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Field Assessment of Land Use Capability of Voigt Property, 59F Riddell Road, Kerikeri

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REPORT ON VOIGT PROPERTY OFF RIDDELL ROAD, KERIKERI

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The following report has been prepared after a walk-over survey of the property, an inspection of soil profiles and recording of other land resource features on different types of land within the property and a discussion with Mr Voigt as to his livestock grazing policies. The Land Use Capability re-assessments were made according to the procedures set out in the 3rd Edition of the Land Use Capability Survey Handbook(1). If an environmental farm plan was being prepared, the resource inventory data (landform, soil type, slope, etc) might be recorded in greater detail but would not alter the general picture in respect of the potential productivity of this farm or its suitability for horticulture.

SUMMARY

1. The Far North District Council's objective of protecting high quality soils within the supply district of the Kerikeri Irrigation Scheme is fully supported, is consistent with the National Policy Statement for Highly Productive Land(2) and with the recommendations of the Northland Horticultural Development Strategy 2010.(3)

2. Unfortunately, the mapping database used by the Far North District Council to identify land suited for horticulture within the Kerikeri Irrigation Scheme supply area is inaccurate in that it identifies land on the Voigt property as having volcanic soils, soils which would be assessed as 'highly productive land' under the National Policy Statement for Highly Productive Land, when in fact they are neither volcanic soils nor actually or potentially 'highly productive'.

3. The soil mapping database used by Far North District Council is based on or derived or interpreted from the New Zealand Land Resource Inventory – Land Use Capability database,(4) the only digital database of its kind with national coverage. It is also recognised as the official database for the National Policy Statement for Highly Productive Land 2022, a regulation under the Resource Management Act 1991.

4. The nzlri-luc map incorrectly records both land use capability unit boundaries and soil types on the Voigt property.

5. Northland Regional Council's 'arcinfo' soil map,(5) which accompanies their 'Soil Fact Sheets,' is also derived from the nzlri-luc digital database and, similarly, records the wrong soil types for the Voigt property.

6. A field inspection, land resource inventory survey and re-assessment of land use capability shows that the soil type maps published by Soil Bureau – DSIR(6) more accurately records the soil types on the property. The dominant soil type on the

property is Hukerenui slit loam (with yellow subsoil), a podzolised 'gumland soil' not suited to horticulture.

7. Small area of flat to undulating land at the front or entrance to the property contains a mix of Hukerenui 'gumland' soils and old, wet 'ironstone soils' formed on volcanic alluvium, which most probably overlies the greywacke and sediments on which, where exposed, the Hukerenui soils formed.

8. Neither of these soil types is suited to horticulture and, despite having established bamboo shelterbelts, the area has not been developed for horticulture and is only used for grazing. Parts of it are too wet for winter grazing of cattle.

9. A narrow tongue of land at the northern end of the property has Kerikeri bouldery clay soils with boulders so large and so numerous that it cannot be developed for horticulture.

10. Because this land cannot be developed for horticulture and has its own stock water supplies, its use for activities other than horticulture will not adversely affect the overall actual or potential horticultural production of the Kerikeri Irrigation Scheme or of 'highly productive land' in the Kerikeri area.

2. BACKGROUND

This property has been included within a proposed new horticulture special purpose zone which surrounds parts of Kerikeri, Waipapa and to protect and provide for growth in the regionally significant established horticulture industry and its supporting Kerikeri irrigation scheme. The timing of this Proposed Plan Change is interesting as it coincides or slightly precedes the National Policy Statement on Highly Productive Land (NPS-HPL). The purpose of the NPS-HPL, a Resource Management Act Regulation which became operative in October 2022, is to protect highly productive land for use in land-based primary production, both now and for future generations.

The Proposed Change to the Far North District Plan is more targeted and is specifically aimed at optimising the water stored and reticulated by the Kerikeri Irrigations Scheme for horticulture. The infrastructure of this scheme was built by the Ministry of Works and Development and started delivering water in the early 1980s. In 1990, local horticulturists and farmers formed the cooperative Kerikeri Irrigation Co Ltd and purchased the assets off the government.

