TO:	NZ Cleanfill Limited	Date:	2 May 2024
COPY TO:	Joe Gray (Saddleback Planning Limited)	Document No:	10206-001-1
FROM:	Mark Delaney		

469 RIDGE ROAD DEVELOPMENT: FAST-TRACK APPLICATION – PRELIMINARY ECOLOGICAL ASSESSMENT

Introduction

NZ Cleanfil Limited (NZCL) is intending to lodge an application for a proposed cleanfill at 469 Ridge Road, Pōkeno ('the site') to be listed on the schedule of the Fast-track Approvals Bill. If included on the schedule, it would seek approvals for its proposal using the fast-track process. This memorandum provides a high-level ecological assessment of the proposal, including an evaluation of regional significance of the project's potential contributions to ecology.

Methodology

A conservative, high-level desktop assessment and site walkover (undertaken by an experienced ecologist on 7 February 2024) informed an assessment of the site's existing ecological values. Terrestrial features were assessed based on their botanic and habitat values, the latter of which was qualitatively assessed, considering indigenous lizards, birds and bats. Freshwater features were classified based on the Auckland Unitary Plan Operative in Part (AUP-OP) definitions. Indicative wetland areas were identified based on wetland delineation protocols (MfE 2022; MfE 2021; Clarkson 2013; Fraser et al. 2018) and classified as per the National Policy Statement for Freshwater Management 2020 (NPS-FM) definition of a 'natural inland wetland'.

The key ecological features identified by the assessment are presented in Attachment A. It is noted that these features are indicative and that at future stages of the application, these features will be further defined.

Background

The site is located within the Manukau Ecological District of the Auckland region. Historically (pre-human), the area would have likely been comprised of the pūriri, taraire forest ecosystem type (WF7) and would have supported a diverse range of invertebrates, amphibians, reptiles, birds and bats (Singers et al. 2017). However, historical aerial imagery available for the area (dated 1942) indicates that the site and much of the surrounding landscape has been cleared for over 80 years and utilised for farming practises (Attachment B).

Currently, the site is used for cattle and sheep farming, with two dwellings and a number of farm associated buildings present. It is approximately 76 ha in size and has varied terrain, with a valley-like profile. The site drops away steeply from the Ridge Road boundary towards the centre gully, before rising again towards the rear (north-western) boundary.

Terrestrial ecology

Under the Proposed Waikato District Plan (PDP), there are two areas meeting the definition of a Significant Natural Area (SNA) on the site, where indigenous vegetation remains. The two SNAs are located on the northern slope of the valley bisecting the site. The larger SNA is 1.5 ha and smaller SNA is 0.7h a in area. Vegetation within these SNAs include a mix of mature regenerating native species. Due to the multiple structural tiers and diversity of mature native species within these areas, as well as the proximity of other SNAs in the area, this vegetation is expected to provide high-quality habitat for indigenous fauna.

Other terrestrial values on site were limited to pasture grasses, amenity plantings around dwellings, a small area of exotic planation on the northeastern boundary and extensive areas of restoration planting mainly centred around the central stream.

Freshwater ecology

One central, main permanent stream cuts across the site's gully, flowing north to south. Several small tributaries within the site flow into this central stream. Several areas on site met the NPS-FM definition of a natural inland wetland (as shown in purple in Attachment A). Within the wetlands margins of the central stream, these areas were typically dominated by mercer grass (*Paspalum distichum*), a common pasture species with a facultative wetland (FACW) indicator rating, and exotic rushes such as soft rush (*Juncus effusus* – FACW). The former is an exotic grass species, which, despite it being introduced to New Zealand in the late 1800s for the purpose of supporting livestock grazing, is not recognised by the Ministry for the Environment's National List of Exotic Pasture Species (Cosgrove et al. 2022). The wetlands were highly degraded, with no fencing or riparian margins present, and clear evidence of stock access (i.e., pugging and grazing). In some areas, the wetlands were highly channelised, indicative of deliberate modification. Often no surface water was present in these areas, or, if present, was stagnant or slow moving. Historic aerials of the site indicate that these features have always been wetlands, rather than stream environments (refer Attachment B). Currently, the wetland-stream complex holds very low ecological value. For the wetland areas, this was due to the absence of native species, lack of structural complexity (i.e., limited to herb layer vegetation), low hydrological heterogeneity (e.g., predominantly uniform runs) and the poor, limited aquatic habitat available for fauna. The central stream and its associated wetland margins was considered of high ecological value, due to the extensive wetland and riparian planting, the high hydrological heterogeneity and the diversity of aquatic habitat.

Assessment of Effects

Proposal

NZCL intends to develop the site as a cleanfill. The proposed cleanfill will be concentrated on the eastern side of the site's gully and central stream wetland complex. The earthworks plans associated with the proposal are provided in Attachment C.

Cleanfills, especially large-scale ones, are typically restricted to gullies to accommodate the volumes of fill. As is the case for the site at 469 Ridge Road, gullies naturally contain stream and wetland environments. As such it is difficult if not impossible to avoid the reclamation of streams and/or wetlands. Consequently, the National Environmental Standards for Freshwater (2020) was amended in January 2023 to include a consenting pathway specifically for landfills and cleanfills. This amendment provides a pathway for these activities to manage unavoidable adverse effects on freshwater features in an appropriate way, i.e. through the mitigation hierarchy.

To facilitate its proposal, RSHL requires the reclamation of the wetlands present on the eastern side of the site's gully (conservatively estimated as 1.2-ha of wetland habitat). However, to appropriately mitigate and offset the adverse effects of this action, RSHL propose to undertake the following activities:

- Construct new restoration wetland environments, on the eastern side of the central stream.

- Planting of a buffer around the new restoration wetlands
- Planting of a 10 m buffer around the identified wetlands on the western region of the site in general accordance of Attachment A.
- Planting of a minimum 40 m ecological corridor along the central stream.
- Planting of a 10 m buffer around SNAs.
- Additional planting to connect the western most SNA to the rest of the proposed planting.
- Prepare a fish management plan prior to works occurring.

Effects on terrestrial values

Terrestrial ecological values on site are limited to the two key SNAs. RSHL are not proposing to remove this vegetation. Rather, the proposed planting and restorative works will allow for an increase in habitat quality, native vegetation diversity, ecological connectivity and buffering function of the site's terrestrial values. In light of the region's history of biodiversity loss and ecosystem fragmentation, this proposal presents a significant opportunity for biodiversity gain within the region.

The removal of other, low-value vegetation (i.e., pasture and amenity plantings) is considered appropriate given the site's current land use and the proposed cleanfill. It is not expected that the removal of this vegetation will result in a loss of ecological function or terrestrial habitat.

Effects on freshwater values

The site's existing freshwater values are associated with the main central stream, its associated wetland margins and the wetland tributaries which drain to the central stream.

The proposal will result in the reclamation of approximately 1.2 ha of the eastern wetlands which are significantly degraded and adversely impacted by the site's current land use.

However, a new wetland, comprising equivalent or greater area, will be created of the site to off-set this reclamation. This wetland will be designed in collaboration with engineers, hydrologists and ecologists. The total area of new restoration wetlands will equal, as a minimum, the same area as the proposed reclaimed wetland area. As such, there will be no loss of wetland extent as a result of the cleanfill.

The new restoration wetlands will be designed to include ecological enhancement features such as a diverse native wetland planting mix which will include multiple structural tiers, increased hydrological heterogeneity (e.g., varying depths and pool habitat), additional habitat features (e.g., rootwads, islands, roosting perches, beaches), less edge effects and native buffer planting. Compared to the existing wetlands these proposed new restoration wetlands would provide for a gain in ecological value. Detailed design of the new restoration wetlands will be developed during the future stages of the consent application.

It is also proposed that the new restoration wetlands are constructed first, prior to cleanfill operations. This will effectively eliminate any potentially time lag between impact and offset activities and reduces uncertainty.

The hydrology of the new restoration wetland will be maintained by diverting the existing wetland catchments through subsoil drains, swales and sediment retention ponds. In addition, the wetlands will be designed close to ground water levels.

A fish management plan will be prepared to address the direct effects on native fish. Furthermore, the additional proposed ecological restoration and enhancement activities (e.g., 10 m buffer planting around the retained identified wetlands on the western region, 10 m buffer planting around SNAs and planting of a 40 m ecological corridor along the centre stream) will further compensate for any adverse ecological effects and provide for greater shading, bank stability and filtration for freshwater features, leading to improved water and habitat quality.

Indirect effects, such as sedimentation or pollution from stormwater or wastewater discharges, are proposed to be adequately mitigated through appropriate controls and following best practise guidelines, ensuring adverse effects on ecological values are no more than minor. Where adverse effects cannot be avoided, these will be managed appropriately through the mitigation hierarchy.

Relevant legislation

The proposal is considered to align with the policies and objective of key pieces of environmental legislation, such as the NPS-FM and the National Policy Statement for Indigenous Biodiversity (NPS-IB).

The main objective of the NPS-FM is to ensure the health and well-being of water bodies and freshwater ecosystems are prioritised. To prioritise the health and well-being of freshwater ecosystems on site, RSHL has engaged Viridis to conservatively identify and qualitatively assess these features, so that reclamation or disturbances can be minimised. Potential significant adverse effects for future development will be able to be appropriately avoided, minimised, remedied, offset or compensated for under the effects management hierarchy. Furthermore, the proposal will result in the establishment of riparian planting and a new wetland system, which will improve the overall quality of freshwater environments on site.

The main objective of the NPS-IB is to ensure, at a minimum, that no overall loss in New Zealand's biodiversity occurs by protecting and restoring indigenous biodiversity values. The proposal is considered to be consistent with the objectives of the NPS-IB, as the biodiversity values of the site have been identified, qualitatively assessed, and no loss in terrestrial biodiversity is anticipated as a result of establishment of the cleanfill activity. Rather, the proposal provides the opportunity to significantly improve the site's terrestrial biodiversity through additional planting and maintenance of SNAs, which will improve the overall diversity, connectivity, and native species habitat and quality of the site's terrestrial features.

Conclusion

The potential impacts of RSHL proposed cleanfill at 469 Ridge Road, Pōkeno, have been assessed in relation to the ecological values currently associated with the site. These include areas of high-value indigenous vegetation (SNAs) and a network of wetlands and streams with varying current ecological values. The proposal, though requiring wetland reclamation, is expected to positively impact the site's overall ecological values, due to the proposed off-setting and restorative works. We are confident that the proposed wetland reclamation can be appropriately mitigated, offset and (if required) compensated for in accordance with the NPS-FM and the NES-F. It is expected that not only will there be no overall loss in wetland extent or value, but an overall net biodiversity gain.

References

Clarkson B. 2013. A vegetation tool for wetland delineation in New Zealand. Prepared for Meridian Energy Limited. Hamilton: Manaaki Whenua Landcare Research.

Cosgrove G.; Dodd M.; James T., 2022. National list of exotic pasture species. Prepared for the Ministry for the Environment by AgResearch Ltd. Wellington: Ministry for the Environment.

Fraser et al. 2018. Hydric soils – field identification guide. Report LC3223 prepared for Tasman District Council. Hamilton: Manaaki Whenua – Landcare Research.

McKenzie & Co 2024. Re: Upper Orewa Road Fast Track Application. A memorandum, prepared by McKenzie & Co Limited for Myland Partner Limited. 24 April 2024.

MfE 2021. Wetland delineation hydrology tool for Aotearoa New Zealand. Ministry for the Environment

MfE 2022. Wetland Delineation Protocols. Ministry for the Environment.

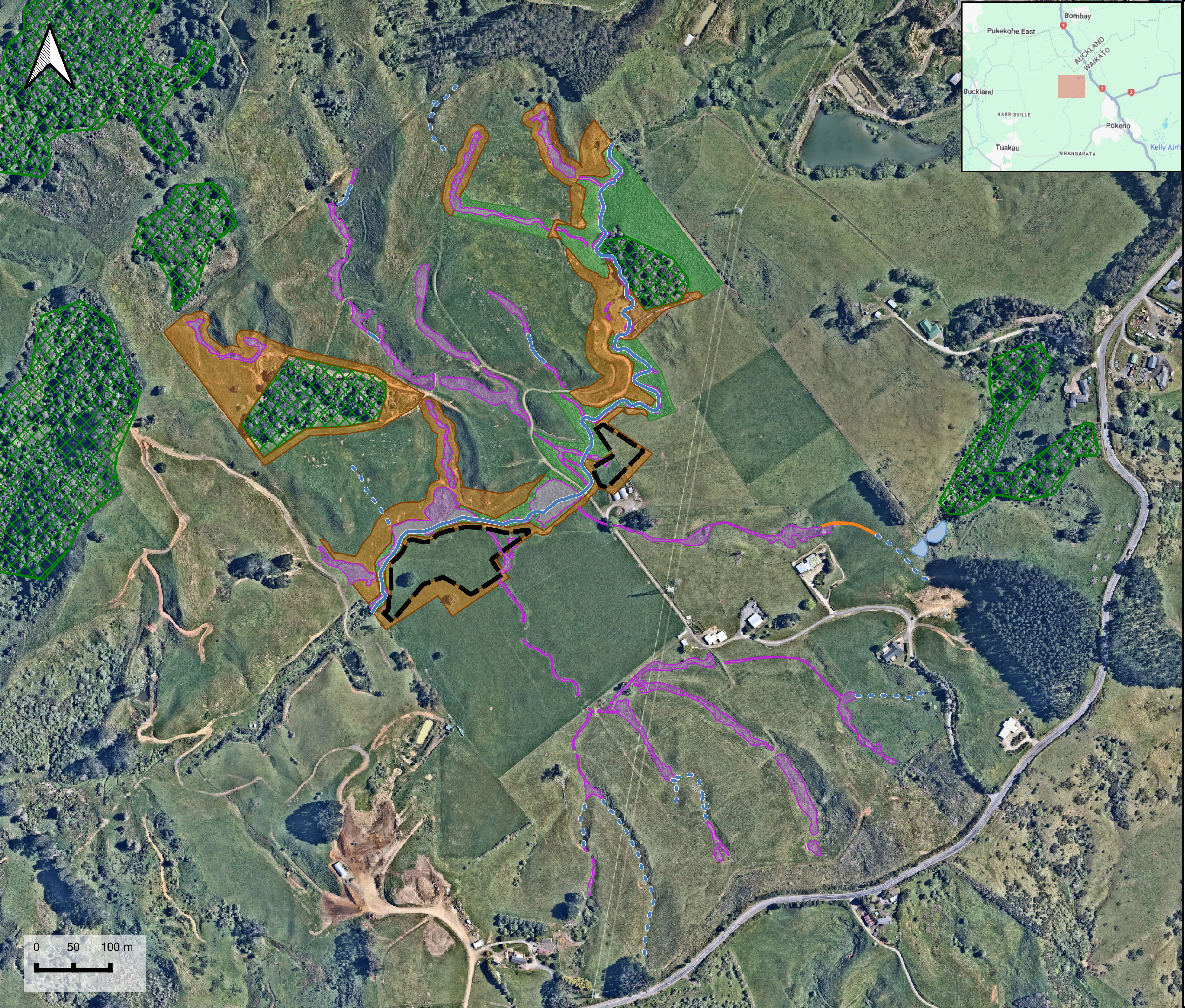
Singers, N.; Osborne, B.; Lovegrove, T.; Jamieson, A.; Boow, J.; Sawyer, J.; Hill, K.; Andrews, J.; Hill, S.; Webb, C. 2017. Indigenous terrestrial and wetland ecosystems of Auckland. Auckland Council.

