

Land Use Capability classification assessment

Orchard Grove site



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1. Introduction

Landsystems undertook an on-site Land Use Capability (LUC) classification assessment of the Orchard Grove site to confirm the soils and LUC units at property scale, the presence of Waikato District Plan-Operative in Part defined high class soils, and highly productive land as defined by the National Policy Statement for Highly Productive Land.

Site Description

Orchard Grove ('the Site') is of irregular shape and is approximately 72.0 hectares, and is situated within the Waikato District, directly adjoining the territorial boundary of Hamilton City to the south, as shown in **Figure 1**.

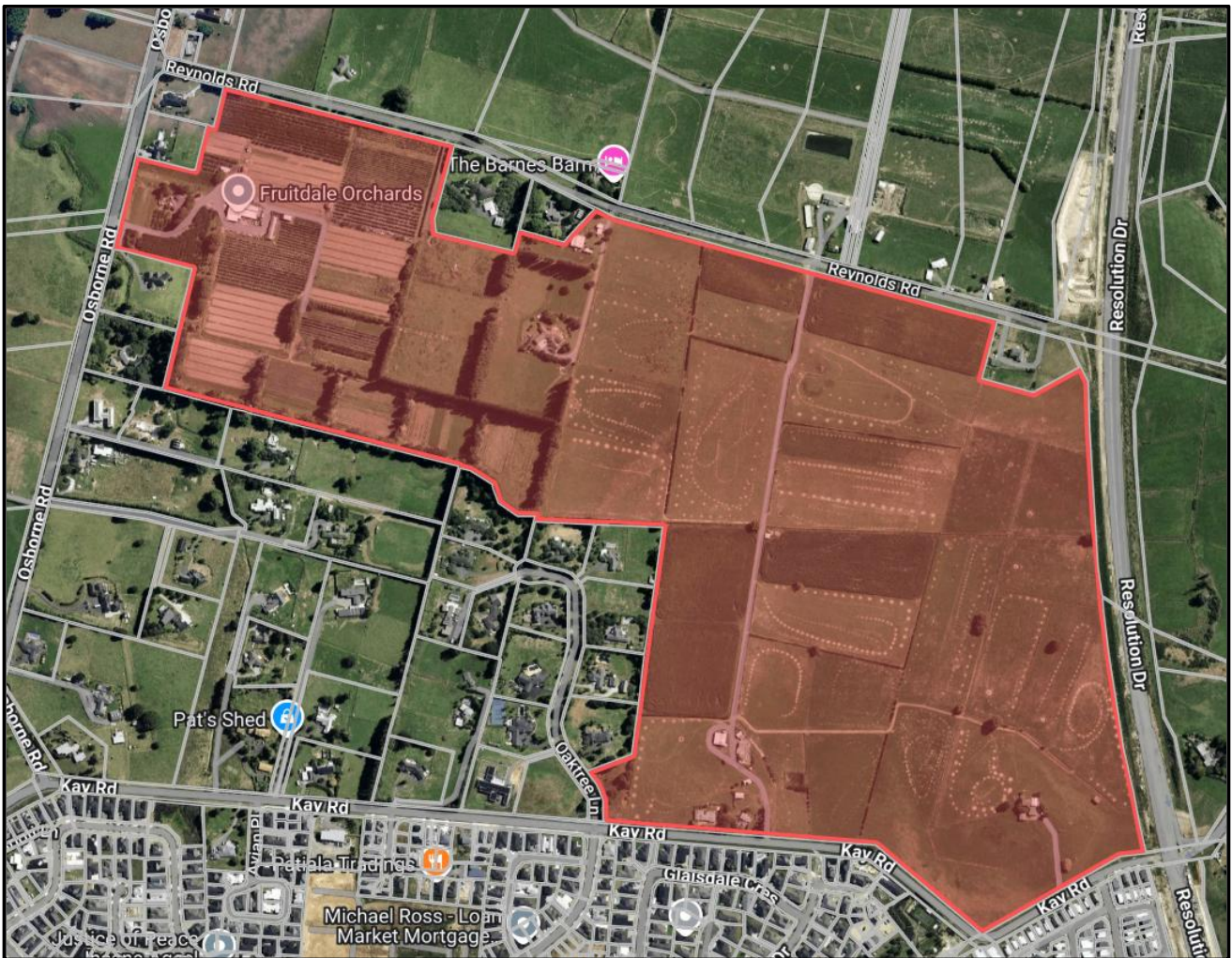


Figure 1: Site locality plan.

The site consists of the parcels held in Records of Title as identified in the Planning Memorandum prepared by Barker & Associates. The site can be accessed by Reynolds Road to the north, Resolution Drive to the east, Kay Road to the south, and Osborne Road to the west. Kay Road lies within the shared jurisdiction of Waikato District and Hamilton City Councils.

The Proposal

The Orchard Grove proposal is for a staged and comprehensively designed residential development (including subdivision, earthworks and land use). The proposal includes subdivision to create

residential lots, a small neighbourhood centre, open space and recreation areas, roading and walking and cycling facilities, three waters infrastructure, and all associated site and civil works.

Approval is required under the Resource Management Act 1991 from Waikato District Council and Waikato Regional Council and Wildlife Act 1953.

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 Handbook¹ 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.

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.

| Increasing limitations to use | LUC Class | Arable cropping suitability† | Pastoral grazing suitability | Production forestry suitability | General suitability | Decreasing versatility of use |
|-------------------------------|-----------|------------------------------|------------------------------|---------------------------------|---------------------------|-------------------------------|
| ↓ | 1 | High ↓ Low | High ↓ Low | High ↓ Low | Multiple use land | ↓ |
| | 2 | | | | | |
| | 3 | | | | | |
| | 4 | | | | | |
| | 5 | Unsuitable | Low ↓ Unsuitable | Low ↓ Unsuitable | Pastoral or forestry land | |
| | 6 | | | | | |
| | 7 | | | | | |
| | 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.

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 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. The on-site soil LUC assessment fulfils that purpose.

3. Waikato District Plan definition of high class soil

Under the Waikato District Plan-Operative in Part (WDP-OiP) definition, “High class soils” are defined as²:

those soils in Land Use Capability Classes I and II (excluding peat soils) and soils in Land Use Capability Class IIIe1 and IIIe5, classified as Allophanic Soils, using the New Zealand Soil Classification.

4. National Policy Statement for Highly Productive Land 2022

The National Policy Statement for Highly Productive Land 2022 (NPS-HPL)³ came into force on the 17th of October 2022.

“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:

² <https://eplan.waikatodistrict.govt.nz/>

³ <https://environment.govt.nz/publications/national-policy-statement-for-highly-productive-land-2022-amended-august-2024/>

(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”.

For the purpose of defining and mapping highly productive land on the site, the Environment Court decision (Decision No. [2024] NZEnvC 83)⁴ determined that only the NZLRI LUC map information at the time the NPS-HPL 2022 became operative (17th October 2022) can be used.

5. 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, and 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 to be available for primary production (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.

⁴ <https://www.environmentcourt.govt.nz/assets/Documents/Publications/2024-NZEnvC-083-Blue-Glass-Limited-v-Dunedin-City-Council.pdf>

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

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

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

- 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)⁵
- S-Map Online (providing map units of Soil Siblings)⁶

Of the available map information sources, the S-Map Online soil map information, 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 the Site are mapped as shown in **Figure 3**. Available NZLRI map information maps the property⁷ as predominantly the Horotiu-Te Kowhai soil complex on flat to gently undulating slopes. The parent material of these soils is the Hinuera Formation, namely, rhyolitic alluvial deposits deposited by the Ancestral Waikato River⁸.