The scheme supplies water to 2,300 hectares of horticultural land and 350 ha of agricultural land, as well as to lifestyle blocks and commercial users within its supply area. It also supplies bulk water to the Far North District Council for town supply to Kerikeri and Waipapa.
It is assumed that the Far North District Council (FNDC) will introduce similar 'horticulture special purpose zones' for areas proposed for service by Tai Tokerau Water Trust reservoirs constructed or under construction near Kaikohe and Waimate North.

3. OPTIMISING 'PUBLIC' INFRASTRUCTURE

While undertaking research (circa 2012) for a Horticultural Development Strategy for the Northland Horticultural Forum, Cathcart[3] estimated that less than 65% of the land considered to be suitable for horticulture within both the Kerikeri and Maungatapere Irrigation Scheme areas could be developed for that purpose due to restrictions caused by reverse sensitivity, size of holdings and pockets of land unsuited to horticulture. In particular, urban sprawl, residential development and subdivision into lifestyle blocks meant that productive orchards and vegetable gardens or land suited to orcharding, and market gardening were being 'crowded out' by competing and conflicting uses.

Despite producers complying with the requirements of the Resource Management Act to contain the effects of their activities to within their property boundaries, reverse sensitivity, often perceived rather than actual effects of primary industry activities, is a major barrier to continuing primary production within the peri-urban environment. The primary industries, farming, forestry, orcharding and arable farming/market gardening, are always under public scrutiny. Their social licence, their right to continue to operate their businesses within a community, can be negatively affected by public pressure, whether or not they are meeting environments legal environmental standards. Public pressure may be exercised by direct opposition via the enforcement and/or planning provisions of the Resource Management Act or a boycott of products.

There has been an ongoing argument within the Kerikeri Irrigation Scheme supply area, for example, over the use of chemicals ('hi-cane') to regulate bud break on kiwifruit, a necessary procedure in a mild climate like Northland which lacks winter chill required to stimulate this process naturally and a procedure currently legal in New Zealand. Urban residents also complain about noise from machinery, specially from early morning and nighttime activity, a necessary part of orchard and garden management, to dust created by cultivation and, in colder parts of New Zealand, to frost-fighting machinery. In many areas, this conflict has been further fuelled by allowing residential houses to be built in close proximity to property boundaries with orchards.

While the Resource Management Act requires landowners to contain any adverse effects to within their property boundaries, which most do, perceived effects are frequently reported to both District and Regional Councils. The NPS-HPL requires Councils, district and regional, to provide protection for highly productive land from reverse sensitivity. As the regional councils have not yet identified highly productive land within their region, we do not know how the district councils plan to do this, perhaps by providing for buffer zones between highly productive land and residential development.

One of the recommendations of the Northland Horticultural Development Strategy was to introduce controls in District Plans specifically aimed at optimising the use of public utilities, as is already the case with urban sewerage schemes, water reticulation and access to State Highways. Non-horticultural uses of land or land uses that reduce the opportunity for irrigated crop development and management would be restricted in favour of horticulture or arable land use.

Unfortunately, the very best land within the supply area in each of these two regionally significant irrigation schemes has been or is currently being developed for housing. This includes Land Use Capability Class 1, Maunu silt loam soils between Austin Road and Maunu Mountain and Class 2 Kerikeri friable clay soils along SH1 and down Kerikeri Road into the town. This conversion of the region's most versatile and potentially most productive soils in areas serviced by community irrigation schemes has continued despite these areas being identified and their productive value brought to the attention of the respective County, City and District Councils from as early as 1966 in the case of the Maunu area and 1974 in the case of Kerikeri. Fragmentation of land titles has also reduced the availability of commercial scale-sized land parcels on potentially highly productive land available and able to attract investment.