Attachments

Attachment A – Map of key ecological features

Attachment B – Historic aerial

Attachment C – Site earthworks plan



VIRIDIS
Environmental Consultants

Key ecological features on site

Rock Solid Holdings Limited

Legend

- Significant natural area
- Exisiting native planting
- Natural inland wetlands
- Constructed pond
- Restoration wetlands
- Constructed channel
- Streams
- Ephemeral channels / Overland flow paths

SOURCES

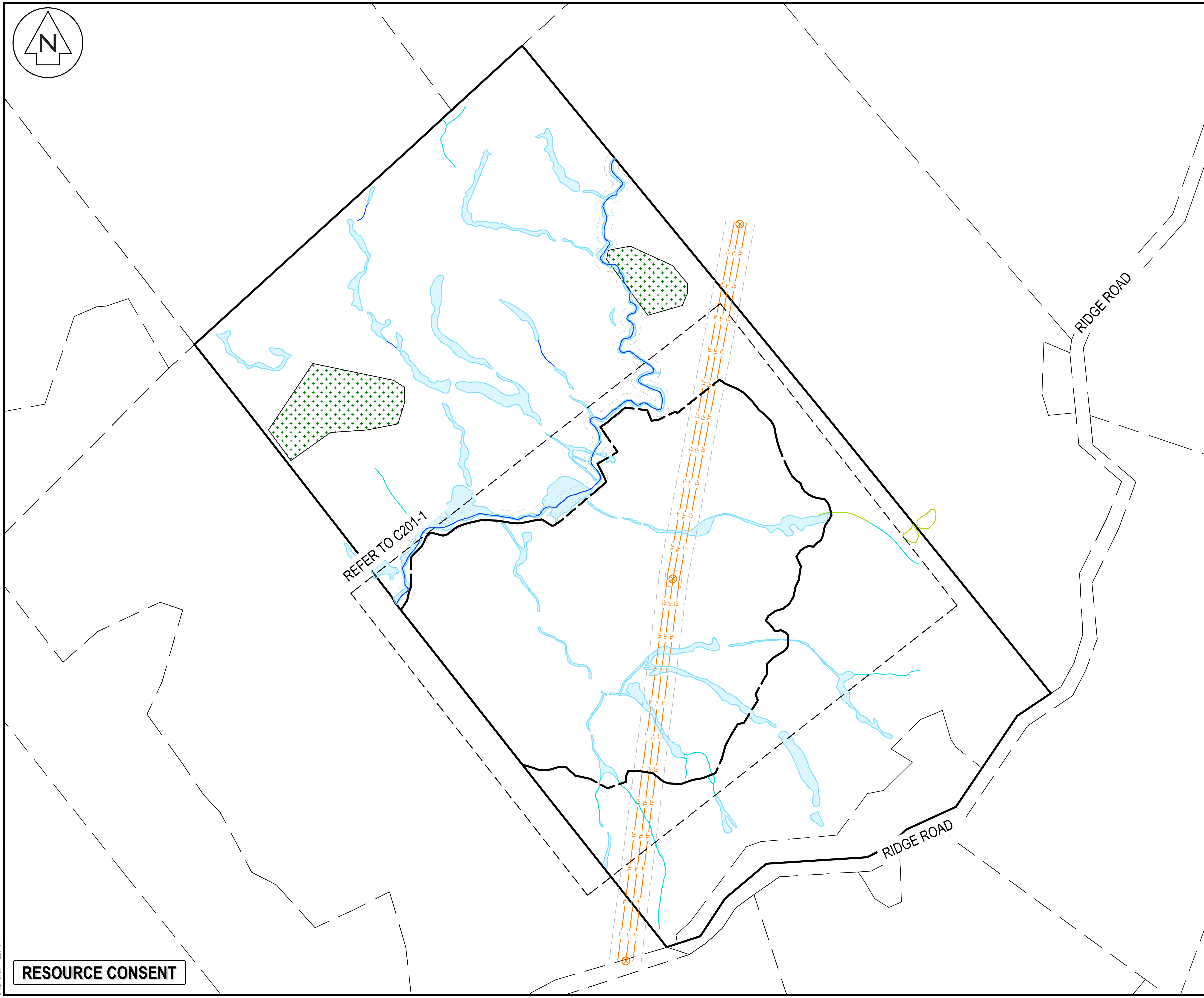
Nearmaps aerial imagery (2023)

DISCLAIMER:
This map/plan is not an engineering draft. This map/plan is illustrative only and all information should be independently verified on site before taking any action.

SCALE **1:6,500** @ A4

PROJECT NO.	10206
DRAWN BY:	A.N
DATE:	24 April 2024

Figure 1. Historic aerial image of the site at 469 Ridge Road, Pokeno, dated 1942.



NOTES
1. ALL WORKS TO BE IN ACCORDANCE WITH AUCKLAND COUNCIL STANDARDS.
2. COORDINATES IN TERMS OF NZ GEODETIC DATUM MT EDEN 2000
3. LEVELS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946.
4. ORIGIN OF LEVELS = SM XXXX SO XXXX(XXXX) PUBLISHED RL=XX.XX, SOURCED FROM THE LINZ DIGITAL GEODETIC DATABASE.
5. IT IS THE CONTRACTORS RESPONSIBILITY TO LOCATE ALL SERVICES THAT MAY BE AFFECTED BY THEIR OPERATIONS.
6. THE CONTRACTOR SHALL COMPLY WITH ALL RELEVANT HEALTH AND SAFETY REQUIREMENTS.
7. THE CONTRACTOR SHALL OBTAIN ALL NECESSARY APPROVAL FROM UTILITY OPERATORS BEFORE COMMENCING WORK UNDER OR NEAR THEIR SERVICES.
8. SEDIMENT CONTROL SHALL BE INSTALLED AND OPERATIONAL BEFORE EARTHWORKS START ONSITE IN ACCORDANCE WITH COUNCIL STANDARDS.
9. CONTRACTOR SHALL PROVIDE AS-BUILT OF WORKING SEDIMENT CONTROL DEVICES AND CONFIRMATION OF POND/DECENT VOLUMES TO ENGINEER.
10. SEDIMENT CONTROL TO COMPLY WITH GD05 STANDARDS.

LEGEND
- EX BDY
- PROP BDY
- PROP EXTENT WORK
- EX SNA
- EX WETLAND
- EX STREAM
- EX TRANSPOWER PYLONS

Rev	Description	By	Date
A	FOR RC	JAW	04/2024

	By	Date
Survey	LIDAR	-
Design	JAW	12/2023
Drawn	JAW	12/2023
Checked	AC	12/2023

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Auckland 1023

Project
BULK EARTHWORK OF 469 RIDGE ROAD POKENO FOR EUROCLASS

Title
PROPOSED EARTHWORK OVERALL PLAN

Project no.	231006
Scale	1:4000@ A3
Cad file	C200 S1-1.DWG
Drawing no.	C200-1
Rev	A

Land Use Capability classification assessment

469 Ridge Road, Pōkeno 2472

Date: 12.4.24

Prepared for: Euroclass
Prepared by: Landsystems

Contents

1. Introduction

An on-site Land Use Capability (LUC) classification assessment of 469 Ridge Road, Pōkeno 2472, totalling 76.1 ha (**Figure 1**), was undertaken in order to confirm the LUC units at property scale and to comply with rules of the Proposed Waikato District Plan (Decisions Version) and the Operative Waikato District Plan (ODP) in relation to the protection of high class soil, and identify the presence and distribution of highly productive land as defined by the National Policy Statement for Highly Productive Land 2022 (NPS-HPL).

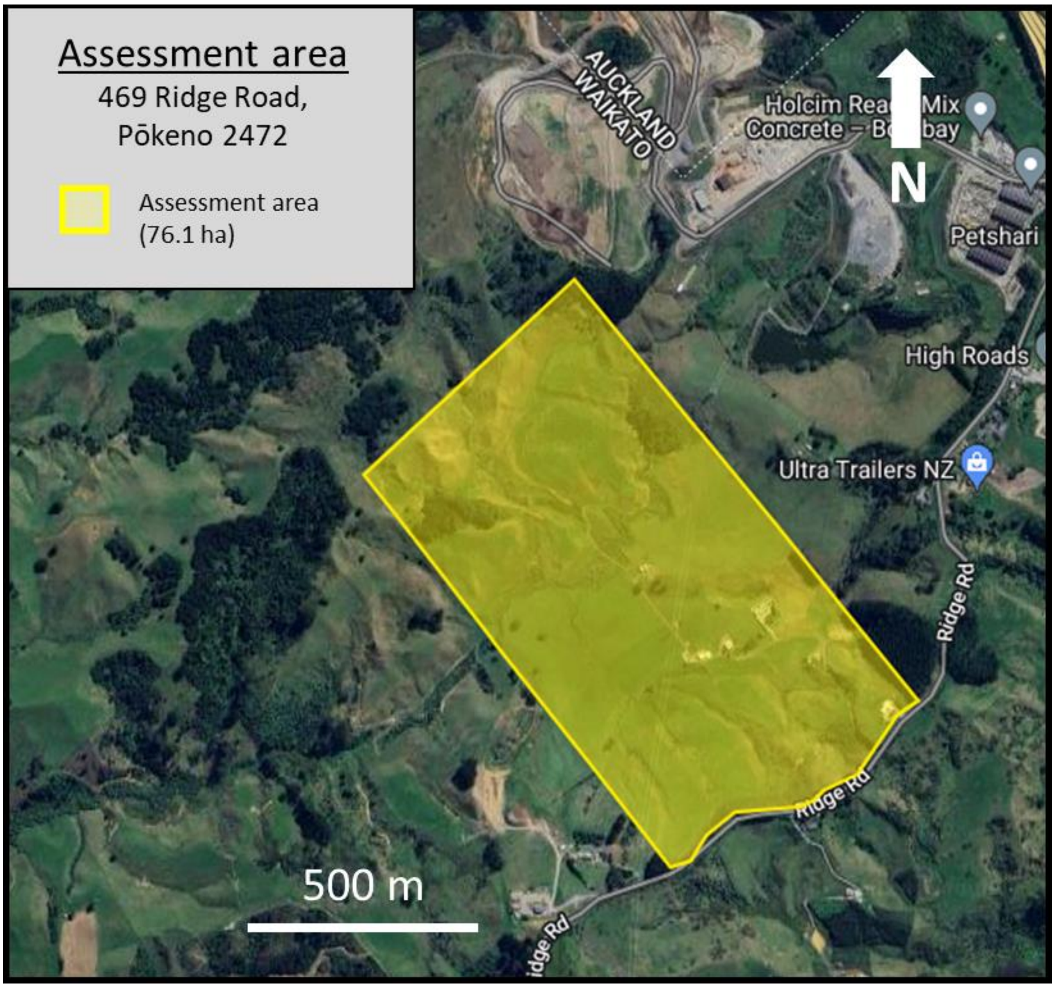


Figure 1*. Assessment area, 469 Ridge Road, Pōkeno 2472.*

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.

Increasing limitations to use ↓ | *Decreasing versatility of use* ↓

LUC Class	Arable cropping suitability†	Pastoral grazing suitability	Production forestry suitability	General suitability
1	High	High	High	Multiple use land
2	↓	↓	↓	
3				
4	Low			
5	Unsuitable			Pastoral or forestry land
6				
7		Low	Low	
8		Unsuitable	Unsuitable	Conservation land

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. Definition of high class soil

The proposed Waikato District Plan - Decisions Version (PDP) defines high quality soil (high class soil) as[2]:

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.

The other applicable definition of high class soil is provided by the Operative Waikato District Plan (ODP):

Land classified as Land Use Capability Class I, II or IIIe, on the New Zealand Land Inventory Worksheets (as amended in the 1986 Second Edition) legend, provided land classified as Class IIIe is further described as containing well and moderately drained soil, in accordance with Milne, J. D. G.; Clayden, B.; Singleton, P. L.; Wilson, A. D. 1995 Soil description handbook (revised edition press). Manaaki Whenua Press, Lincoln, New Zealand.

5. 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 (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.

2 https://www.waikatodistrict.govt.nz/docs/default-source/your-council/plans-policies-and-bylaws/plans/district-plan-review/decisions/proposed-waikato-district-plan-(decisions-version)/part-1-introduction-and-general-provisions/interpretation/part-1_5-interpretation_definitions.pdf?sfvrsn=20e29ac9_2

3 National Policy Statement for Highly Productive Land 2022. September 2022. Effective from the 17th of October 2022.

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".

This assessment has been carried out using the Land Use Capability classification. The estimates of highly productive land in the assessment are based on a LUC classification of 1, 2 or 3.

6. 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:

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

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 in the assessment area are mapped as shown in **Figure 3**. Available NZLRI map information maps the property[6] as a mixture of Brookby clay loam on flat to gently undulating to rolling slopes with an LUC classification of 3e4, Kapu hill soil on moderately steep slopes with a LUC classification of 6e2, and Brookby hill soil and Kapu hill soil complex on moderately steep slopes with a LUC classification of 6e3.

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 is shown in **Table 2**. The estimates were made using Google MyMaps.

***Table 1**. Summary of the NZLRI soil and LUC map unit characteristics in the assessment area.*

Soil type (NZSC Soil Order)	Parent material	Soil drainage	Slope class	LUC unit (limitation)
Brookby clay loam (Ultic Soil)	Waitemata group siltstone, sandstone and tuffaceous sandstone	Imperfectly drained	C+A (0 - 15°)	3e4 (erosion)
Kapu hill soil (Brown Soil)	Hamilton ashes and rhyolitic material	Imperfectly drained	E (21 - 25°)	6e2 (erosion)
Brookby hill soil + Kapu hill soil complex (Ultic Soil and Brown Soil)	Waitemata group siltstone, sandstone and tuffaceous sandstone and Hamilton ashes and rhyolitic material	Imperfectly drained	E (21 - 25°)	6e3 (erosion)

[4] https://lris.scinfo.org.nz/layer/48076-nzlri-land-use-capability-2021/
[5] https://smap.landcareresearch.co.nz/maps-and-tools/app/
[6] https://lris.scinfo.org.nz/layer/48134-nzlri-north-island-edition-2-all-attributes/

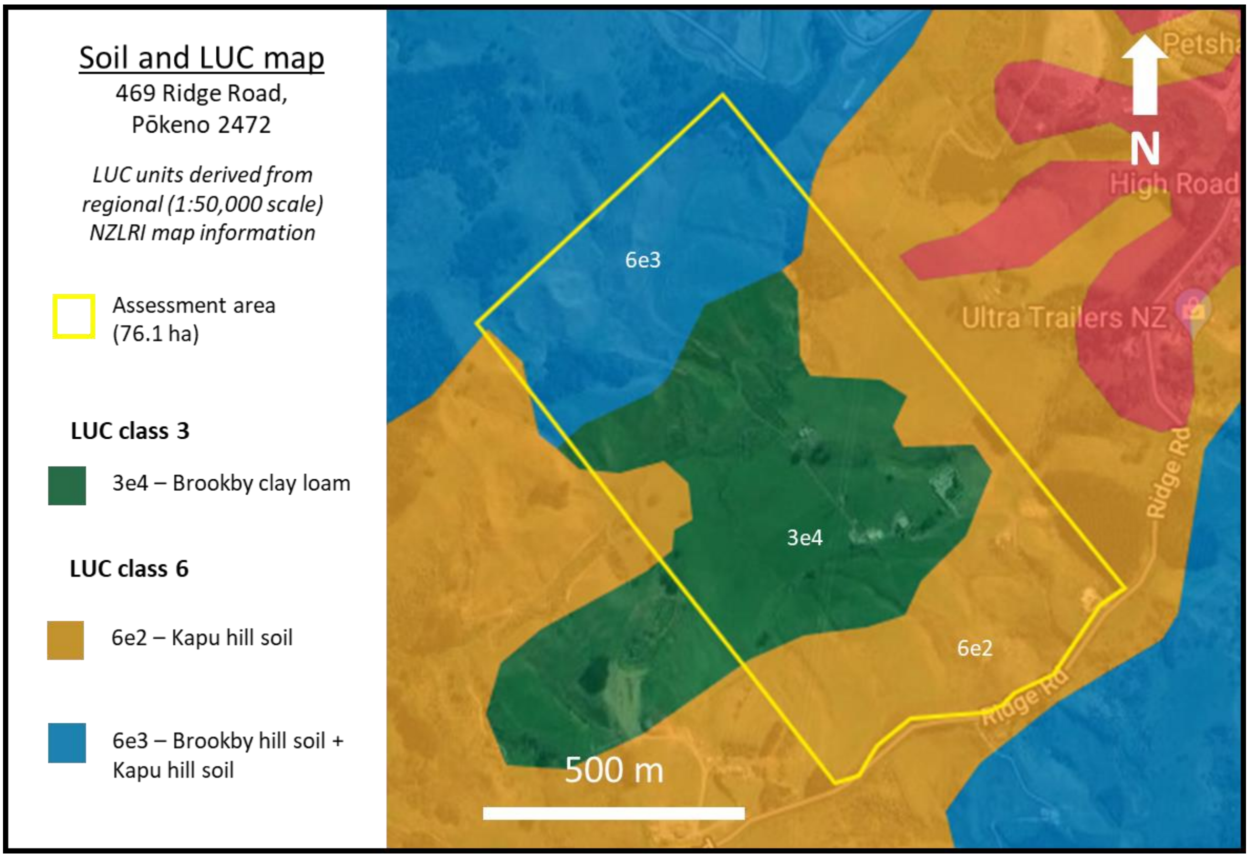


***Figure 3**. LUC units for the assessment area, derived from available regional scale NZLRI map information.*

Based on the available NZLRI and NZFSL map information the soils and LUC map units on the assessment area are: imperfectly drained Brookby clay loam on flat to rolling slopes and classified as LUC 3e4 (38% of the assessment area); imperfectly drained Kapu hill soil on moderately steep slopes, classified as LUC 6e2 (37% of the assessment area); and imperfectly drained complex of Brookby hill soil and Kapu hill soil on moderately steep slopes, classified as LUC 6e3 (25% of the assessment area) (**Tables 1** and **2**).