The Site contains 74% well drained to imperfectly drained Horotiu silt loam-Te Kowhai silt loam complex (Allophanic Soil) on flat to gently undulating slopes (0-3°) with an LUC classification of LUC 2s1. Twenty-six percent of the Site comprises moderately well drained Hamilton clay loam (Granular Soil) on strongly rolling slopes (16-20°). These map units have an LUC classification of LUC 4e2 and occur on the northeast and southeast boundaries.

⁵ <https://iris.scinfo.org.nz/layer/48076-nzlri-land-use-capability-2021/>

⁶ <https://smap.landcareresearch.co.nz/maps-and-tools/app/>

⁷ <https://iris.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 Site, derived from regional scale NZLRI-LUC map information.

Table 1 gives the general characteristics of the soils and LUC units as mapped in Figure 3. The approximate % cover of these regional NZLRI derived LUC units were estimated using Google MyMaps.

Table 1. Summary of the NZLRI soil and LUC map unit characteristics and approximate % cover (estimated from Figure 3) of regional NZLRI derived LUC units within the Site.

| Soil type (NZSC Soil Order) | Parent material | Soil drainage | Slope class | LUC unit (limitation) | Area of total assessment area ha (%)* |
|---|---|-------------------------------------|-------------|-----------------------|---------------------------------------|
| Horotiu-Te Kowhai complex (Allophanic +Gley Soil) | Hinuera Formation alluvial sediments | Well drained to imperfectly drained | A+B | 2s1 (soil) | 54.0 (75) |
| Hamilton clay loam (Granular Soil) | Strongly weathered "Hamilton Ash Formation" | Moderately well drained | D | 4e2 (erosion) | 18.0 (25) |

*% areas rounded to whole number.

Based on the available NZLRI and NZFSL map information the majority of the assessment area is a mosaic of well drained to imperfectly drained Horotiu-Te Kowhai soil complex, on flat to gently undulating slopes and classified as LUC 2s1 (75% of the Site area); with a smaller area of moderately well drained Hamilton clay loam, classified as LUC 4e2 (25% of the Site area) (Table 1).

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 Gley Soils (39%), followed by Allophanic Soils (26%), Brown Soils (19%), Ultic Soils (7%), Granular Soils (6%) and Podzol Soils (3%) (**Figure 4** and **Table 2**).

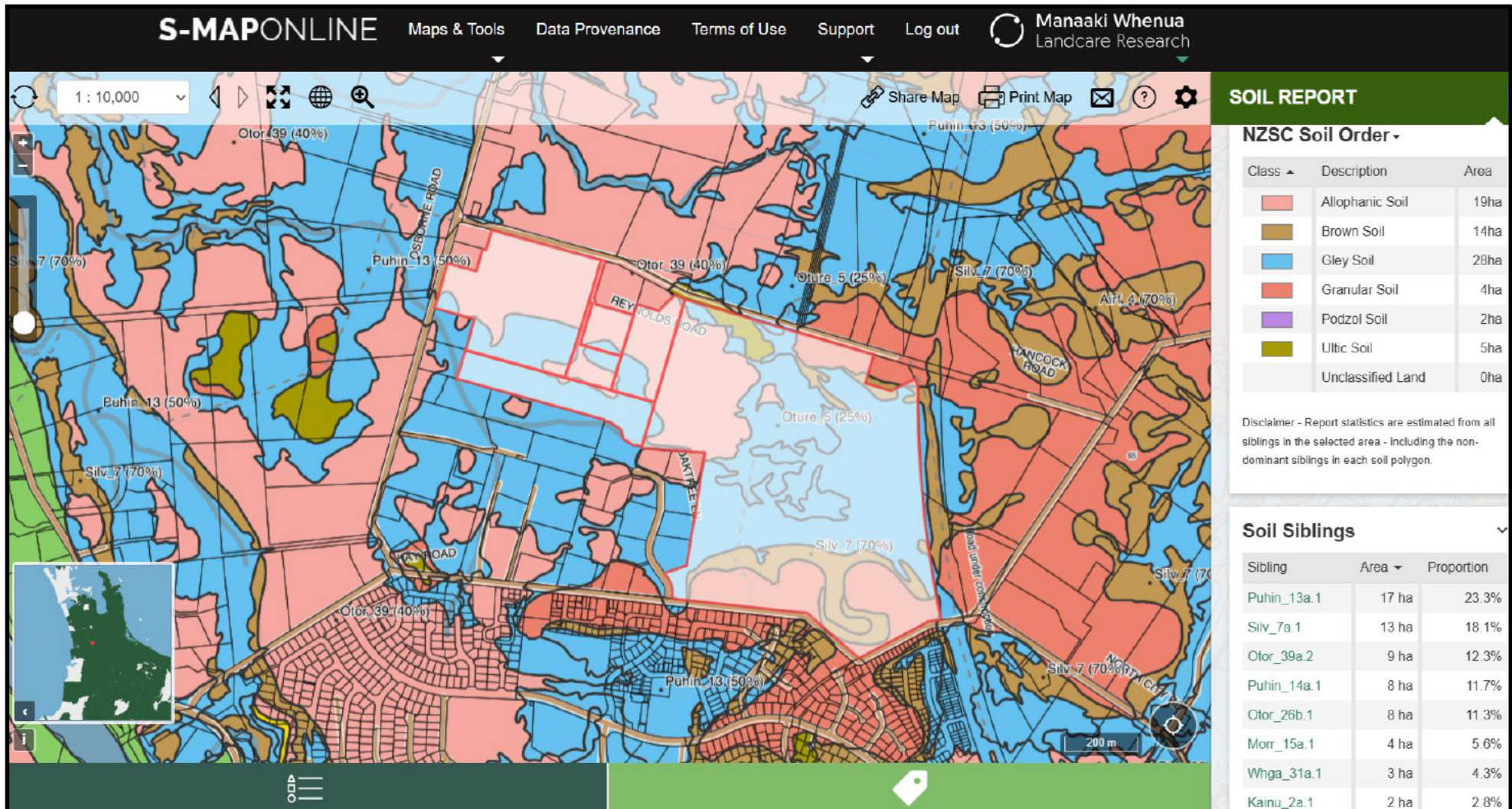


Figure 4: S-Map soil (Soil Order) distributions for the Site.

Table 2 provides 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 the Site. 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 website⁹.

Table 2. S-Map soil sibling map unit characteristics for the Site.

| S-Map Family | S-Map Sibling | Soil Series name | NZSC (Soil Order) | Soil drainage | Proportion (%) |
|--------------|---------------|------------------|-------------------|-------------------------|----------------|
| Pukehina | Puhin_13a.1 | Te Kowhai | Gley (GOT) | Poorly drained | 23.3 |
| Silverdale | Silv_7a.1 | Bruntwood | Brown (BOM) | Imperfectly drained | 18.1 |
| Otorohanga | Otor_39a.2 | Horotiu | Allophanic (LOT) | Well drained | 12.3 |
| Pukehina | Puhin_14a.1 | Te Kowhai | Gley (GOT) | Poorly drained | 11.7 |
| Otorohanga | Otor_26b.1 | Horotiu | Allophanic (LOT) | Moderately well drained | 11.3 |
| Morrinsville | Morr_15a.1 | Hamilton | Granular (NOT) | Moderately well drained | 5.6 |
| Whangaripo | Fanga_31a.1 | Whangaripo | Ultic (UYM) | Imperfectly drained | 4.3 |
| Kainui | Kainu_2a.1 | Kainui | Ultic (UYBG) | Imperfectly drained | 2.8 |
| Matapehe | Mpehe_12a.1 | Te Rapa | Podzol (ZOT) | Imperfectly drained | 2.8 |
| Oturere | Oture_5a.1 | Te Rapa | Gley (GOO) | Poorly drained | 2.8 |
| Te Rapa | Rapa_1a.1 | Te Rapa | Allophanic (LGO) | Moderately well drained | 2.8 |
| Airfield | Airf_4b.1 | Horsham | Brown (BOM) | Imperfectly drained | 1.1 |
| Temuka | Temu_97a.1 | Topehaehae | Gley (GOT) | Poorly drained | 0.6 |
| Temuka | Temu_76a.1 | Rotokauri | Gley (GOT) | Poorly drained | 0.5 |
| Airfield | Airf_7c.2 | - | Brown (BOM) | Imperfectly 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.

