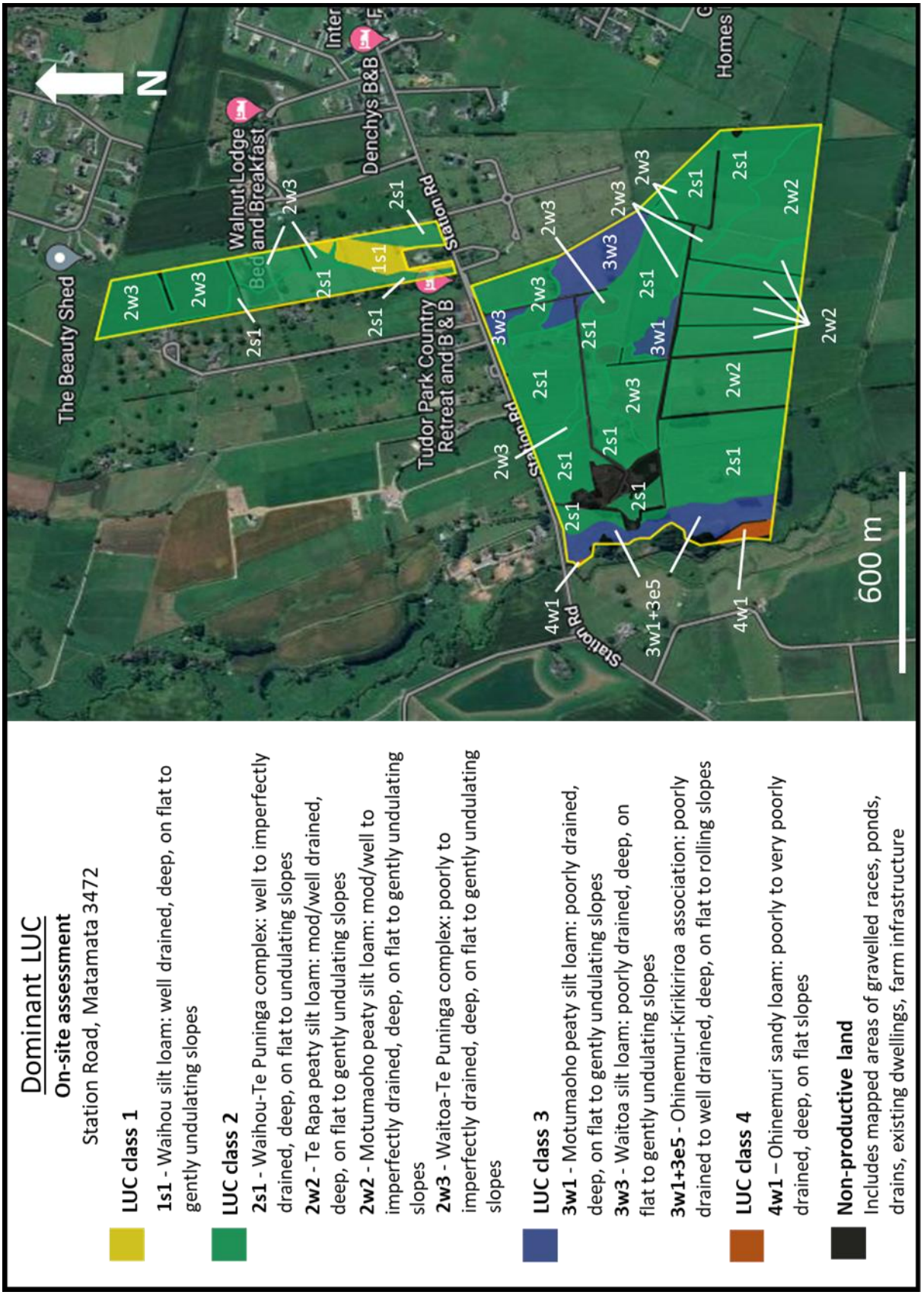
The detailed on-site assessment showed a greater area of poorly to imperfectly drained LUC 2w3, LUC 3w1 and 3w3 land which may constrain the variety of productive land uses suitable for this site. Areas of moderately well to imperfectly drained LUC 2w2 land, comprising organic soils, are likely suited only to pastoral use.