***Table 2**. Approximate % cover of regional NZLRI derived LUC units (estimated from **Figure 3**), and based on regional NZLRI, HCS-PDP and HCS-OPD high class soil and NPS-HPL highly productive land.*

LUC unit	HCS - PDP	HCS - OPD	NPS - HPL	Assessment area ha (%)*
3e4	Not HCS	Not HCS#	HPL	29.1 (38)
6e2	Not HCS	Not HCS	Not HPL	28.3 (37)
6e3	Not HCS	Not HCS	Not HPL	18.7 (25)

#Not ODP high class soil due to imperfect drainage; *% areas rounded to whole number.

Based on the available 1:50,000 scale NZLRI information and proposed Waikato District Plan (Decisions Version) and Operative Waikato District Plan definitions for high class soil, LUC 3e4, 6e2 and 6e3 are not high class soil.

Based on the available 1:50,000 scale NZLRI information and applying the NPS-HPL, LUC 3e4 land is considered highly productive land and LUC unit 6e2 and 6e3 are not highly productive land (**Figure 4**).

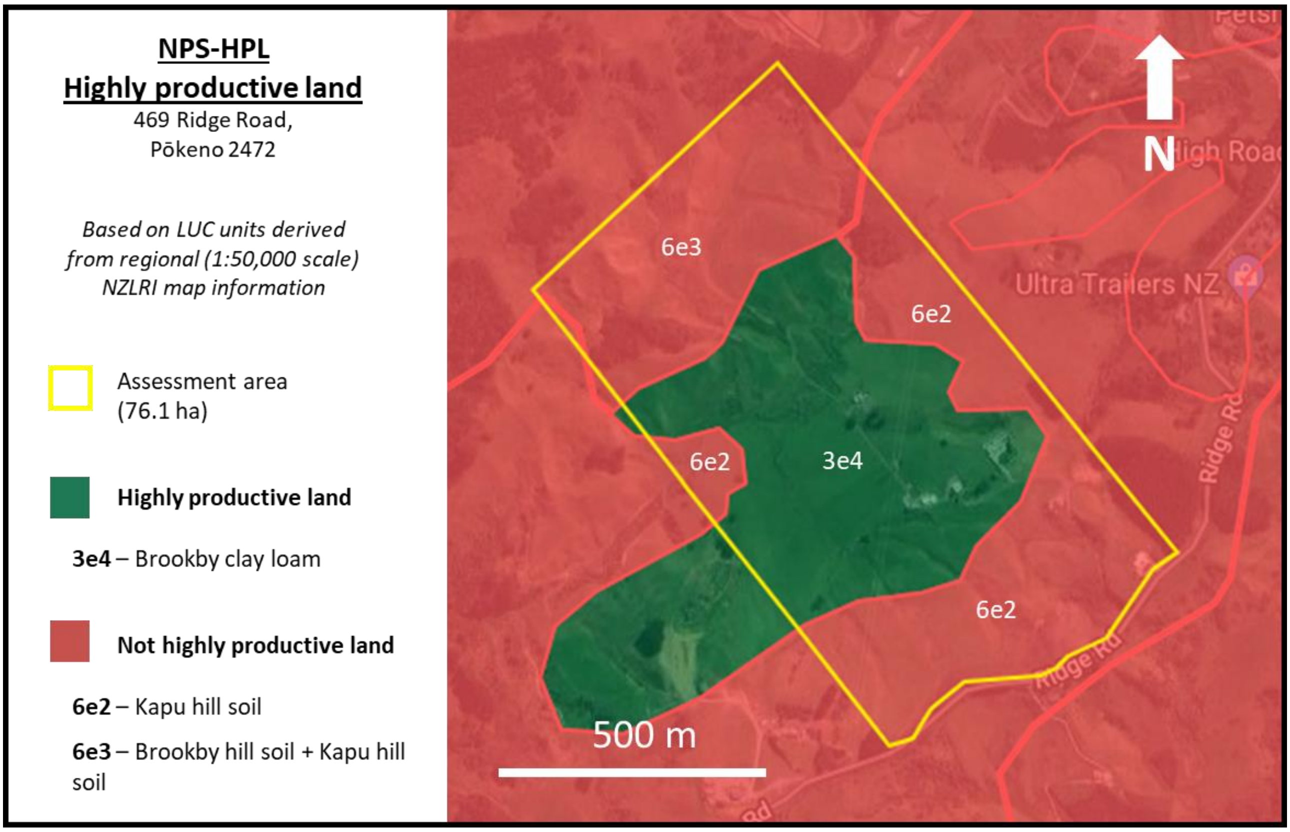


Figure 4. *The distribution of NPS-HPL defined highly productive land based on the NZLRI (1:50,000 scale) map information for the assessment area.*

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 soils in the assessment area as 81% Brown Soil, 18% Granular Soil, less than 1% Gley Soil, and less than 1% Allophanic Soil (**Figure 5**). A simplified S-Map soil sibling map is provided in **Figure 6** with S-Map soil sibling information and the estimated proportion of each soil sibling in the map unit.

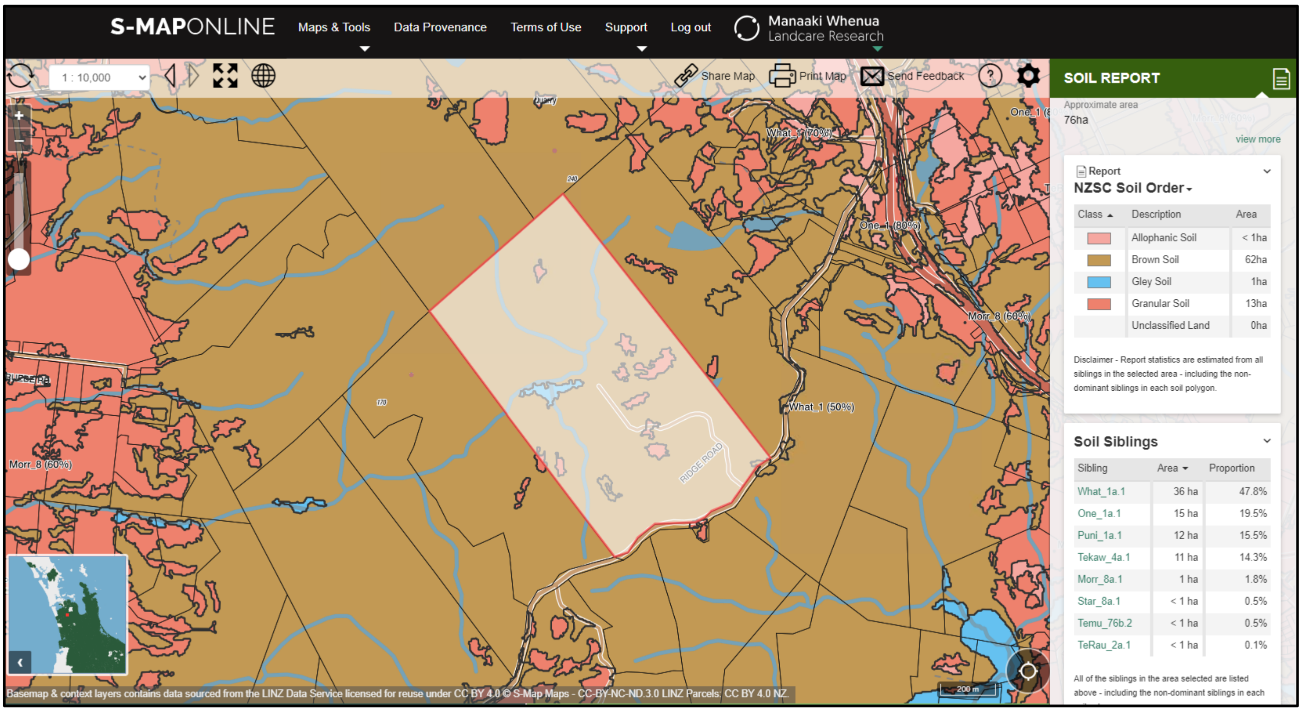


Figure 5. *S-Map soil (Soil Order and soil sibling) distributions for the assessment area.*

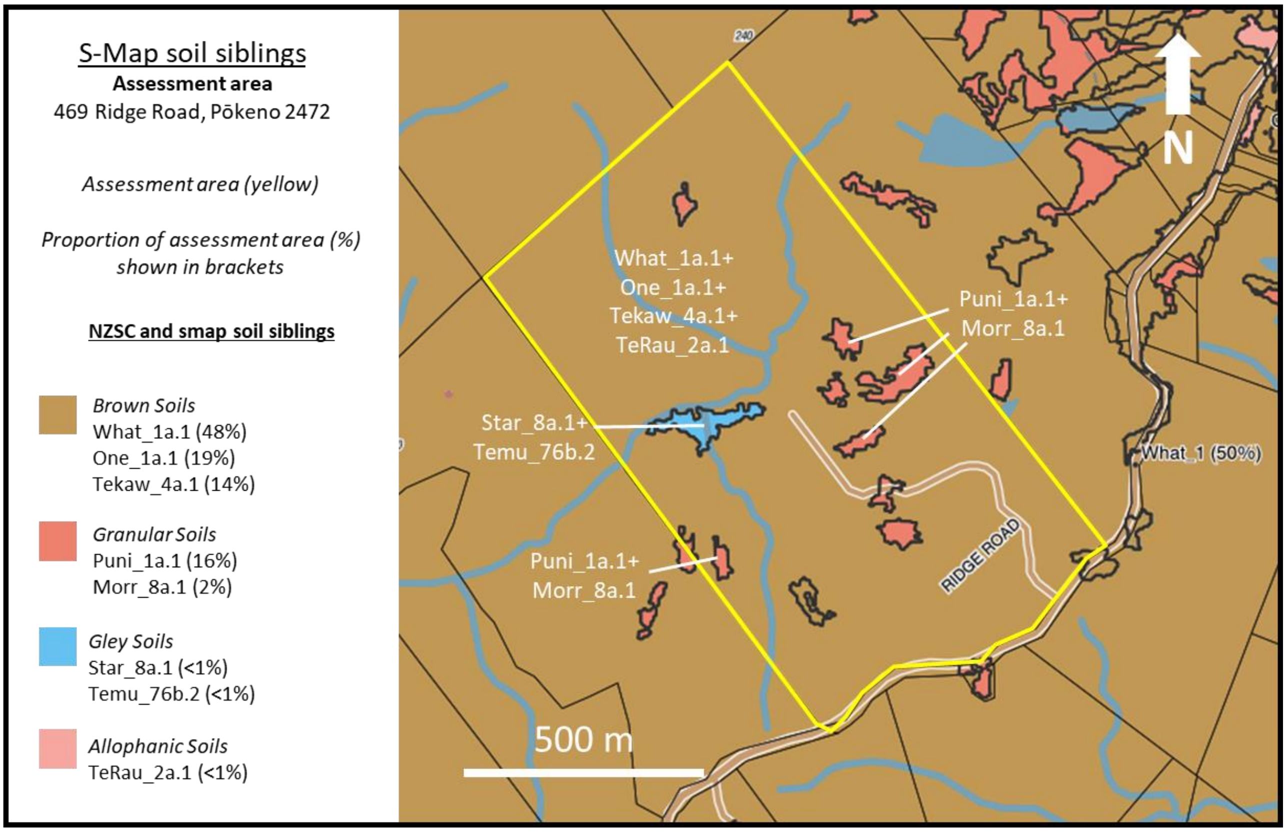


Figure 6. *Simplified S-Map soil sibling map units for the assessment area.*

Table 3 provides a summary of the S-Map soil sibling map unit characteristics, including parent material, soil depth, soil texture and drainage, for the assessment area. This information is derived from S-Map Online factsheets and can be sourced from the S-Map Online website[7]

***Table 3**. S-Map soil sibling map unit characteristics for the assessment area, 469 Ridge Road, Pōkeno 2472.*

S-Map soil sibling	Soil Order[8] (Subgroup code)	Soil material	Soil depth	Soil texture	Soil drainage	Correlated soil series name[9]
What_1a.1	Brown (BMM)	Basalt rock	Deep (> 1m)	Loam	Imperfectly drained	Not available
One_1a.1	Brown (BXT)	Rhyolitic and basalt rock	Deep (> 1m)	Clay	Moderately well drained	Not available
Puni_1a.1	Granular (NOM)	Rhyolitic rock	Deep (> 1m)	Clay	Imperfectly drained	Not available
Tekaw_4a.1	Brown (BMT)	Basalt rock	Deep (> 1m)	Loam	Moderately well drained	Not available
Morr_8a.1	Granular (NOT)	Rhyolitic rock	Deep (> 1m)	Clay	Moderately well drained	Patumahoe
Star_8a.1	Gley (GOO)	Basalt and rhyolitic rock	Moderately deep (40-60 cm)	Loam over clay	Poorly drained	Aka Aka
Temu_76b.2	Gley (GOT)	Rhyolitic and basalt rock	Deep (> 1m)	Clay	Poorly drained	Helvetia
TeRau_2a.1	Allophanic (LOA)	Rhyolitic rock	Deep (> 1m)	Clay	Well drained	Karaka

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.

7. 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 mapped at 1:15,000 to 1:50,000 scale. The Land Use Capability Handbook sets out recommended mapping scales for inventory surveys and LUC mapping (p100).

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

[8]NZSC – New Zealand Soil Classification: Hewitt AE (2010) New Zealand Soil Classification. 3rd ed. Landcare Research Science Series No. 1. Lincoln, Manaaki Whenua Press.

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

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 Lynn et al. (2009)[10] would be required.