⁹ <https://smap.landcareresearch.co.nz/maps-and-tools/app/>

7. NPS-HPL assessment based on regional map information

Based on the available 1:50,000 scale NZLRI information and applying the NPS-HPL, LUC 2s1 land (75% of the Site area) is considered highly productive land. LUC 4e2 land (25% of the Site area) is not considered highly productive land (Figure 5).



Figure 5. The distribution of NPS-HPL highly productive land for the Site, based on the NZLRI LUC (1:50,000 scale) map information.

8. 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.

The 1:50,000 scale NZLRI data provides good foundational physical information for regional planning. However, its use as a definitive map requires an appropriate scale. For this report's objective of assessing high-class soil and soil resources, their productive capacity, and informing land productivity, the on-site assessment is more accurate and fit for purpose in providing the necessary soil and Land Use Capability (LUC) information.

9. On-site LUC classification assessment

Method

Landsystems undertook an on-site property scale LUC assessment of the 72.0 ha Site according to standard methods (Milne et al., 1993¹⁰ and Lynn et al., 2009⁹). The on-site assessment was undertaken on Tuesday 17th, Wednesday 18th and Thursday 19th of June 2025.

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 LUC classification, in turn used to determine the extent of 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 225 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 provide 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 72.0 ha site equated to an observation density of 3.1 observations per hectare (or one observation per 0.32 ha). Considering the Site area as a whole,

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

this density of observations (using conventional mapping techniques) is sufficient to support a map scale of between 1:7,000 to 1:10,000¹¹.

10. On-site LUC assessment

A generalised physiographic distribution of soils within the assessment area is shown below in **Figure 6**¹². The Waikato Plains consist of volcanogenic alluvium deposited by the Waikato River during its fan building stage which ended about 12,000 years ago. The volcanogenic alluvium, known as the Hinuera Formation, consists of rhyolitic sands, silts and gravels, which infilled the existing hilly ash covered landscape and in the present day only low rolling ridge crests protrude through the alluvium. The emplacement of alluvium altered the original drainage patterns and caused formation of lakes. Peat subsequently formed in many of the lakes, back swamp areas, and adjacent low-lying land. As a result, the Waikato Plains comprise two distinct sub-patterns; a mineral soil pattern based on the volcanogenic alluvium deposited by the Waikato River and an organic soil pattern, with intergrades between the two.¹³

The main landform units and soils of the assessment area include mineral soils formed on the plains (Horotiu-Te Kowhai soil complex), peaty gley soils formed on the margins of peat (Te Rapa Series), organic soils formed on the plain (Kaipaki and Motumaoho Series); low hills and fans in in the Hamilton Basin (Hamilton and Kainui Series), and modified soil areas (not shown in **Figure 6**).

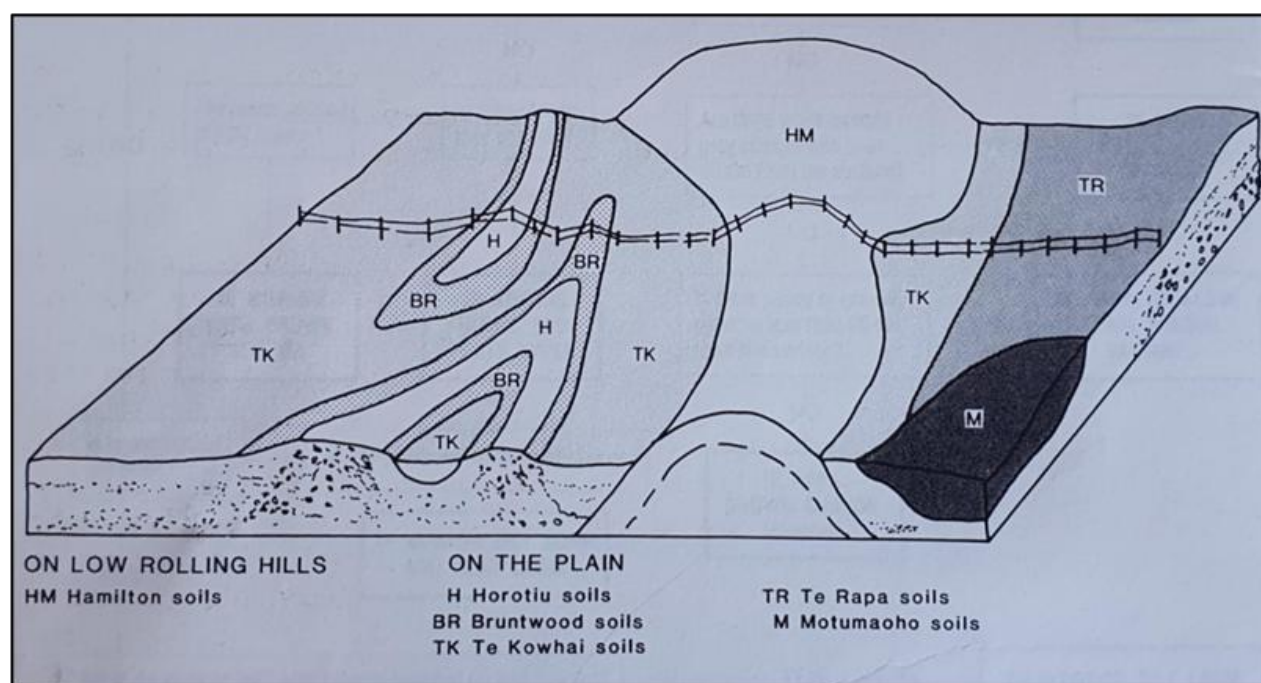


Figure 6: Schematic showing the position of main soils in the landscape (from Singleton¹⁴)

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

¹² Singleton, P. 1991. Soils of Ruakura – a window on the Waikato. DSIR Land Resources, Scientific Report No. 5. Image from pg. 30.

¹³ Singleton, P. 1991. Soils of Ruakura – a window on the Waikato. DSIR Land Resources, Scientific Report No. 5.

¹⁴ Singleton, P. 1991. Soils of Ruakura – a window on the Waikato. DSIR Land Resources, Scientific Report No. 5. Image from pg. 30.

A summary of the soils and LUC units identified in the assessment area are provided in Table 3. The main soils observed and examples of poorly to very poorly drained and non-productive land in the assessment area are shown in Figures 7 and 8. 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.