The drainage and slope characteristics of the land to be utilised for the proposed Stage 1, 2 and 3 solar farm is likely suitable for dual use solar farming, allowing the productive potential of the soil to continue to be utilised for pasture production and sheep grazing, whilst supporting primary electricity generation.

Appendix 1: Enlarged map image from Figure 10.

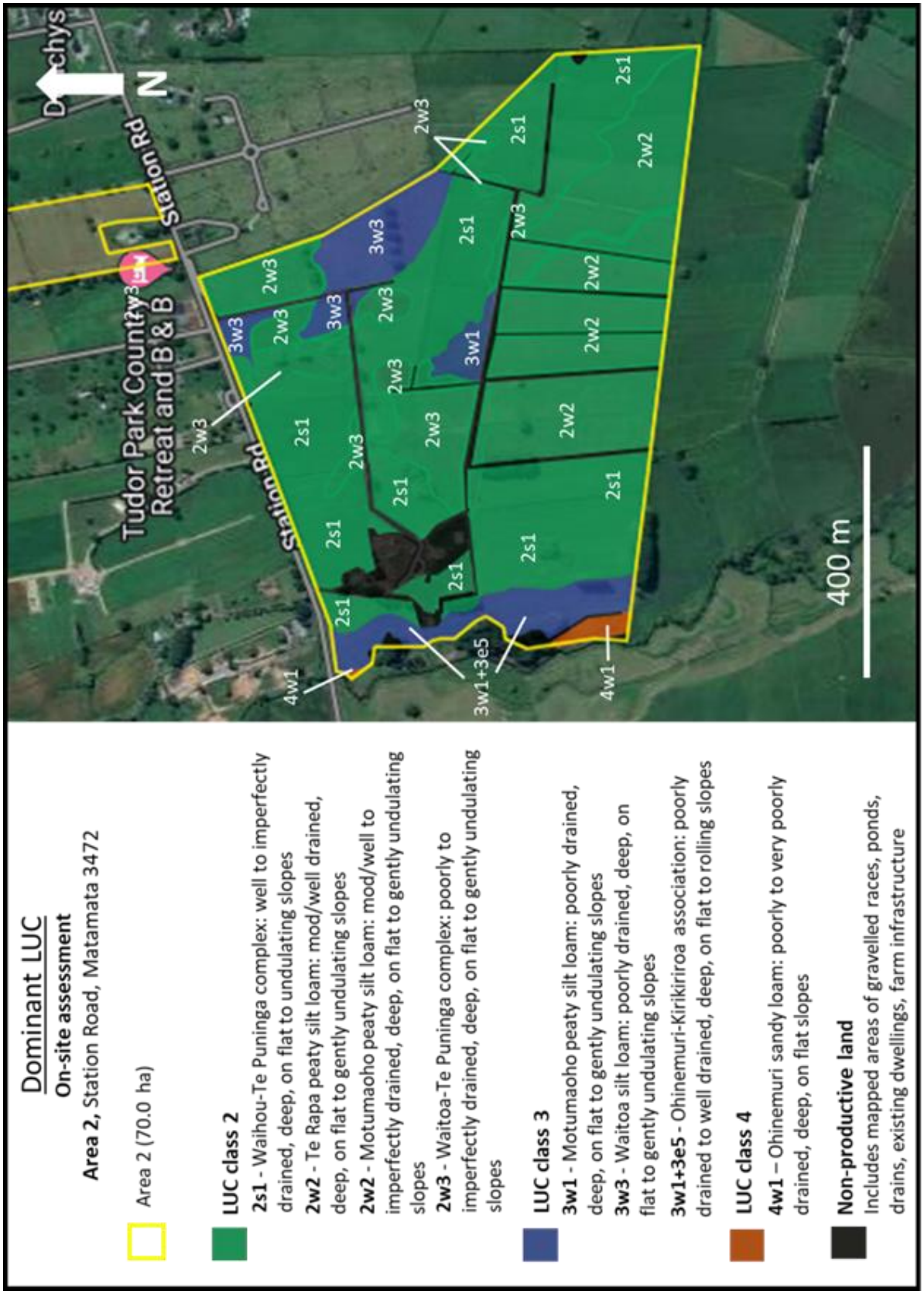


Appendix 2: Enlarged map image from Figure 11.



Appendix 3: Enlarged map image from Figure 12.

Appendix 4: Enlarged map image from Figure 13.



Appendix 5: Enlarged map image from Figure 15.