8. On-site LUC classification assessment

Method

Landsystems undertook an on-site property scale LUC assessment of the 76.1 ha assessment area, 469 Ridge Road, Pōkeno 2472, according to standard methods (Milne et al., 1993[11] and Lynn et al., 2009[9]). The on-site assessment was undertaken on Friday 8th of March 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 42 soil auger observations (excluding additional observations for checking boundaries) to determine the LUC map units. A higher proportion of observations were undertaken on the site area with potential highly productive land. Details of the 42 observations is provided in **Appendix 1**.

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 Smap 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 . Where no corresponding LUC unit was available, the unit was coded with LUC class and limitation (e.g. 4s).

Mapping scale

The number of soil auger observations across the 76.1 ha Ridge Road site equated to an observation density of 0.55 observations per hectare (or one observation per 1.8 ha). Considering the site area as a whole, this density of observations (using conventional mapping techniques) is sufficient to support a map scale of

[10] 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.

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

between 1:10,000 to 1:15,000.[12] However, a greater proportion of the observations were on the potential highly productive land area in which the supported mapping scale would be closer to 1:10,000 (one observation per ha on average). [13]

9. On-site soil and LUC classification

A summary of the soils and LUC units identified in the assessment area are provided in **Table 4**. The main soils observed 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 4. *Soils and dominant LUC units identified for the assessment area, 469 Ridge Road, Pōkeno 2472 (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)
Patumahoe clay loam (Granular Soil)	Hamilton ashes over basalt	Clay loam	B/A (3-7°)	Deep (100+ cm)	Moderately well drained	2e2 (slope)
Kapu clay loam (Brown Soil)	Hamilton ashes over various lithologies	Clay loam	B/A (3-7°)	Deep (100+ cm)	Imperfectly to moderately well drained	2e2 (slope)
Rotokauri clay loam (Gley Soil)	Alluvium and colluvium of mixed lithologies	Clay loam	A (0 -3°)	Deep (100+ cm)	Imperfectly drained	2w3 (wetness)
Patumahoe clay loam (Granular Soil)	Hamilton ashes over basalt	Clay loam	C/B (6 - 13°)	Deep (100+ cm)	Moderately well drained	3e2 (slope)
Kapu clay loam (Brown Soil)	Hamilton ashes over various lithologies	Clay loam	C+B (4 - 15°)	Deep (100+ cm)	Moderately well drained	3e2 (slope)
Rotokauri clay loam (Gley Soil)	Alluvium and colluvium of mixed lithologies	Clay loam	A (0 -3°)	Deep (100+ cm)	Poorly `drained	3w2 (wetness)
Truncated Anthropic Soil (Patumahoe clay loam)	Hamilton ashes over basalt	Clay loam over heavy clay	B (4 - 7°)	Very shallow (< 5 cm)	Poorly drained	4s* (soil)
Kapu clay loam (Brown Soil)	Hamilton ashes over various lithologies	Clay loam	C (8 - 15°)	Deep (100+ cm)	Moderately well drained	4e2 (slope)
Brookby clay loam (Ultic Soil)	Weathered sedimentary rocks	Clay loam	D/C (18 -20°)	Deep (100+ cm)	Moderately well drained	4e3 (slope)
Rotokauri clay loam (Gley Soil)	Alluvium and colluvium of mixed lithologies	Clay loam	A (0 -3°)	Deep (100+ cm)	Very poorly drained	4w1 (wetness)
Kapu clay loam (Brown Soil)	Hamilton ashes over various lithologies	Clay loam	E/F (24 - 28°)	Deep (100+ cm)	Moderately well drained	6e2 (slope)
Brookby hill soil (Ultic Soil)	Weathered sedimentary rocks	Clay loam	E+D (16 - 25°)	Deep (100+ cm)	Moderately well drained	6e3 (slope)
Modified soil / non-productive land	Tracks, drains and seeps, native vegetation, riparian plantings and existing dwellings					-

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

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

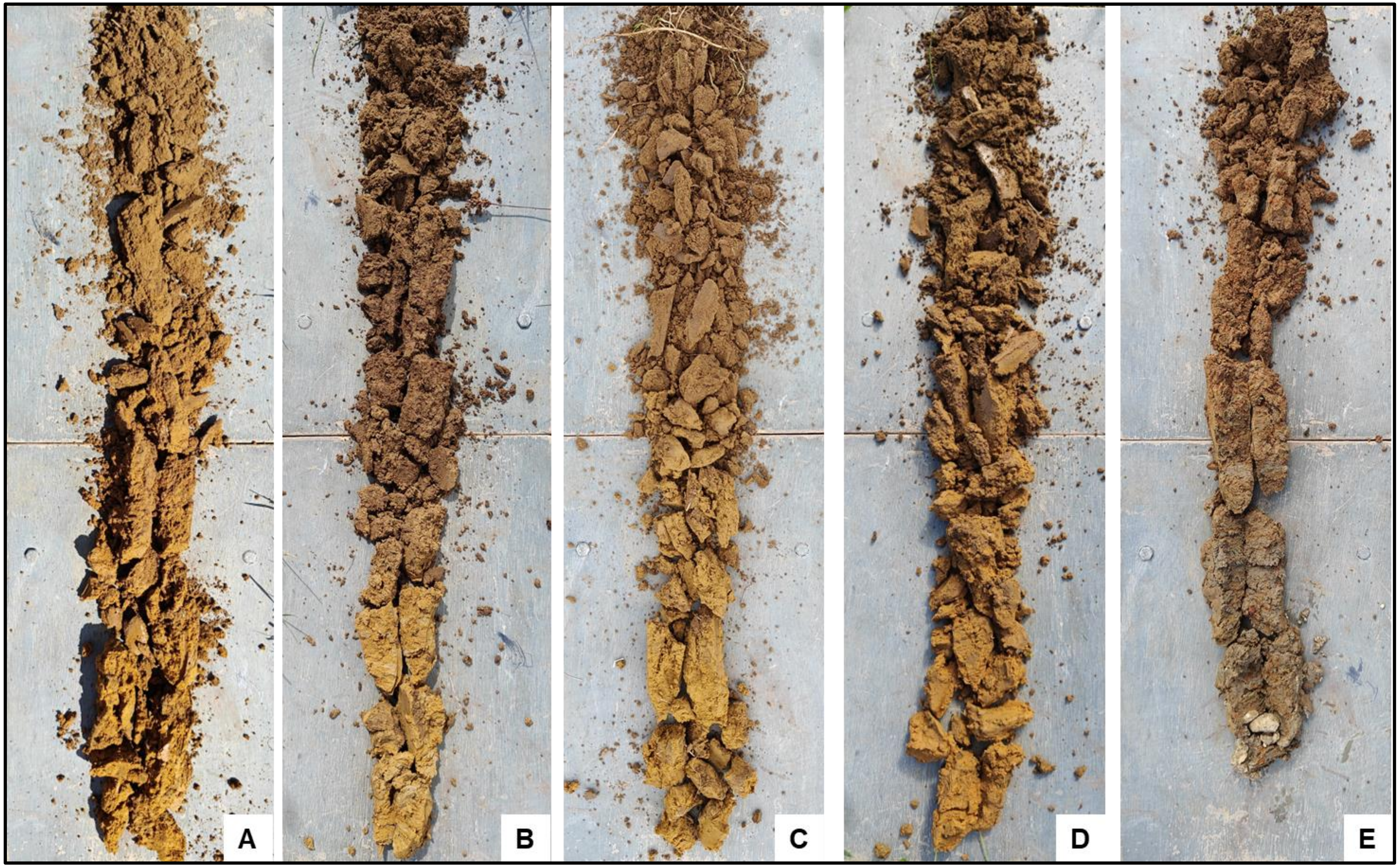


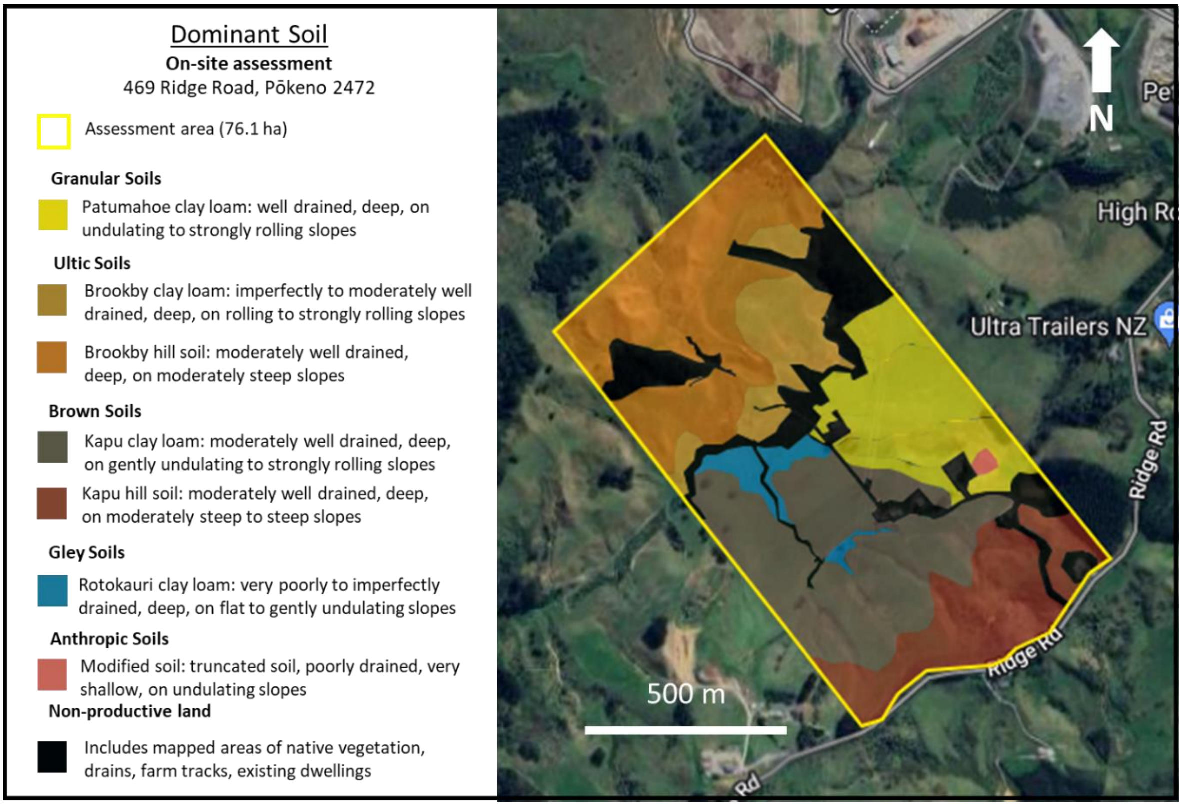
Figure 7. *Example soil profiles of the dominant soils identified in assessment area. A) Patumahoe clay loam, LUC 2e2 on B slopes; B) Rotokauri clay loam, LUC 2w3 on A slopes; C) Kapu clay loam, LUC 3e2 on C slopes; D) Patumahoe clay loam, LUC 3e2 on C slopes; E) Rotokauri clay loam, LUC 3w2 on A slopes.*

The detailed on-site assessment showed the gently undulating to rolling slopes of the eastern boundary of the assessment area comprised moderately well drained, deep, Patumahoe clay loam (**Figure 7A**, **7D** and **Figure 8**)[14] (Granular Soil within the New Zealand Soil Classification[15]), assigned an LUC classification of 2e2 and 3e2. There was a small area near an existing dwelling of modified Patumahoe clay loam which has been reclassified as an Anthropic Soil due to truncation resulting in a very shallow soil (topsoil now less than 5 cm in thickness) on heavy clay subsoil. This small area was mapped as LUC 4s*.

In the central region of the assessment area on gently undulating to strongly rolling slopes, the imperfectly to moderately well drained, deep, Kapu clay loam (Brown Soil) was observed (**Figure 7C** and **Figure 8**) and assigned LUC 2e2 and 3e2 (moderately well drained). On the southern boundary of the assessment area the Kapu hill soil, a moderately well drained, deep soil on moderately steep to steep slopes was found and had an LUC classification of 6e2.

In the northern part of the assessment area on rolling to strongly rolling slopes, the imperfectly to moderately well drained, deep, Brookby clay loam (Ultic Soil), LUC 4e3 occurred, and on moderately steep slopes, the moderately well drained, deep, Brookby hill soil **(Figure 8)** occurred, and was assigned an LUC classification of 6e3.

There were also areas of non-productive land within the assessment area, including existing dwellings with curtilage, farm infrastructure, drains, wetland areas, areas of native vegetation and farm tracks (**Figure 8**). In low-lying areas and toe-slopes in the central part of the assessment area, poorly to very poorly drained, Rotokauri clay loam (Gley Soil) is found, and assigned an LUC classification of 2w3 (imperfectly drained) (**Figure 7B**), or 3w2 (poorly drained) or 4w1 (very poorly drained) (**Figure 7E**).



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[14] A larger version of this map is provided in Appendix 2.

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

Figure 8. *The distribution of dominant soils for the assessment area, 469 Ridge Road, Pōkeno 2472*

The estimated distribution of dominant soils, LUC classes and LUC units are given in **Figure 9** (a larger version of this map is provided in **Appendix 3**).

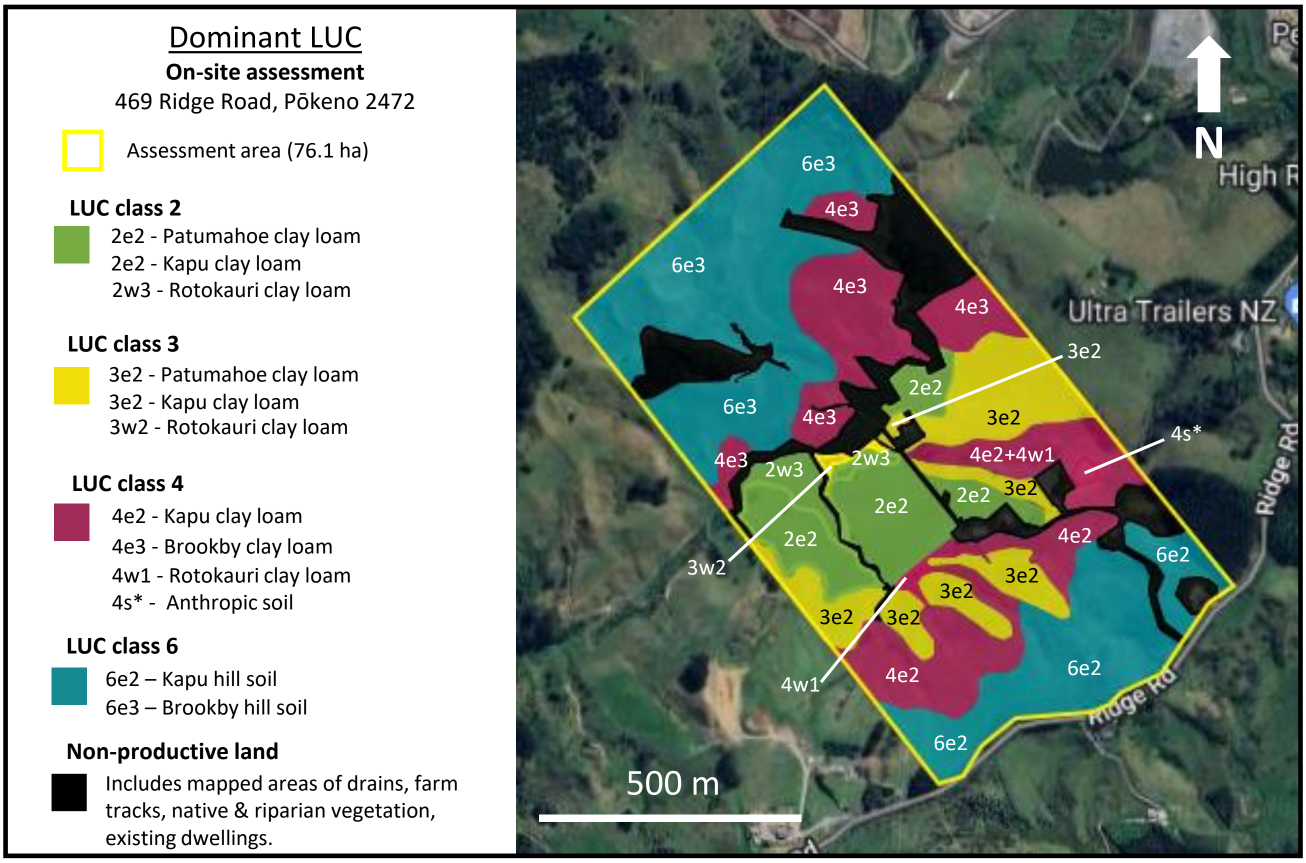


Figure 9. *The distribution of dominant soils, LUC classes and units for the assessment area, 469 Ridge Road, Pōkeno 2472*

10. Revised LUC classification

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

Based on the regional scale NZLRI map information (shown in **Figure 3**), 38% of the total assessment area was mapped as LUC 3e4 (imperfectly drained Brookby clay loam), 37% as 6e2 land (moderately well drained Kapu hill soil) and 25% as LUC 6e3 (moderately well drained Brookby hill soil and Kapu hill soil complex) (refer **Table 2**).