Table 3. Soils and dominant LUC units identified for the Site (in order of increasing limitations).

| Soil type (NZSC Soil Order) | Parent material | Texture profile | Slope class | Soil depth | Soil drainage | Dominant LUC unit (limitation) |
|--|---|---|--------------|-------------------------------------|--|--------------------------------|
| Horotiu-Te Kowhai complex, <i>Bruntwood silt loam dominant</i> (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) |
| Hamilton clay loam (Granular Soil) | Strongly weathered tephra on 'Hamilton Ash Formation' | Silty clay loam on clay loam on clay | B (2-6°) | Deep (100+ cm) | Moderately well drained | 2e2 (slope) |
| Te Rapa peaty silt loam (Gley Soil, drained) | Decomposed peat on rhyolitic alluvial deposits of the 'Hinuera Formation' | Peaty silt loam over sandy loam over silty clay loam or sand | A (0-3°) | Deep (100+ cm) | Imperfectly to moderately well drained | 2w2 (wetness) |
| Kaipaki peaty loam (Organic Soil, drained) | Decomposed peat on rhyolitic alluvial deposits of the 'Hinuera Formation' | Peaty loam over peat | A (0-3°) | Deep (100+ cm) | Moderately well to imperfectly drained | 2w2 (wetness) |
| Horotiu-Te Kowhai complex, <i>Te Kowhai silt loam dominant</i> (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) |
| Hamilton clay loam (Granular Soil) | Strongly weathered tephra on 'Hamilton Ash Formation' | Silty clay loam on clay loam on clay | C+B (6-14°) | Deep (100+ cm) | Moderately well drained | 3e3 (slope) |
| Te Kowhai 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 | 3w1 (wetness) |
| Hamilton clay loam (Granular Soil) | Strongly weathered tephra on 'Hamilton Ash Formation' | Silty clay loam on clay loam on clay | D+C (10-25°) | Deep (100+ cm) | Moderately well drained | 4e2 (slope) |
| Kainui silt loam (Ultic Soil) | Tephra on 'Hamilton Ash Formation' | Silt loam on clay loam | C+D (10-20°) | Deep (100+ cm) | Imperfectly drained | 4e3 (slope) |
| Te Kowhai silt loam (Gley Soil) | Rhyolitic alluvial deposits of the 'Hinuera Formation' and colluvium from surrounding low hills | Silt loam over silt or sand | A (0-3°) | Deep (100+ cm) | Very poorly drained | 4w* (wetness) |
| Modified soil (Fill + Truncated Anthropoc Soil) | Deposited fill on soils derived from 'Hinuera Formation' sediments | Areas of fill >30 cm, areas of no topsoil, gravel at surface or at very shallow depths, unable to auger | A (0-3°) | Very shallow (cannot auger) to deep | Poorly drained | 4s* (soil) |
| Modified soil / non-productive land | Existing houses and curtilage, farm races, drains, gravelled storage areas, pond, deposited fill areas, orchard infrastructure and sheds. | | | | | - |

*LUC class and limitation only as no corresponding LUC unit in NZLRI Extended Legend.

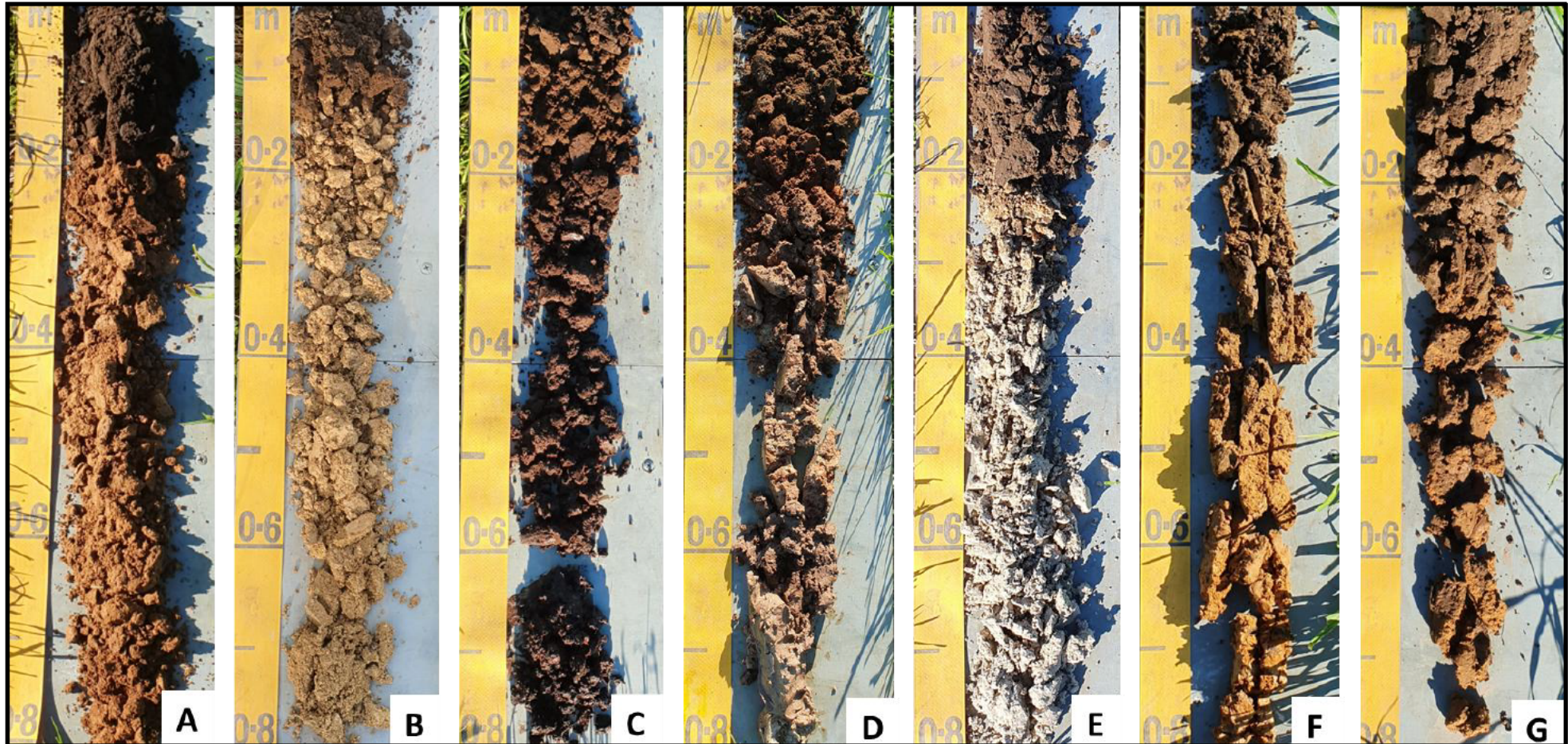


Figure 7: Example soil profiles of the dominant soils identified in the Site. A) Horotiu silt loam, LUC 2s1 on A+B slopes; B) Bruntwood silt loam, LUC 2w3 on A slopes; C) Kaipaki peaty loam, LUC 2w2 on A slopes; D) Te Rapa peaty silt loam, LUC 2w2 on A slopes; E) Te Kowhai silt loam, LUC 3w1 on A slopes; F) Hamilton clay loam, LUC 3e3 on C+B slopes; G) Kainui silt loam, LUC 4e3 on C+D slopes.