However, detailed on-site mapping showed some discrepancies in the extent of LUC class 3 land, and occurrence of LUC class 2 land that was not shown in regional mapping (refer **Tables 5** and **6**). LUC class 3 land was overestimated (detailed mapping at 13%), whereas 12% of the assessment area was LUC class 2 land, and 15% of the area was mapped as non-productive land, including extensive native trees, wetlands, drains, farm tracks and existing dwellings. The balance, 60%, was mapped as LUC class 4 (23%) and LUC class 6 (37%) land.

11. On-site high class soil

Regional scale assessment showed no soils within assessment area as Proposed Waikato District Plan and Operative Waikato District Plan high class soil (refer **Table 2**). This was due to the LUC 3e4 Brookby clay loam being mapped as having imperfect drainage.

Detailed on-site assessment showed drainage of these LUC class 3 soils was better than anticipated (i.e. moderately well drained, refer **Figure 7C** and **7D**), and therefore classifying LUC 3e2 and 3e4 areas as high class soil under the Operative Waikato District Plan definition (**Table 5** and **Figures 10** and **11**).

Table 5*. High class soil within the assessment area, based on the LUC map units identified by the on-site assessment.*

LUC unit (dominant)	HCS - PDP	HCS - OPD	Area ha, (%)$
2e2	High class soil	High class soil	7.8 (10)
2w3	High class soil	High class soil	1.5 (2)
3e2	Not high class soil	High class soil	9.6 (13)
High class soil total			HCS-PDP = 9.3 (12) HCS-ODP = 18.9 (25)
3w2	Not high class soil	Not high class soil	0.3 (<1)
4e2	Not high class soil	Not high class soil	8.0 (11)
4e2+4w1	Not high class soil	Not high class soil	3.2 (4)
4e3	Not high class soil	Not high class soil	6.0 (8)
4w1	Not high class soil	Not high class soil	0.3 (<1)
4s*	Not high class soil	Not high class soil	0.2 (<1)
6e2	Not high class soil	Not high class soil	10.6 (14)
6e3	Not high class soil	Not high class soil	17.5 (23)
NPL^	Not high class soil	Not high class soil	11.2 (15)
Not high class soil total			Not HCS-PDP = 66.9 (88) Not HCS-ODP = 57.2 (75)

$ % areas rounded to whole number; * LUC class and limitation only; ^ NPL = Non-productive land/modified soil.

Applying the Proposed Waikato District Plan (Decisions Version) definition for high class soil, LUC 2e2 and 2w3 are classified as high class soil. LUC 3e2, 3w2, 4e2, 4e3, 4w1, 4s*, 6e2 and 6e3 are not high class soil. Modified soil areas are not high class soil.

Applying the Operative Waikato District Plan definition for high class soil, LUC 2e2, 2w3, and 3e2 are classified as high class soil. LUC 3w2, 4e2, 4e3, 4w1, 4s*, 6e2 and 6e3 are not high class soil. Modified soil areas are not high class soil.

Therefore, applying the PDP definition for high class soil, an estimated 9.3 ha (12%) is classified as high class soil. The balance of the area, 88%, is not high class soil, with 55.7 ha (73%) soils that are not high class and 11.2 ha (15%) of modified soil or non-productive land.

Applying the ODP definition for high class soil, an estimated 18.9 ha (25%) of the assessment area is classified as high class soil. The balance, or 75%, is not high class soil, including 46.0 ha (60%) comprising soils that are not high class and 11.2 ha (15%) of modified soil or non-productive land.

The distribution of PDP and ODP high class soil is shown in **Figures 10** and **11** (larger versions of these maps are provided in **Appendix 4** and **5**).

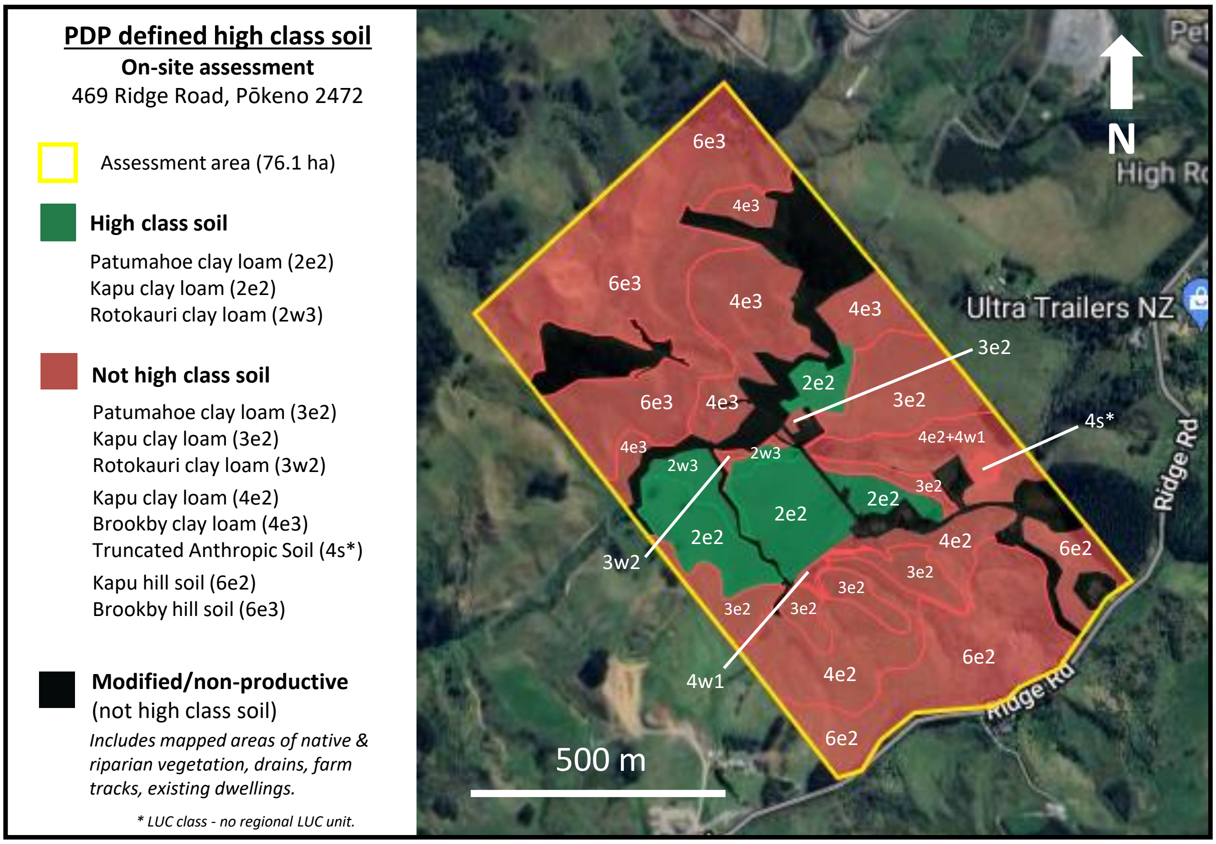


Figure 10. *The distribution of PDP high class soil within the assessment area.*

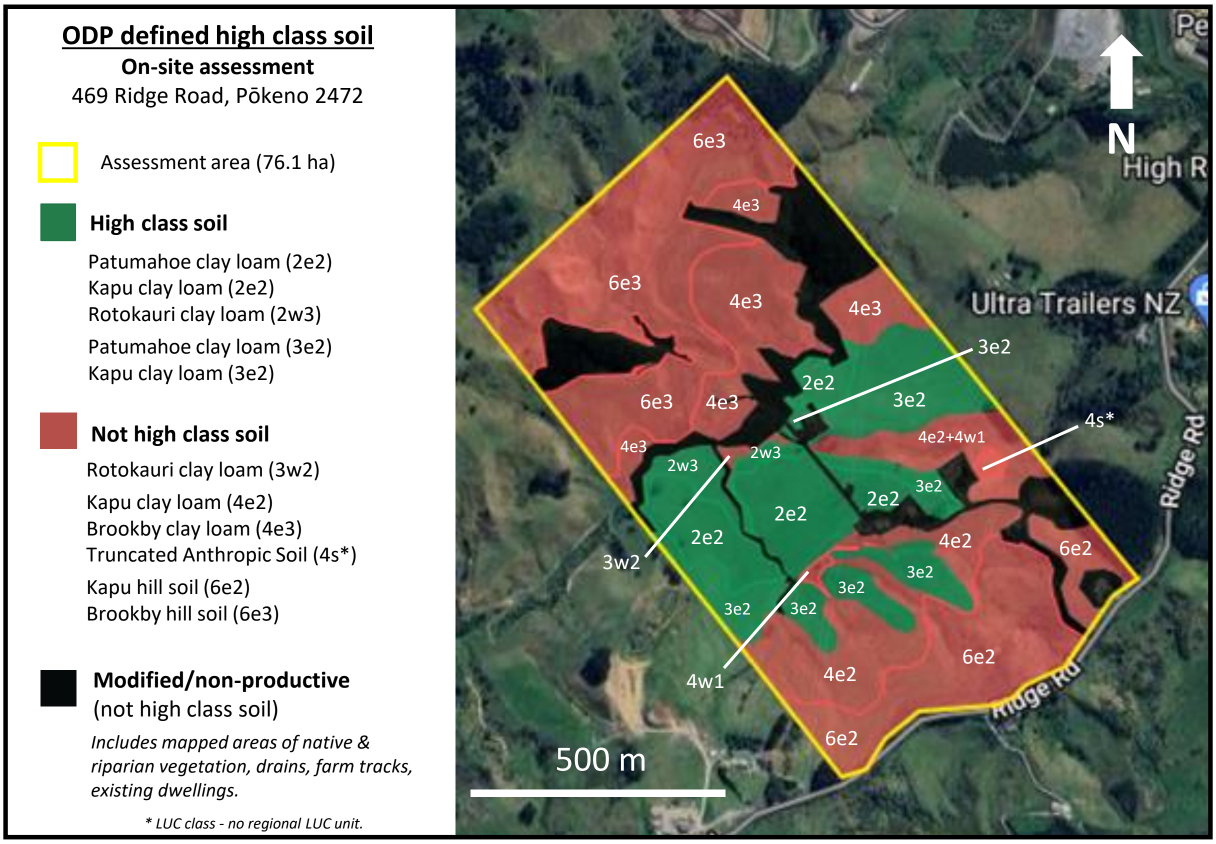


Figure 11. *The distribution of ODP high class soil within the assessment area.*

12. On-site NPS-HPL highly productive land

The LUC map units for the assessment area are further classified according to the NPS-HPL highly productive land (**Table 6**).

Table 6*. NPS-HPL highly productive land for the entire assessment area, based on the LUC map units identified by the on-site assessment.*

LUC unit (dominant)	NPS-HPL highly productive land (HPL)	Area ha, (%)$
2e2	HPL	7.8 (10)
2w3	HPL	1.5 (2)
3e2	HPL	9.6 (13)
3w2	HPL	0.3 (<1)
HPL total		19.1 (25)
4e2	Not HPL	8.0 (11)
4e2+4w1	Not HPL	3.2 (4)
4e3	Not HPL	6.0 (8)
4w1	Not HPL	0.3 (<1)
4s*	Not HPL	0.23 (<1)
6e2	Not HPL	10.6 (14)
6e3	Not HPL	17.5 (23)
NPL^	Not HPL	11.2 (15)
Not HPL total		57.0 (75)

$ % areas rounded to whole number; * LUC class and limitation only; ^ NPL = Non-productive land/modified soil.

Based on the interpretation of NPS-HPL clause 3.5(7), LUC units 4e2, 4e2+4w1, 4e3, 4w1, 4s*, 6e2 and 6e3 are not highly productive land, and LUC 2e2, 2w3, 3e2 and 3w2 are highly productive land. The areas of non-productive land are not highly productive land.

Of the land within the entire assessment area:

- 25% is highly productive land (LUC class 2 and 3),
- 60% of the land area is productive land but not highly productive land (LUC class 4 and 6), and
- 15% of the land area is non-productive land, and not highly productive land.

The distribution of NPS-HPL highly productive land is shown in **Figure 12** (a larger version of this map is provided in **Appendix 6**).

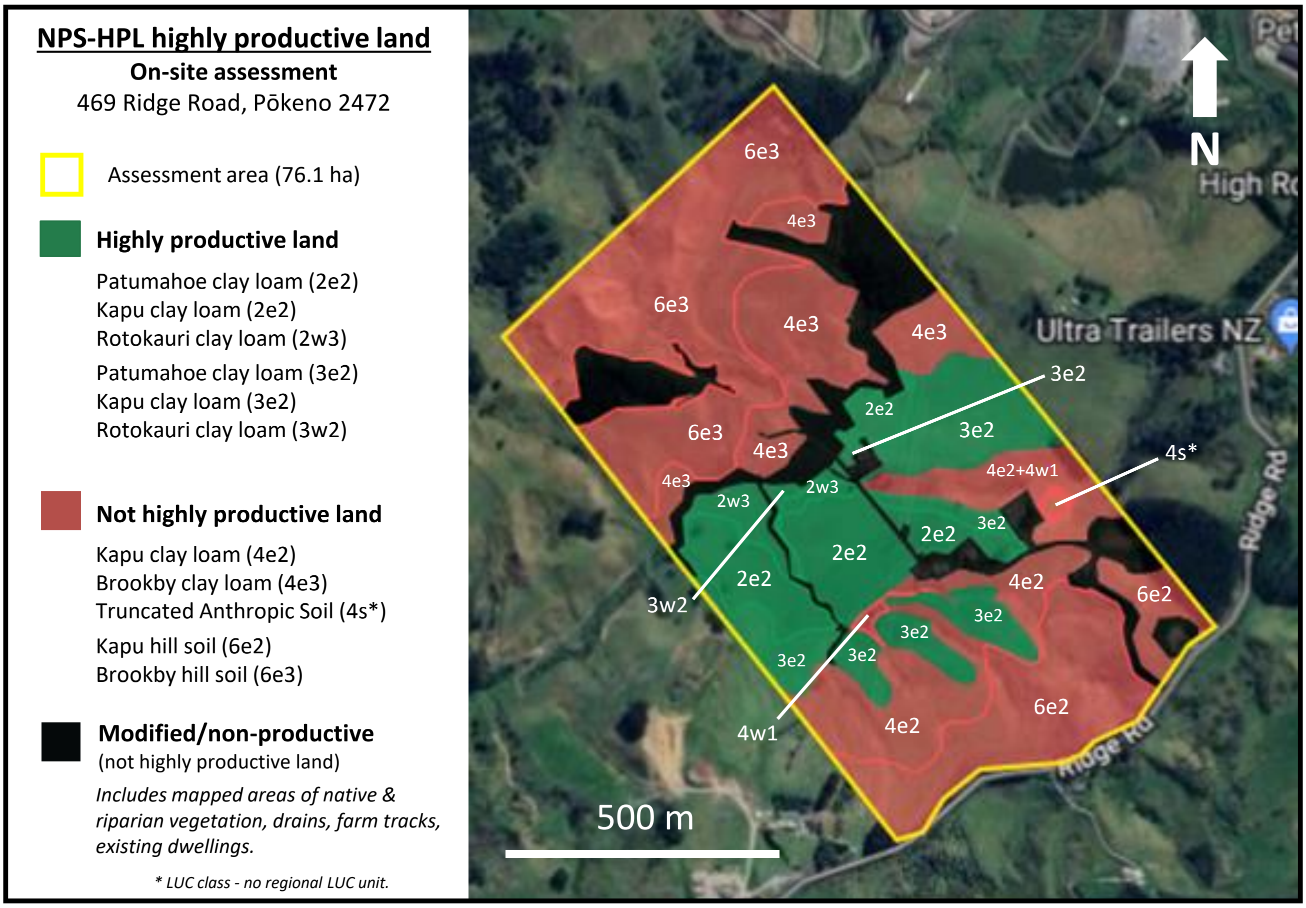


***Figure 12**. The distribution of NPS-HPL highly productive land within the assessment area.*

13. NPS-HPL comments

The detailed on-site LUC assessment classified 25% of the assessment area as NPS-HPL highly productive land (LUC 2e2, 2w3, 3e2, and 3w2) with the balance of the area (75%) not highly productive land (LUC class 4 and 6 and non-productive land).

Of the highly productive land, there are areas of LUC 3e2 land that are somewhat fragmented by surrounding steeper (LUC 4e2) land. The small size of the fragmented LUC 3e2 land and topographic limitations of the surrounding LUC4e2 land may restrict the range of land uses that are practical.

The soil wetness limitations of the LUC 2w3 and 3w2 land will restrict year round cropping (summer months only) and horticultural use. These areas are most suited to pastoral land uses, with no or lighter stocking in wetter months.

14. Cleanfill and soil remediation

Development of the site proposes to fill the flat to strongly rolling areas with cleanfill. The resulting cleanfill area aims to have the soil and land restored to a condition of highly productive land as defined by the NPS-HPL (LUC class 2-3 land).

Soil restoration occurs once the usual earth moving and engineering consolidation procedures have completed filling and shaping the surface. The procedure for soil restoration is outlined in **Appendix 7**.[16]

To achieve this, topsoil and subsoil (overlying the cleanfill), will be stored separately and replaced in sequence on the areas to be restored.

The method of restoration, provided by soil remediation guidelines, will ensure the final soil is as productive as undisturbed soils on similar slopes.

Following cleanfill placement and subsequent soil restoration, it is probable that the productive capacity of the site will be increased by the replacement of the steeper land (strongly rolling LUC 4e2 land), with undulating to rolling LUC class 2-3 land.

Another key potential improvement would be that the current non-contiguous areas of LUC 3e2 land will become contiguous allowing for improved utilisation of the site for productive use.

15. Summary

The detailed on-site assessment showed approximately 60% of the assessment area comprised moderately well drained, deep, Patumahoe clay loam, Brookby clay loam, Kapu clay loam, Brookby hill soils, and Kapu hill soils on rolling to moderately steep slopes (LUC 4e2, 4e3, 6e2 and 6e3) and very poorly drained Rotokauri clay loam, LUC 4w1. Of the balance, 25% of the assessment area comprised moderately well drained, deep, Patumahoe clay loam on undulating to rolling slopes (LUC 2e2 and 3e2), imperfectly to moderately well drained Kapu clay loam (LUC 2e2), moderately well drained Kapu clay loam (LUC 3e2), poorly to very poorly drained Rotokauri clay loam (LUC 2w3 and 3w2), and 15% non-productive land.

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

<u>Assessment area:</u>	
Regional scale NZLRI LUC:	LUC class 6 - 62%
	LUC class 3 - 38%
Detailed on-site LUC mapping:	LUC class 6 - 37%
	LUC class 4 - 23%
	NPL - 15%
	LUC class 3 - 13%
	LUC class 2 - 12%

Based on LUC classification alone:

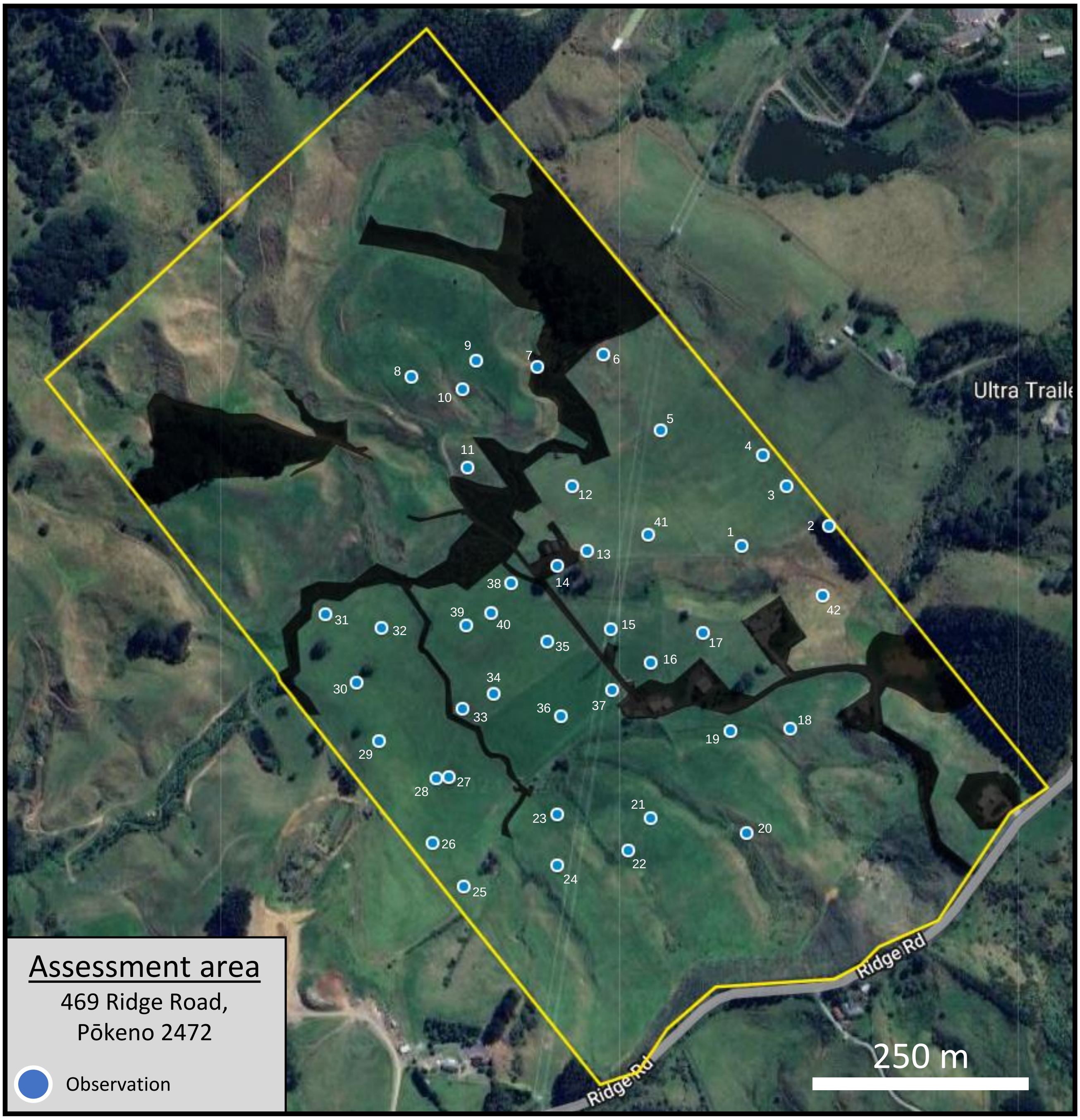
- Applying the Proposed Waikato District Plan (Decisions Version) definition for high class the assessment area has 12% high class soil (LUC 2e2 and 2w3).
- Applying the Operative Waikato District Plan definition for high class soil, the assessment area has 25% high class soil (LUC 2e2, 2w3 and 3e2).
- The areas classified as LUC 2e2, 2w3, 3e2, and 3w2 (25% of the assessment area) are potentially NPS-HPL, highly productive land.
- The areas classified as LUC 4e2, 4e3, 4s*, 4e2+4w1, 4w1, 6e2 and 6e3 (60% of the assessment area) are not highly productive land.
- The non-productive land areas (15% of the entire assessment area) are not highly productive land.

[16] These guidelines (on their own do not constitute a soil management plan.

Some of the highly productive land areas are somewhat are fragmented by land that is not classed as highly productive land (e.g., LUC 4e2, 4e3, 4s*, 4e2+4w1, 4w1 land). Therefore, the range of land uses that are practical may be restricted due to the small size of the fragmented highly productive land areas and topographic limitations (rolling to moderately steep slopes) of the surrounding land that is not highly productive land.

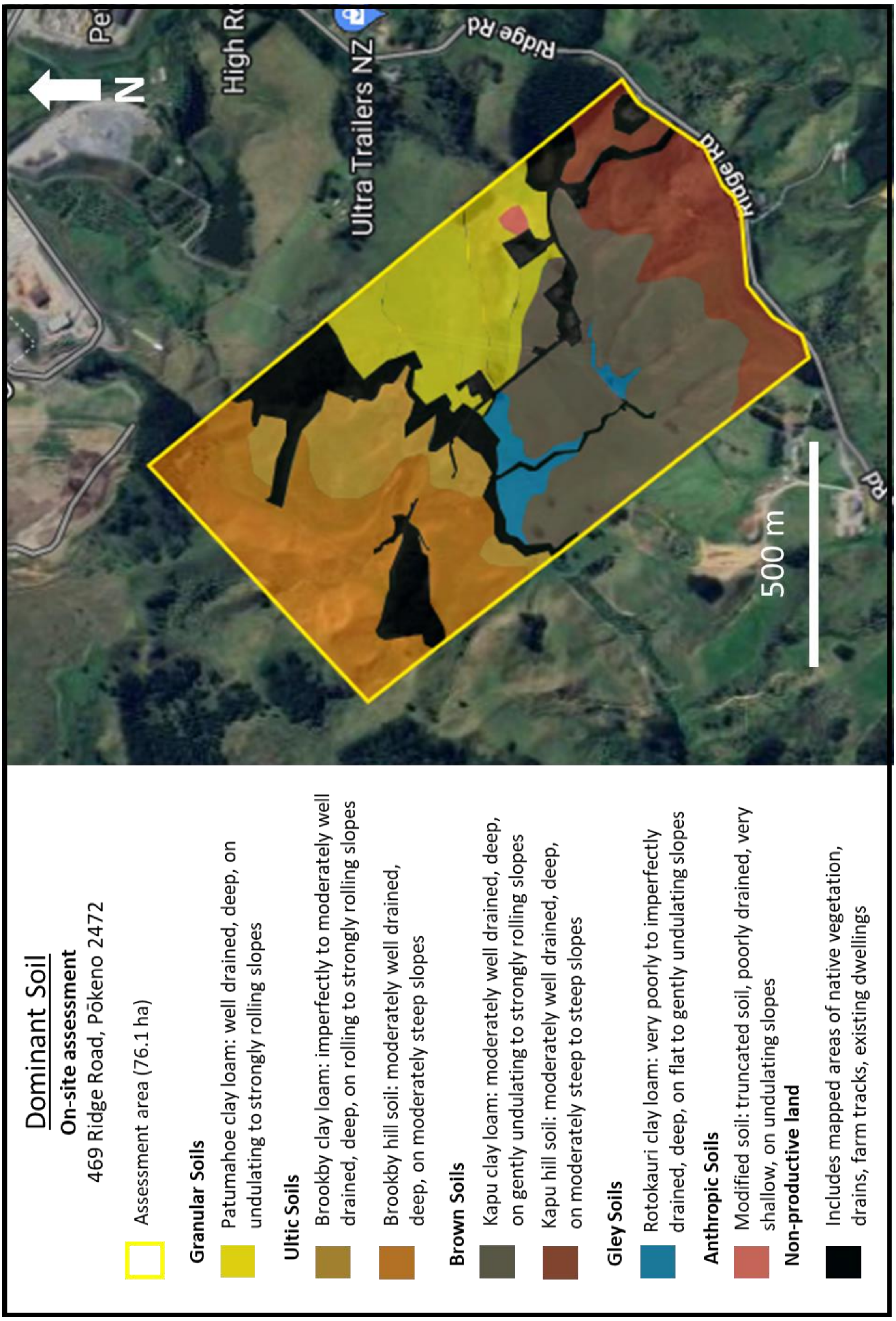
Following cleanfill placement and subsequent soil restoration, it is probable that the productive capacity of the site will be increased by the replacement of the steeper land (strongly rolling LUC 4e2 land), with a larger, more contiguous area of undulating to rolling LUC class 2-3 land.