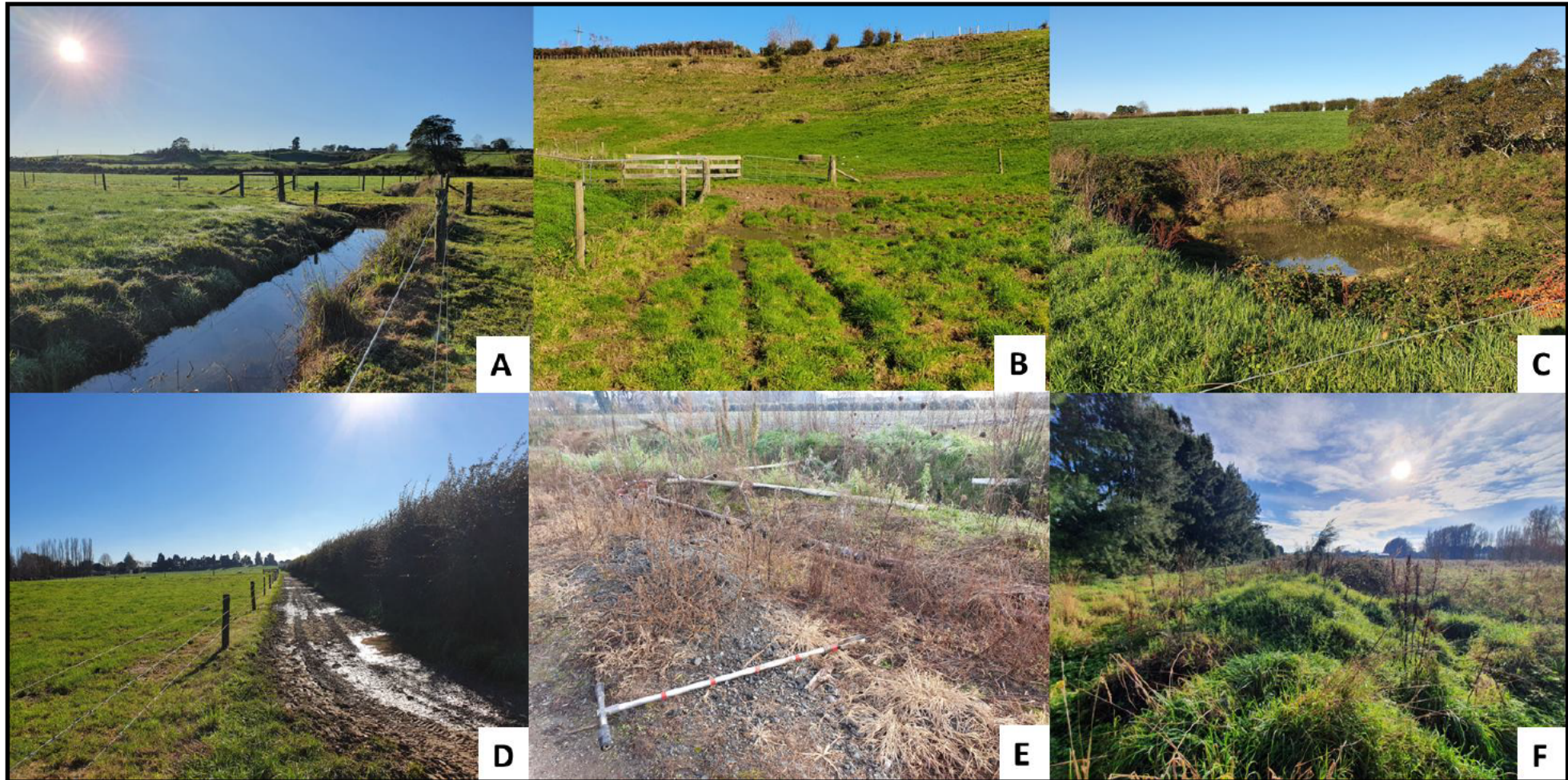


Figure 8: Example non-productive land and very poor drainage identified at the Site. A) Full drains around peat areas (Kaipaki peaty loam, LUC 2w2); B) Area of free-standing/ponded water (LUC 4w) and active slips at base of strongly rolling to moderately steep slopes (Hamilton clay loam, LUC 4e2); C) Pond; D) Gravelled race and shelterbelt; E) Area of Fill Anthropogenic soil (modified soil), rubbish, gravelled race and drain in orchard block; F) Fill Anthropogenic soil (LUC 4s) in orchard block.

The detailed on-site assessment confirmed much of the Site 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 Waikato are known as the Horotiu-Te Kowhai soil complex¹⁵, a complex of poorly drained Te Kowhai soil series to imperfectly drained Bruntwood soil series to well drained Horotiu soil series, often found in close proximity to one another.

Much of the western (currently an orchard) and central portion of the Site was dominated by a mosaic of imperfectly to well drained ridges and imperfectly to poorly drained swales, typical of soils formed on the Hinuera Surface. The slightly elevated areas (ridges) contained the imperfectly to well drained, deep, Horotiu-Te Kowhai soil complex (Bruntwood silt loam dominant) (**Figure 7B** and **9**) and assigned LUC 2s1. Lower lying areas (swales) between ridges were occupied by poorly drained to imperfectly drained Te Kowhai silt loam (**Figure 7E** and **9**) and Bruntwood silt loam soils (Horotiu-Te Kowhai soil complex). These were assigned a LUC classification of 2w3 (**Figure 9**). Also in west were three paddocks that were dominated by modified soil, including extensive areas of mounded fill material (**Figure 8F**) and gravel, covered in blackberry, drains, and a gravelled race. Prior to disturbance these paddocks would have been a continuation of the poorly to imperfectly drained Te Kowhai silt loam dominated LUC 2w3 land. There are small pockets of remnant soils within the dominant Fill and Truncated Anthropogenic Soils (modified soils).

Drained Organic Soils (Kaipaki Series) and drained peaty Gley Soils (Te Rapa Series) were observed in the flat central and eastern portion of the Site (**Figure 9**). These organic soils formed after transport and deposition of material by the ancient braided river system (Ancestral Waikato River) dammed valleys, forming areas with a high water table in which peat was able to develop¹⁶. The Kaipaki peaty loam is an organic soil with a peat thickness of more than 1 m, and the peat is strongly decomposed in the topsoil and upper subsoil, and moderately to weakly decomposed beneath (**Figure 7C**). In its natural state the Kaipaki Series are poorly drained, however, these have been artificially drained to lower the high water table and consequently are moderately well to imperfectly drained. The Kaipaki peaty 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 that is less than 40 cm thick, with a dark reddish brown humic layer occurring immediately below the topsoil (**Figure 7D**). 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 imperfectly to moderately well drained with a LUC classification of 2w2 (**Figure 9**). Due to artificial drainage of both the Te Rapa and Kaipaki soils, some soil boundaries were dictated by paddock drains.

On the northeastern and southern boundary of the Site older low hills protrude through the younger volcanogenic alluvium of the Hinuera Surface and the Hamilton Series and Kainui Series soils were observed. The Hamilton clay loam (Granular Soil), found in the northeast and southeast, is a moderately well drained, deep, heavy clay soil, assigned an LUC classification of 2e2 on undulating slopes, LUC 3e3 (**Figure 7F**) on undulating to rolling slopes, and LUC 4e2 on strongly rolling to moderately steep slopes. The Kainui silt loam (Ultic Soil) is imperfectly drained, deep, and found on

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

¹⁶ Singleton P. 1991. Soils of Ruakura – a window on the Waikato. DSIR Land Resources Scientific Report No. 5.

the low hills in the south of the Site, on strongly rolling slopes, with an LUC classification of 4e3 (Figure 7G).

Areas of Gley Soils were common at the base of low hills within the Site and soils formed in the material eroded from the surrounding hills (colluvium) (Figure 8B) and adjacent alluvium from the plains. These soils were poorly to very poorly drained, can have silt loam or clay loam topsoil textures, with mottled silt loam or clay loam to clay subsoils. Where soils were poorly drained the Te Kowhai silt loam (Figure 7E) dominated and was assigned an LUC classification of 3w1. Small unmappable pockets of poorly drained Rotokauri clay loam were also found among the LUC 3w1 area. Where drainage was very poor at the base of strongly rolling to moderately steep (LUC 4e2) slopes, active slips and ponded surface water (after drainage) were observed and these areas were assigned an LUC classification of 4w (Figure 8B).