Appendix 1: Soil observation details

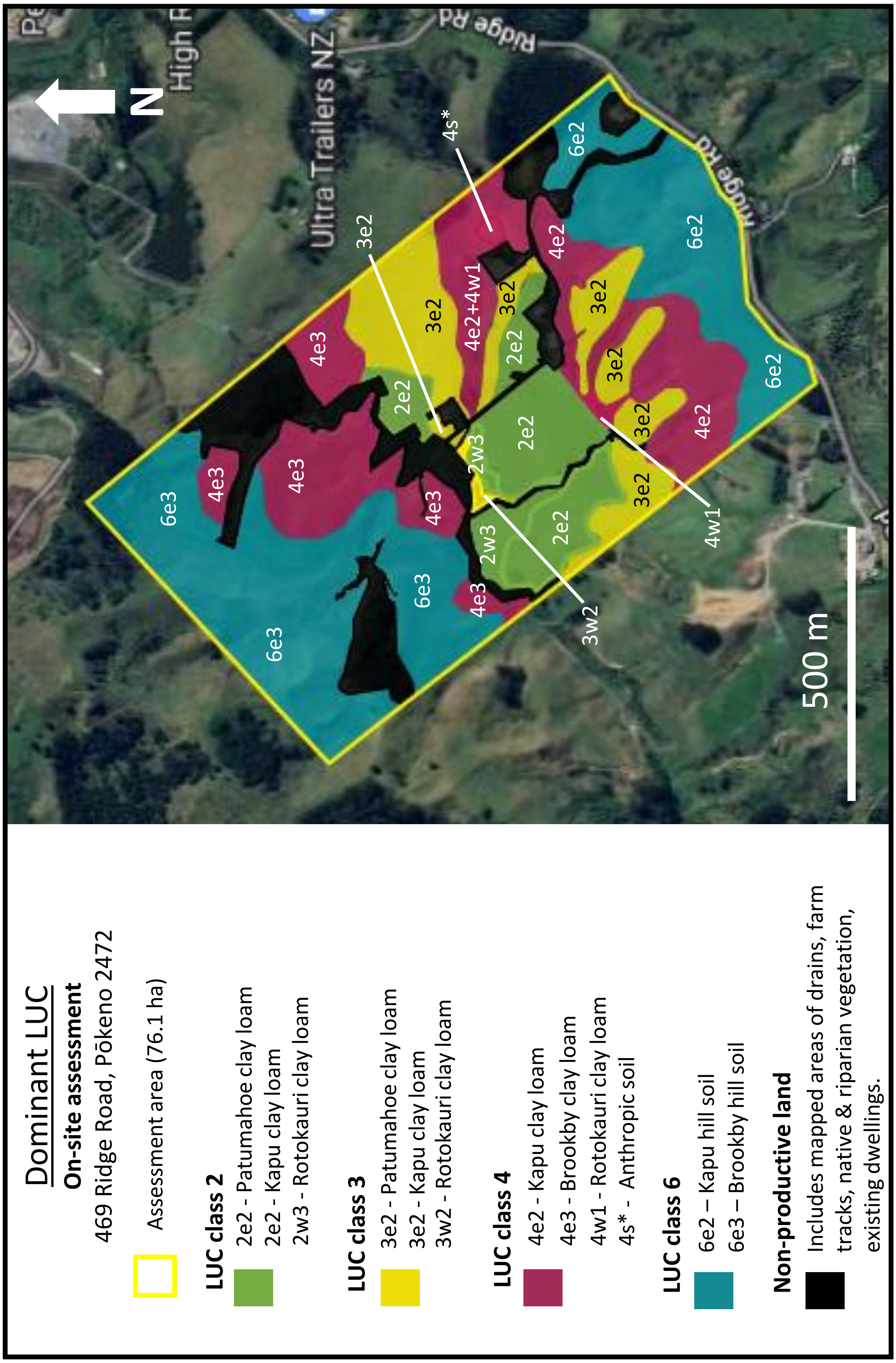


Observation	Soil order	Slope class	Limitation	Soil drainage	Soil depth (cm)	A depth (cm)	Depth to heavy clay (cm)
1	Granular	C	e	Modertately well	45-100	18	35
2	Granular	C	e	Modertately well	45-100	5	30
3	Granular	C	e	Modertately well	45-100	15	60
4	Granular	C	e	Modertately well	45-100	15	40
5	Granular	C	e	Modertately well	45-100	15	50
6	Granular	D	e	Modertately well	45-100	15	50
7	Brown	E	e	Imperfect	45-100	15	55
8	Brown	C (D+C)	e	Imperfect	45-100	12	50
9	Brown	C (D+C)	e	Imperfect	45-100	15	55
10	Brown	D (D+C)	e	Imperfect	45-100	5	45
11	Brown	D (D+C)	e	Imperfect	45-100	10	45
12	Granular	B	e	Modertately well	45-101	15	35
13	Granular	C	e	Modertately well	45-100	15	50
14	Granular	B	e	Modertately well	45-101	15	50
15	Brown	C	e	Imperfect	45-100	15	50
16	Brown	B	e	Imperfect	45-100	15	50
17	Brown	C	e	Modertately well	45-100	12	45
18	Brown	B	e	Imperfect	45-100	15	50
19	Brown	B	e	Imperfect	45-100	15	50
20	Brown	E	e	Modertately well	45-100	10	50
21	Brown	C	e	Modertately well	45-100	10	50
22	Brown	D	e	Modertately well	45-100	10	45
23	Brown	C	e	Modertately well	45-100	12	55
24	Brown	C	e	Modertately well	45-100	15	70
25	Brown	C	e	Modertately well	45-100	15	55
26	Brown	C	e	Modertately well	45-100	15	60
27	Brown	B	e	Modertately well	45-100	10	30
28	Gley	B	w	Imperfect	45-100	20	70
29	Brown	B	e	Modertately well	45-100	12	50
30	Brown	B	e	Modertately well	45-100	10	50
31	Brown	A	w	Imperfect	45-100	15	60
32	Brown	A	w	Imperfect	45-100	15	55
33	Brown	B	w	Imperfect	45-100	15	50
34	Brown	B	e	Modertately well	45-100	15	70
35	Brown	B	e	Modertately well	45-100	15	70
36	Brown	B	e	Modertately well	45-100	15	40
37	Brown	C	e	Modertately well	45-100	15	40
38	Gley	A	w	Poor	45-100	20	-
39	Brown	A	w	Imperfect	45-101	15	-
40	Brown	B	e	Modertately well	45-100	15	70
41	Brown	C	e	Well drained	45-100	15	45
42	Anthropic	B	s	Imperfect	0-20	5	5

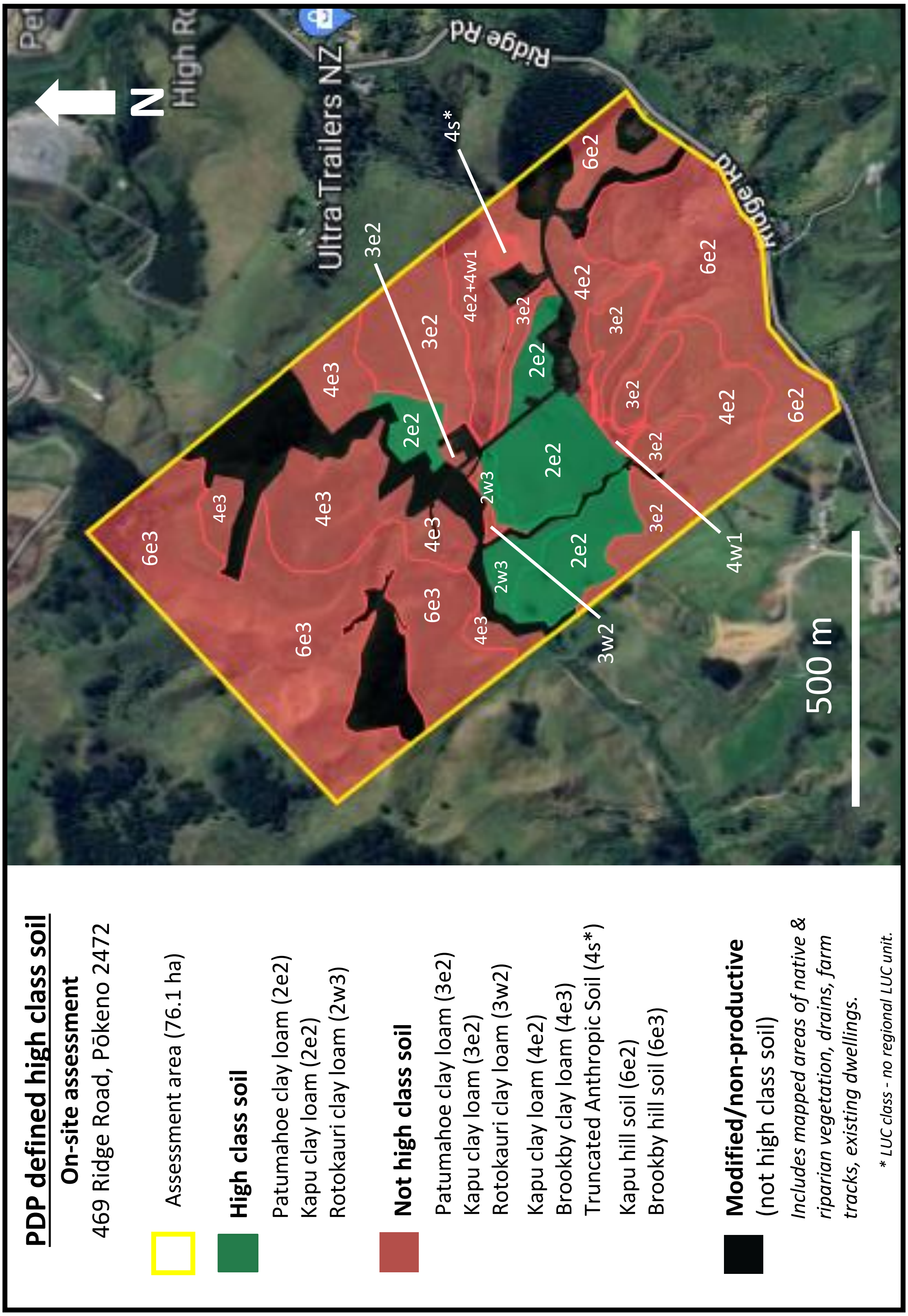
Appendix 2: Enlarged map image from Figure 8.



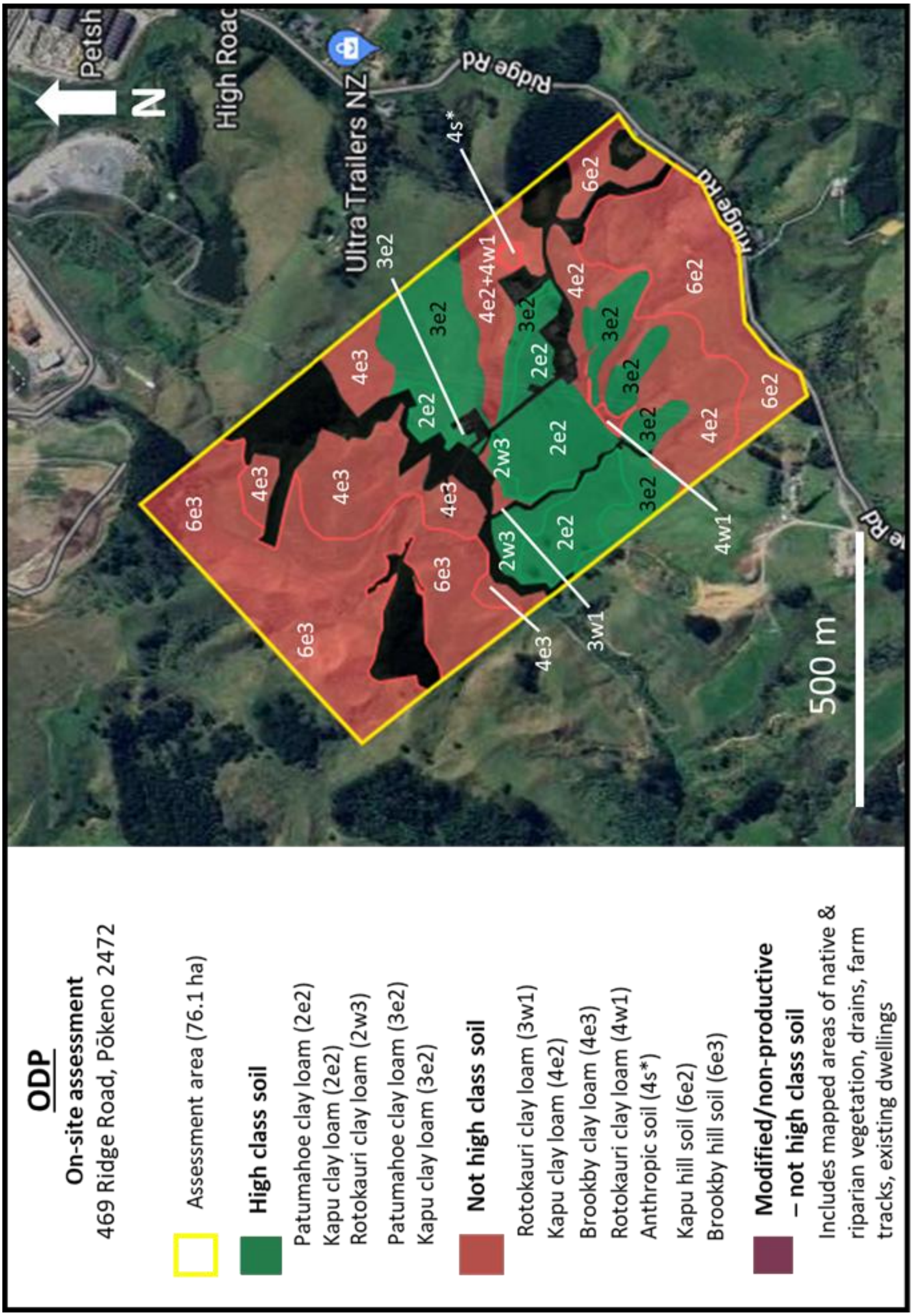
Appendix 3: Enlarged map image from Figure 9.



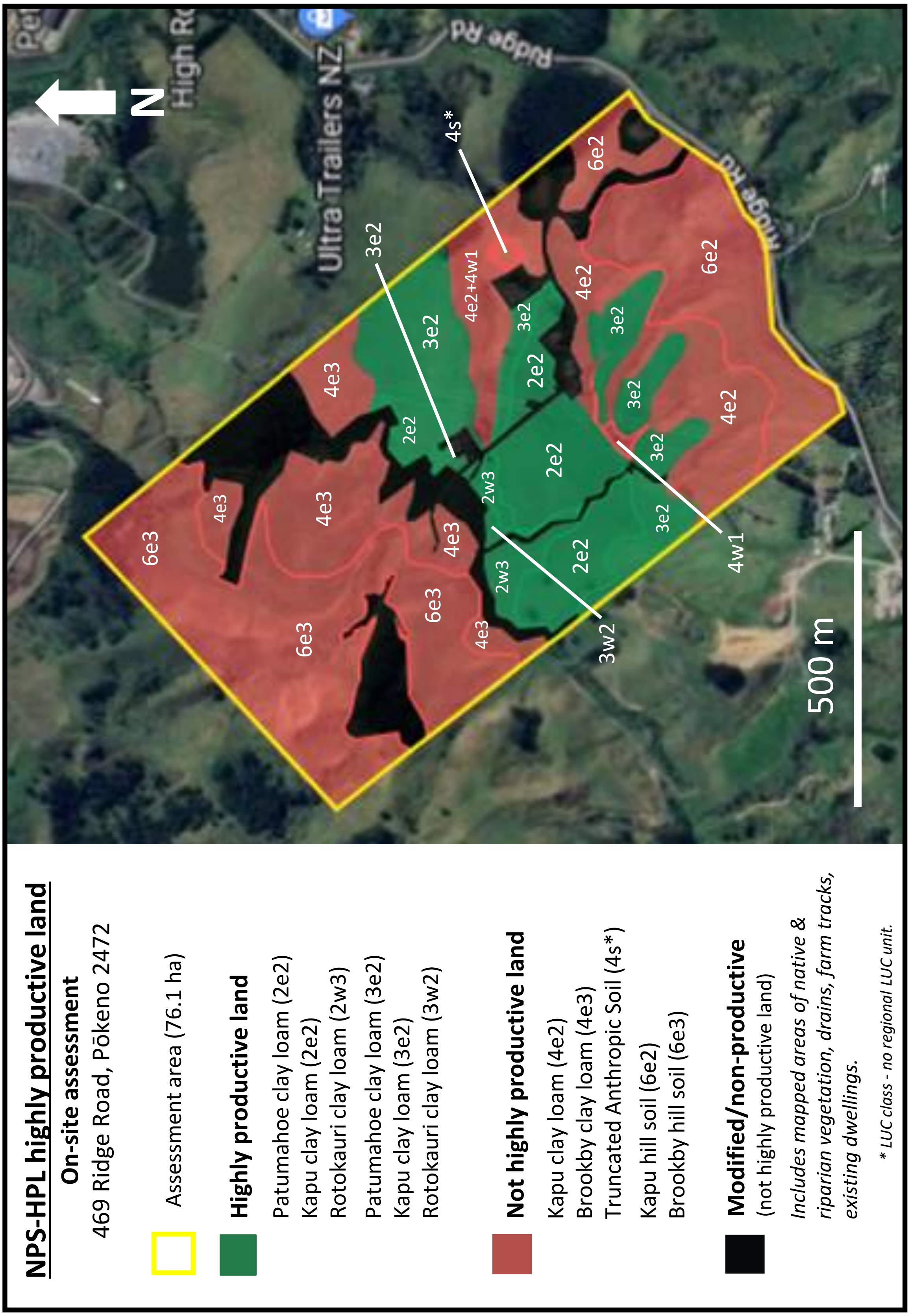
Appendix 4: Enlarged map image from Figure 10.



Appendix 5: Enlarged map image from Figure 11.



Appendix 6: Enlarged map image from Figure 12.



Appendix 7: Soil restoration.

Soil restoration

The proposed development includes the placement of clean fill within a yet to be defined (fill) area.

To achieve this, topsoil and subsoil will be incrementally removed, stored separately and replaced in sequence on the area to be restored. The method of restoration will ensure the final soil is at least as productive as undisturbed soils on similar slopes. The following soil restoration programme is suggested once final cleanfill earthworks have been completed.

Restoration key concepts

The two main factors that achieve successful land restoration for plant growth, including vegetable growing, are preparation of filled surfaces to ensure it has the appropriate contour and slope, and careful reinstatement of the subsoil and topsoil material so they are not compacted.

At this site, the general soil profile consists of a 15 cm of A horizon (topsoil) over 40-60 cm of clay loam B horizon (subsoil). The ideal depth of the restored soil profile is 75 cm of stone-free material which has a topsoil depth of at least 15 cm on at least 60 cm of subsoil. If this is achieved, and slopes of the final land surface are <15 degrees, then the land can be returned to a condition equivalent to LUC class 2-3 land.

On slopes less than 7 degrees the land will be restored to LUC class 2 with slight limitations to arable use. Slopes of 8 to 15 degrees will be LUC class 3.

Because of the clayey nature of the soil it is not possible to improve the land to LUC class 1.

Pasture is the best initial vegetation for preparing the soil for vegetable growing. The fine roots of pasture create soil structure and grow into the new subsoil to coat cracks and pores. Generally, after three years in pasture and with careful stock management to avoid compaction, the new soil is suitable for cropping. The restored soil can also be planted directly with permanent vegetation such as natives or amenity shrubs and trees.

Soil removal and placement

As a general principle, the handling of topsoil and subsoil materials is best done in dry conditions (i.e. moisture content at least below field capacity) to avoid soil compaction. Compaction restricts root growth and drainage and is the main risk to reusing the material and returning the soil to a usable condition for plant growth or cropping.

Light track-driven machinery is preferred for the removal of soil to be used in restoration. This helps avoid the considerable compaction and shearing of soil by large heavy rubber tyred machines. Alternatively, flotation tyred machines could be used. Short hauls should be aimed for with minimal handling of all soil materials.

Soil removal and storage

All trees and vegetation including large root systems, old fences, rock, debris, and all obstructions of whatever kind, whether natural or artificial, encountered within the area of the works is best removed and disposed of in an appropriate approved manner.

Appropriate sediment control measures need to be carried out to prevent the discharge of silt into watercourses, or onto, or through downstream properties.

Before any soil stripping activities are carried out all existing pastures need to be chemically killed using a broad-spectrum herbicide and a sufficient time allowed for the vegetation to die. Alternatively, they can be hard grazed to bare soil. Other types of vegetation also needs to be killed and/or removed. This will avoid green vegetative materials being incorporated in soil stockpiles. Decomposition of buried green organic residues in soil stockpiles generally has an adverse effect on the soil which can affect its later use in rehabilitation.

Suitable temporary stockpile areas for storing topsoil and subsoil materials need to be separately designated. Soils under the temporary stockpile areas must be protected from compaction and degradation. The subsoil stockpile area needs the topsoil removed before being used. This is not necessary for the topsoil stockpile area.

Any temporary stockpiling of materials needs to be done in a controlled manner, concurrently graded as necessary to ensure mass stability and prevent mass movement. If being kept for a significant period of time stockpiles need to be grassed to avoid erosion. All topsoil material needs to be stripped from all affected land prior to the commencement of any trafficking of the area and stockpiled in a secure area where mass movement and erosion are not likely.

Subsoil material immediately under the topsoil to be used in restoration is stripped from affected land immediately following the stripping of the topsoil and stockpiled separately from the topsoil material, on designated secure areas where mass movement and erosion are not likely. Sufficient subsoil material needs to be stored to reinstate a subsoil depth that is preferably at least 60 cm over areas to be restored. Any subsoil containing rocks should be discarded.

With good scheduling it may be possible to avoid stockpiling most of the topsoil and subsoil materials and they can be placed directly on the prepared overburden once the final levels have been reached.

Sequence of soil replacement

Once the compacted fill and cut areas are stable and near the final level, they can be graded to achieve the final slope in preparation for the procedure for soil replacement. After final grading of the cut and fill areas is completed using the usual earth moving and engineering consolidation procedures, the shaped surface can be ripped parallel to the contour to eliminate potential slippage surfaces and root restricting or water perching layers.

It is necessary to manage run-off from the neighbouring areas. This is particularly the case at the head of gullies and depressions. Run-off from upper slopes needs to be managed to ensure it does not erode the newly reinstated surfaces.

Once the shape and slope of the final new land surface has been attained, the soil materials can be returned in their original order, again using light tracked or flotation tyred machinery. Gravel or boulders should not be present within 75 cm of the final soil surface (within the restored soil profile).

Between the replaced layers of subsoil and topsoil, the surface is ripped along the contour (if any) or otherwise treated to eliminate slippage surfaces and root restricting or water perching layers. Smooth, abrupt interfaces between texturally contrasting materials must be avoided.

Subsoil and topsoil replacement operations are best carried out when the soil materials are in a relatively dry condition, i.e. soil moisture content is at least below field capacity. Vehicular traffic and soil handling should be kept to a minimum and all soil compaction rectified by appropriate tillage/ripping treatments prior to establishment of a plant cover. Special care needs to be taken to avoid continually using the same vehicle tracks when redistributing the soil materials, or if this is not possible then the excessively tracked areas need to be ripped.

Subsoil and topsoil materials should be distributed in such a way as to achieve an approximately uniform stable thickness over the whole area. Compaction needs to be avoided and the surface protected from wind and water erosion before and after it is re-vegetated.

The restored soil would ideally reach the following criteria:

- Approximately 75 cm of plant growth medium with little or no limitations to root penetration. (Soil penetration resistance would not exceed approximately 2300 kPa). This includes the replaced soil materials as well as the ripped subsurface materials.
- Soil strength to be such that there is no serious limitation to cultivation and movement of machinery.
- No water-logging or anaerobic conditions within the root zone (~40 cm).

Figures 1 and **2** indicate the placement sequence to achieve the above conditions.

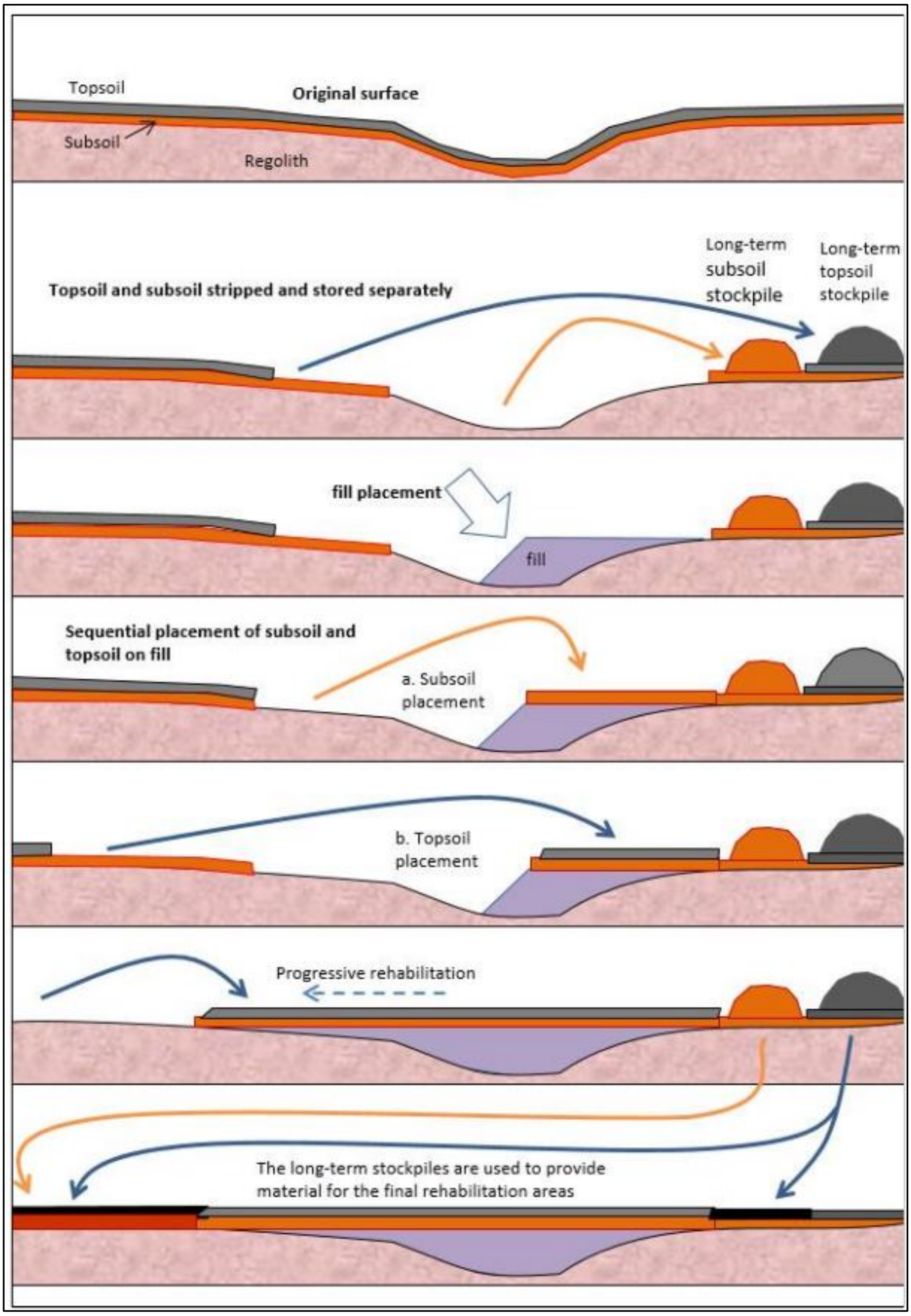


Figure 1. *Sequence of topsoil and subsoil removal and replacement on fill or cut surface.*

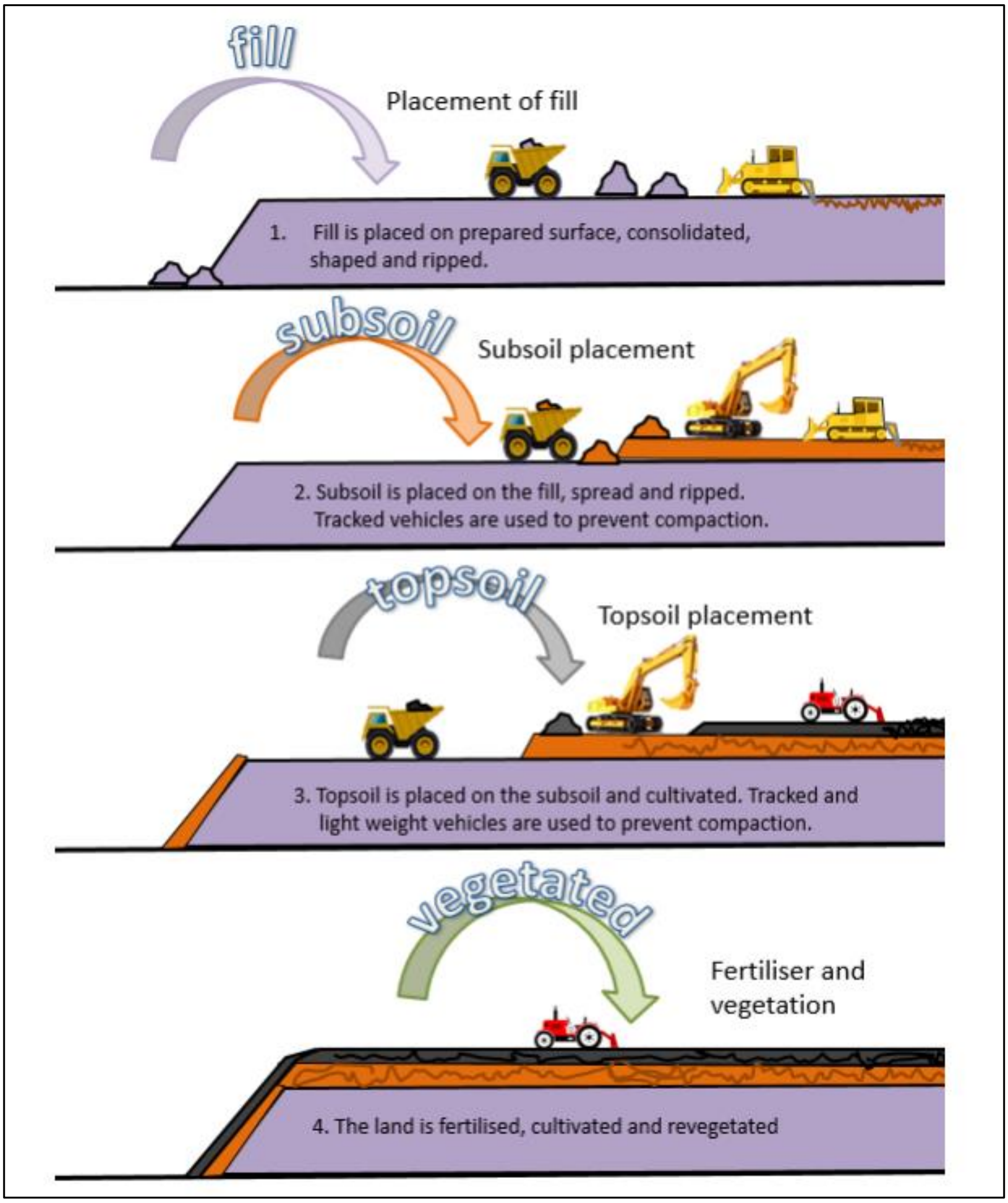


Figure 2. *Sequence of soil replacement and preparation.*

Re-vegetation and post placement management

Following the replacement of the soil profile, a qualified agronomist can advise on fertiliser application and other soil treatments, as determined by soil test, to encourage effective re-vegetation. Suitable pasture/plant species for the local conditions should also be selected.

Re-vegetation is best undertaken as soon as practicable after topsoil replacement, in order to minimise possible deterioration of soil structure and development of erosion problems on bare cultivated soils. On any cut-bank batters the use of mulches or hydro-seeding may be necessary to control erosion, promote germination of seeds and increase the moisture retention capacity of the soil.

Pasture is the best vegetation for restoring the soils to a condition suitable for cropping. Pasture roots help create soil structure and penetrate into the subsoil. This helps ensure the cracks needed for drainage and air supply in the soil are kept open.

To encourage rapid recovery of soil structure and macroporosity stocking rates will need to be kept to a minimum for at least three (3) years with only light-weight stock such as yearling cattle and sheep being allowed on the pastures. This helps prevent recompacting the soil. Deer, bulls and pigs should not be allowed under any circumstances during the recovery period. The number of grazing animals should be managed during wet periods, with total withdrawal of stock if the soils are at or above field capacity, and a management system which promotes grass harvesting (hay and/or silage) over the initial years is to be encouraged. Cultivation is best avoided for at least three (3) years to facilitate recovery of soil structure. Any repairs to pasture can be made by under sowing techniques rather than recultivation.

Areas of obviously impeded drainage which show by way of surface ponding should be examined to establish if any moisture restricting layer exists and appropriate ripping or subsurface aeration undertaken to shatter such compacted layers. If such ripping is unsuccessful then drainage will need to be considered.

At slope angles less than seven degrees cultivated soil has only slight erosion risk and the reinstated areas would qualify as LUC class 2 land. Steeper slopes pose more of an erosion risk to cropping and are best not cultivated and kept in pasture.

If the soils are re-established over the filled areas by following the above principles, then:

- Plant roots will be able to extend themselves through the total volume of the restored materials to seek nutrients and moisture.
- The amount of plant available moisture that can be held within the soil profile would approximate, or even increase, what was originally present.