There were also areas of non-productive land within the Site (Figure 8 and 9), including farm and orchard infrastructure, existing houses and curtilage, gravelled storage areas, drains (Figure 8A and 8E), pond (Figure 8C), gravelled farm races (Figure 8D) and shelter belts (Figure 8F).

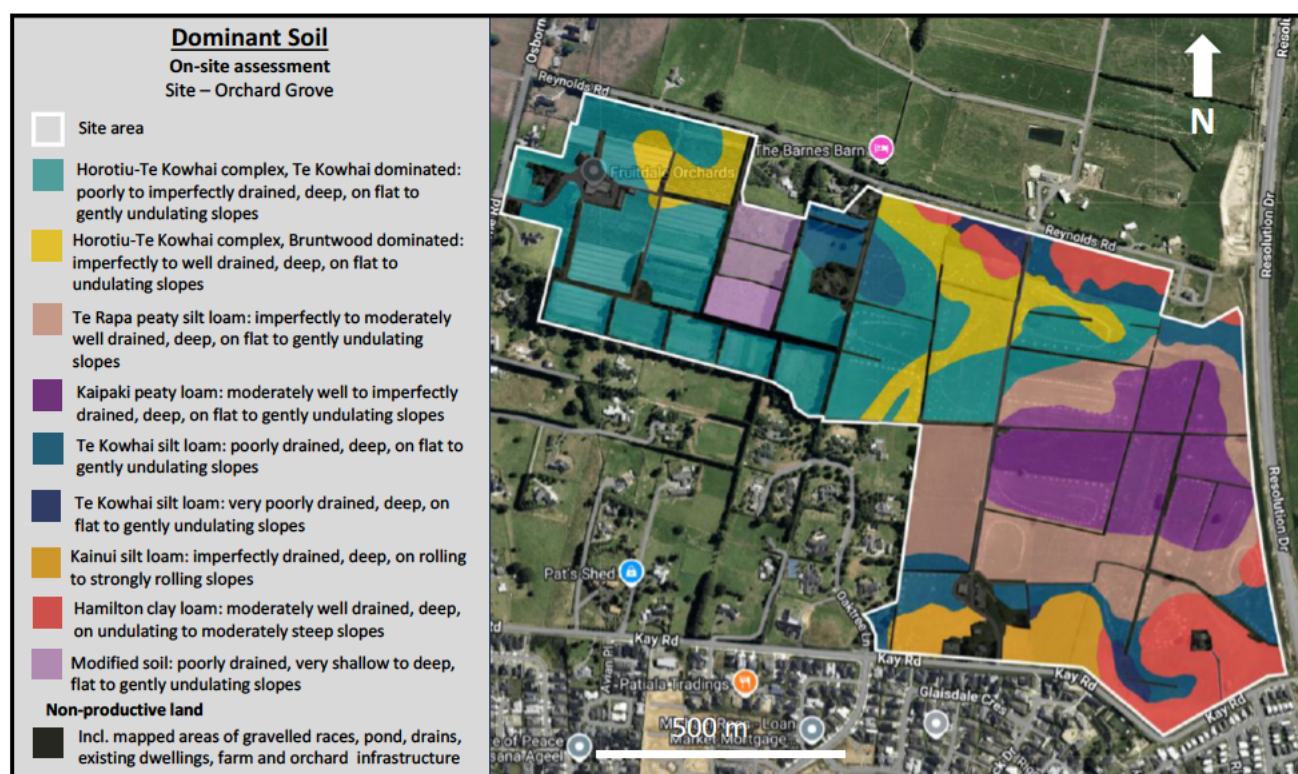


Figure 9: The on-site mapped distribution of the dominant soils for the Site.¹⁷

The estimated distribution of dominant soils, LUC classes and LUC units are given in Figure 10.

¹⁷ See Appendix 1 for larger map.

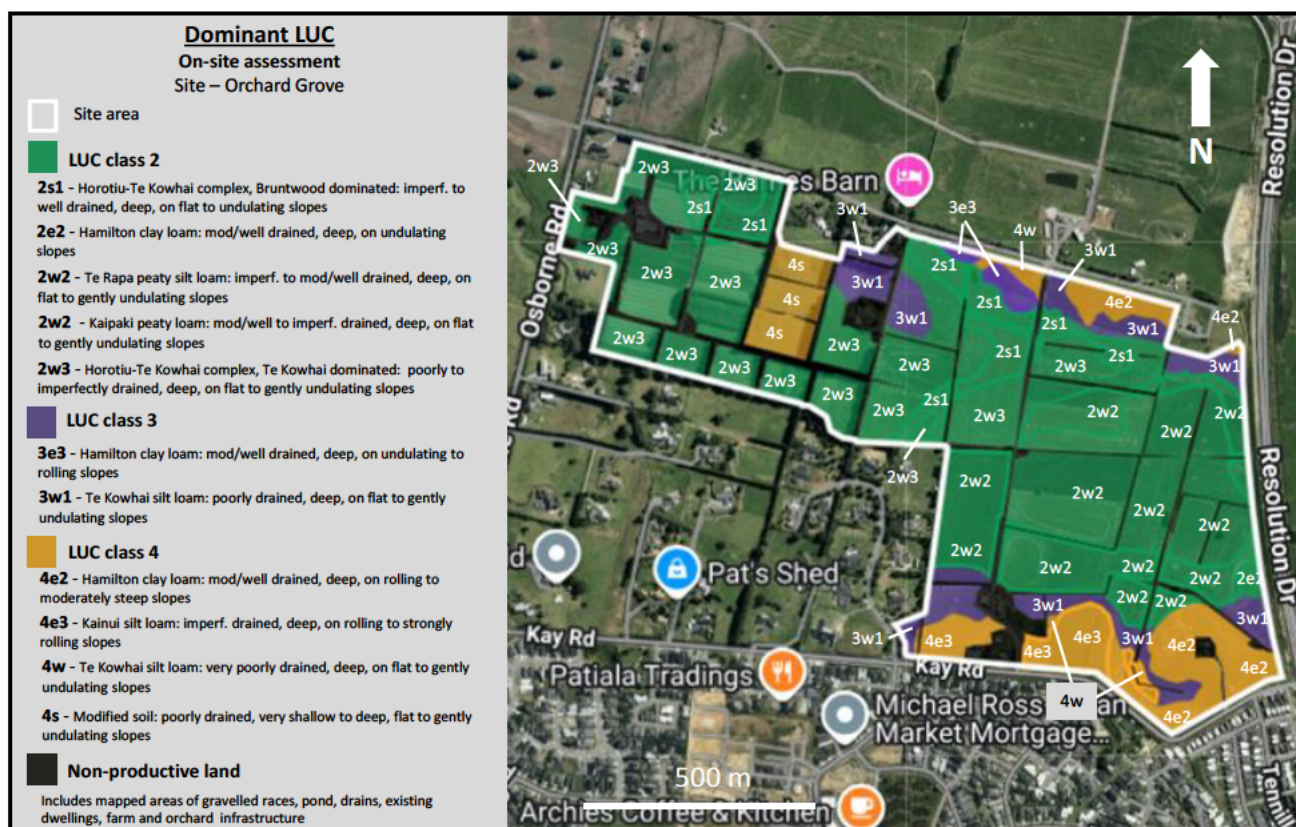


Figure 10: The on-site mapped distribution of dominant LUC units for the Site.¹⁸

11. 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 available NZLRI and NZFSL map information (Figure 3) the majority of the assessment area was mapped as a mosaic of well drained to imperfectly drained Horotiu-Te Kowhai soil complex, on flat to gently undulating slopes and classified as LUC 2s1 (75% of the Site); with a smaller area of moderately well drained Hamilton clay loam on strongly rolling slopes, classified as LUC 4e2 (25% of the Site).

However, detailed on-site mapping showed discrepancies in the extent of LUC class 2, 3 and 4 land and drainage characteristics across the Site (refer Table 4 below and Figures 9 and 10).

Specific comments are as follows:

- Seventy-five percent of the Site was mapped at LUC 2s1 at a regional scale. Detailed LUC mapping showed this to be an overestimation of LUC 2s1 land, with only 8% of the Site LUC 2s1.

¹⁸ See Appendix 2 for larger map.

- On-site mapping showed 62% of the land as LUC class 2, however, there was a greater proportion land with poorer soil drainage, including 26% mapped as poorly to imperfectly drained LUC 2w3 land (Table 4).
- No Organic Soils were mapped at the Site according to regional scale NZLRI information (or S-Map Online). However, detailed on-site mapping showed 14% of the area to be moderately well to imperfectly drained Kaipaki peaty loam (LUC 2w2) (Figures 7C, 9 and 10); an Organic Soil. Peaty Gley Soils (Te Rapa peaty silt loam) also made up 14% of the Site and are often found on the margins of Organic Soils (peat land) in the Waikato. Both soils have been artificially drained.
- Detailed on-site mapping showed soils to have a mix of drainage classes. Poorly to very poorly drained land (LUC 3w1 and LUC 4w) made up 10% of the Site and were missing from regional scale maps.
- Strongly rolling to moderately steep land (LUC 4e2 and 4e3) made up 11% of the Site.
- Within the orchard an area of 2.3 ha (~3% of the Site) was mapped as modified soil, dominated by either Fill Anthropic Soil or Truncated Anthropic Soil (LUC 4s).
- 13% of the Site was mapped as non-productive land, including mapped areas of gravelled races, a pond, extensive drains and shelterbelts, existing dwellings, farm and orchard infrastructure (Table 4, Figures 8-10).

Table 4. LUC classes, LUC units and dominant soil type within the Site, based on the LUC map units identified by the on-site assessment.

| LUC class | Dominant LUC unit | Dominant soil type | LUC unit area (ha) | LUC class area, ha, (%) [§] |
|-----------------------------------|-------------------|---|--------------------|--------------------------------------|
| 2 | 2s1 | Horotiu-Te Kowhai complex, Bruntwood dominant | 5.7 | 44.7 (62) |
| | 2e2 | Hamilton clay loam | 0.3 | |
| | 2w2 | Te Rapa peaty silt loam | 10.3 | |
| | | Kaipaki peaty loam | 9.7 | |
| | 2w3 | Horotiu-Te Kowhai complex, Te Kowhai dominant | 18.7 | |
| 3 | 3e3 | Hamilton clay loam | 0.7 | 7.0 (10) |
| | 3w1 | Te Kowhai silt loam | 6.3 | |
| 4 | 4e2 | Hamilton clay loam | 5.0 | 10.7 (15) |
| | 4e3 | Kainui silt loam | 2.7 | |
| | 4w | Te Kowhai silt loam | 0.7 | |
| | 4s | Modified soil | 2.3 | |
| Non-productive land/modified soil | | | 9.6 (13) | |

[§]% areas rounded to whole number.

12. On-site WDP-OiP high class soil classification

Detailed on-site assessment showed 49% of the assessment area as high class soil (LUC 2s1, 2e2, 2w2-Te Rapa Series and 2w3) under the WDP-OiP definition for high class soil (Table 5, Figure 11).

The balance, 51% of the Site, was LUC 2w2-Kaipaki Series (Organic Soil), LUC 3e3, LUC 3w1, LUC 4e2, LUC 4e3, LUC 4w, and LUC 4s, which is not high class soil. Non-productive areas (13% of the Site) including mapped areas of gravelled races, a pond, extensive drains and shelterbelts, existing dwellings, farm and orchard infrastructure, are not high class soil (Table 5, Figure 11).

Table 5. WDP-OiP high class soil for the Site based on the on-site mapped LUC map units.

| LUC unit (dominant) | High class soil | Area ha, (%) [§] |
|---------------------------|---------------------|---------------------------------|
| 2s1 | High class soil | 5.7 |
| 2e2 | High class soil | 0.3 |
| 2w2* (Te Rapa Series) | High class soil | 10.3 |
| 2w3 | High class soil | 18.7 |
| High class soil total | | High class soil = 35.0 (49) |
| 2w2@ (Kaipaki Series) | Not high class soil | 9.7 |
| 3e3 | Not high class soil | 0.7 |
| 3w1 | Not high class soil | 6.3 |
| 4e2 | Not high class soil | 5.0 |
| 4e3 | Not high class soil | 2.7 |
| 4w | Not high class soil | 0.7 |
| 4s | Not high class soil | 2.3 |
| NPL [#] | Not high class soil | 9.6 |
| Not high class soil total | | Not high class soil = 37.0 (51) |

[§]% areas rounded to whole number; *Te Rapa Series = Gley Soil; @Kaipaki Series = Organic Soil; [#]NPL = Non-productive land.

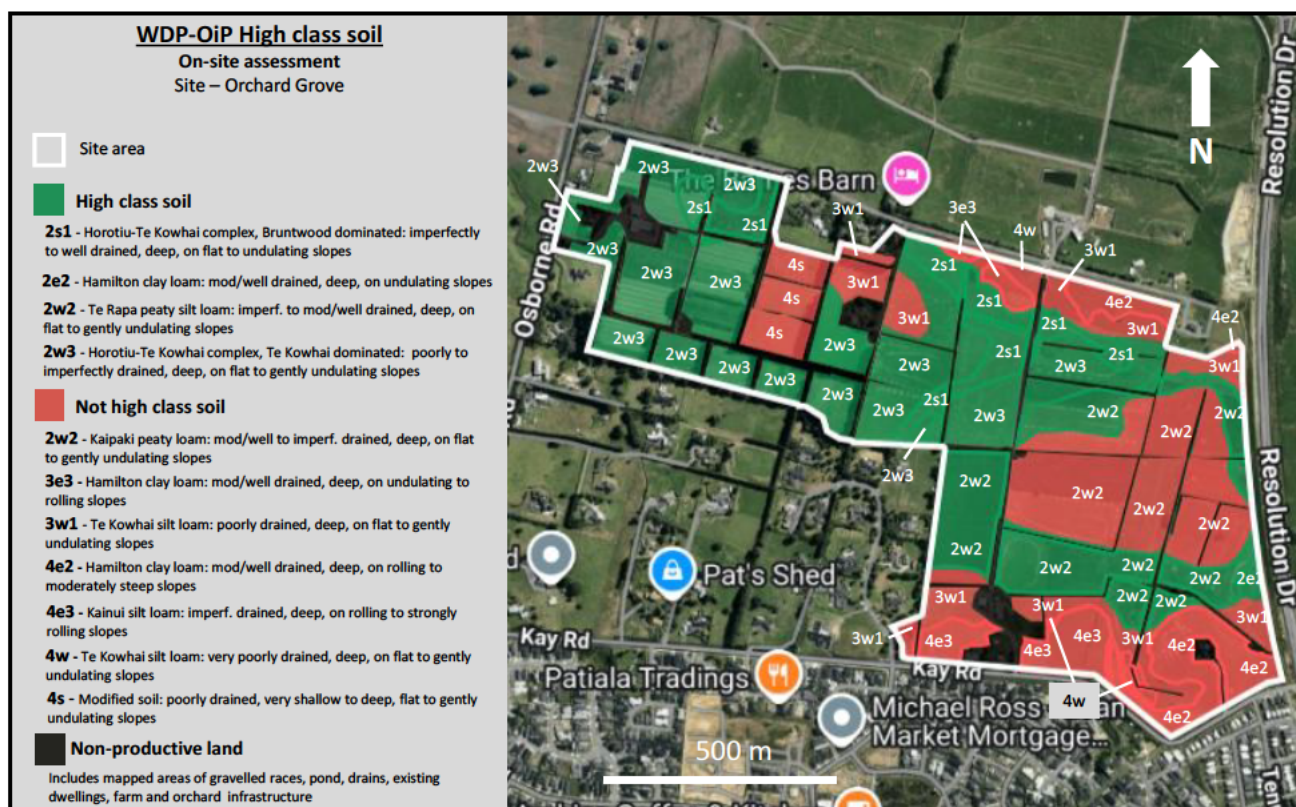


Figure 11: On-site mapped distribution of WDP-OiP defined high class soil for the Site.¹⁹

13. LUC limitations and productive capacity

The main land use limitations at the Site are the susceptibility of land to erosion (a function of slope and substrate type) and soil wetness (high water table, slow internal drainage, susceptibility to flooding)²⁰.

Drainage: Detailed on-site mapping showed soils to have a mix of drainage classes, with the dominant drainage class (26%) as imperfectly to poorly drained (LUC 2w3), and 10% poorly to very poorly drained (LUC 3w1 and LUC 4w). The soil wetness limitations of LUC 2w3 and 3w1 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 and 3w1 land is likely to affect the yield and/or survival of water sensitive crops²¹. Therefore, these LUC 2w3 and 3w1 areas are most suited to pastoral land uses, with no or lighter stocking in wetter months, and limited rotational arable uses in drier months only. LUC 4w land (1% of the Site), is prone to frequent flooding and is

¹⁹ See Appendix 3 for larger map.

²⁰ 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.

²¹ 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

excessively wet after drainage and is considered productive land with severe limitations for arable use.

The LUC 2w2 land within the Site (covering 28%) is mapped as the Kaipaki peaty loam and Te Rapa peaty silt loam soils, Organic Soils and peaty Gley 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 strength²². This land is best suited to pastoral land uses with no or lighter stocking in wetter months and limited rotational arable uses in drier months only.

Slope class: Approximately eleven percent of the Site was classified as LUC 4e2 and LUC 4e3 land, with slopes of up to 25 degrees. This land has moderate susceptibility to erosion under cultivation and is best suited for pastoral use, conservation planting or production forestry.

14. Summary

Based on NZLRI LUC map information, 75% of 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 predominantly consisted of Horotiu-Te Kowhai soil complex (Te Kowhai silt loam dominated) on flat to gently undulating slopes, an isolated area of Horotiu-Te Kowhai soil complex (Bruntwood silt loam dominated) on flat to undulating slopes, pockets of Te Kowhai silt loam in low-lying swales, Te Rapa peaty silt loam and Kaipaki peaty loam on flat to gently undulating slopes, areas of undulating to moderately steep Hamilton clay loam and Kainui silt loam on low hills, with some areas of modified soils and non-productive land.

The poorly to imperfectly drained Horotiu-Te Kowhai complex on flat to gently undulating slopes is classified as LUC 2w3, and the isolated areas of imperfectly to well drained Horotiu-Te Kowhai complex on flat to undulating slopes is classified as 2s1. Imperfectly to moderately well drained Te Rapa peaty silt loam and moderately well to imperfectly drained Kaipaki peaty loam on flat to gently undulating slopes are classified as LUC 2w2. Small areas of poorly to very poorly drained soils on flat slopes: Te Kowhai silt loam is classified as LUC 3w1 and LUC 4w. The low hills of variable slope comprised the moderately well drained Hamilton clay loam on undulating slopes (LUC 2e2), undulating to rolling slopes (LUC 3e3) and rolling to moderately steep slopes (LUC 4e2), and imperfectly drained Kainui silt loam on rolling to strongly rolling slopes (LUC 4e3). Finally, a small area of Fill and Truncated Anthropogenic Soil (modified soil) was observed and classified as LUC 4s.

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

Regional scale NZLRI and NZFSL map information showed 75% of the total assessment area was mapped as LUC 2s1 (well drained to imperfectly drained Horotiu-Te Kowhai soil complex on flat to

²² McLeod M. 1992. Soils of part northern Matamata County, North Island, New Zealand. DSIR Land Resources Scientific Report No. 18

undulating slopes), and 25% of the assessment area as moderately well drained Hamilton clay loam (on strongly rolling slopes), classified as LUC 4e2.

Detailed on-site mapping showed discrepancies in the extent of LUC class 2, class 3 and class 4 land and drainage characteristics across the Site. Furthermore, on-site mapping showed the occurrence of Organic Soils within the Site and associated peaty Gley Soils (combined these account for 28% of the Site area).

Of the 62% LUC class 2 land mapped, there was a greater proportion of poorly to imperfectly drained LUC 2w3 land (25% of the Site), only 8% was LUC unit 2s1 (imperfectly to well drained), and 28% of the land was occupied by drained organic and peaty gley soils (Kaipaki peaty loam-Organic Soil and Te Rapa peaty silt loam-peaty Gley Soil, both LUC 2w2). These soils associated with peat land and peat land margins were not shown on the regional scale NZLRI map information. Poorly drained Te Kowhai silt loam (LUC 3w1) and very poorly drained Te Kowhai silt loam (LUC 4w), associated with wet toe slope areas beneath low, but short hills and were also missing from regional scale maps.

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

Site - Orchard Grove:

Regional scale NZLRI-LUC: LUC class 2 - 75%
LUC class 4 – 25%

On-site LUC: LUC class 2 - 62%
LUC class 3 - 10%
LUC class 4 - 15%
NPL - 13%

Detailed on-site assessment showed 49% of the assessment area as high class soil (LUC 2s1, 2e2, 2w2-Te Rapa Series and 2w3) under the WDP-OiP definition for high class soil. The balance, 51% of the Site was LUC 2w2-Kaipaki Series (Organic Soil), LUC 3e3, LUC 3w1, LUC 4e2, LUC 4e3, LUC 4w, and LUC 4s, which are not high class soil. Non-productive areas (13% of the Site) including mapped areas of gravelled races, a pond, extensive drains and shelterbelts, existing dwellings, farm and orchard infrastructure, are not high class soil.

The Site's productive capacity is constrained by soil wetness and erosion susceptibility (slope). The dominant limitations stem from wetness, with LUC 2w3 and LUC 3w1 classified as imperfectly to poorly drained, restricting year-round cropping and horticulture due to high water tables. Similarly, the artificially drained peaty soils of LUC 2w2 will have trafficability issues in wetter months. Consequently, these wetness-affected areas are primarily suited to pastoral land uses with lighter or no stocking during wetter periods, with rotational arable use only potentially viable in drier months. Additionally, land classified as LUC 4e2 or 4e3 has slopes posing a moderate erosion risk under cultivation, and is best reserved for pastoral use or production forestry.

Appendix 1: Enlarged map image from Figure 9.



Appendix 2: Enlarged map image from Figure 10.