4. IDENTIFYING POTENTIALLY HIGHLY PRODUCTIVE LAND

The National Policy Statement for Highly Productive Land (NPS-HPL or NPS and HPL) defines HPL as land identified as Class 1, 2 or 3 on the New Zealand Land Resource Inventory – Land Use Capability digital database (nzlri-luc) maintained by Manaaki Whenua - Landcare Research. This database was chosen as it is the only one with national coverage and it is easily accessible online. A subsequent Environment Court decision[7] and an Amendment to the NPS[8] in August 2024 confirm that if the land is identified as Class 1, 2 or 3 on the nzlri-luc database, it is legally HPL, despite any evidence to the contrary. Regional Councils have until September 2025, 3 years after the NPS-HPL came into effect, to more accurately define what is meant by HPL within their respective regions and to more accurately identify HPL on maps of a suitable scale.

4.1 Land Use Capability Classification - The nzlri-luc database classifies all land within New Zealand according to the New Zealand Land Use Capability Classification system. This is an **8-Class** system under which:

- Classes 1 to 4 are arable or potentially arable land, but also suited to other primary production - horticulture, pasture production and production forestry;
- Classes 5, 6 and 7 are non-arable, usually due to steepness, erodibility , wetness of climatic limitations;
- Class 8 land has no productive value but may well have value for watershed protection or biodiversity values.
- Generally, the potential productivity and the versatility of the land, the range of crops it may grow, decreases from Class 1, which is both highly productive and highly versatile, and Class 7 which has few productive uses and limited to a very narrow range of crops or uses.

These 8 Classes are subdivided into '**Sub-Classes'** according to their major limitation to productive use. These Sub-Classes currently include 'e' for erosion, 'w' for wetness, 's' soil limitations or 'c' climatic limitations.

LUC Subclasses are further subdivided into '**LUC Units,'** the most detailed scale of LUC mapping. Discrete areas of land with the same soil types, slope, erosion risk, potential productivity and requiring the same management to achieve sustainable production are identified as **'polygons'** on the land use capability map and assigned a LUC Unit symbol.

For example, in Northland, a polygon assessed as Class 4e12 is undulating to gently rolling land with podzolised soils which are prone to sheet and gully erosion when under pasture and to sheet, rill and gully erosion when cultivated. It is of low natural fertility with soils that are wet in winter and can be drought-prone in summer. Class 4e12 is best suited to pastoral farming but can be cultivated to establish a summer fodder crop, for example maize for grazing or silage, as part of a pasture replacement programme. This will need to be a short season, fast maturing fodder crop which, because the soil is too wet, may not be planted until later October-early November and must be harvested, and the land re-established in pasture by mid-April to enable the young grass to be grazed and dense pasture cover established to prevent erosion over winter. If cultivated too often, too vigorously or when the soil is too wet or too dry, soil structure can be easily destroyed, productivity reduced, and the risk of erosion increased.

The LUC system ranks land according to its versatility of land use, Class 1 land being the most versatile, Class 2 less versatile through to Class 4 which is only marginally suited to arable or horticultural use. Also, within Classes, some LUC Units are more versatile than others. It is, therefore, very important to assess actual or potential productivity at an LUC Unit level, not the broad LUC Class level as used in the FNDC, presumably Northland Regional Council, and NPS-HPL identification of highly productive land.

4.2 Description of Northland Land Use Capability Units - The Extended Legend for Northland,[9] which accompanied the hard copy MWD Worksheets, the predecessors to the nzlri-luc digital database, describes 100 LUC Units for the Northland Peninsula, the area north of the Auckland urban boundary. The Worksheets were published at a scale of 1:50,000 and the maps digitised

to create the nzlri-luc database. Surveying at a farm scale by three LUC consultants in the Northland-Auckland region has identified another 30 or more Northland Units.

This detailed mapping has also further extended our understanding of the complexity of soil types in Northland. The pedologists[6] who undertook the mapping of soil types in Northland also identified a range of 'variants' of the basic mapped soil types, in some places 10 or more variants in a polygon or under a named soil type. This variation, even within paddocks, is well recognised by practical farmers, orchardists and market gardeners and a polygon showing a 'soil type' may, in reality, encompass a mosaic or complex of soil types, a consequence of the region's very complex geology, landform and previous vegetation. The first generation of soil maps listed up to 4 separate soil types within a polygon, either as, for example, YK + HK + WK meaning a mix of distinctly Waikare, Hukerenui and Wharekohe silt loams, or YK – WK meaning a complex of soil types covering Waikare, Hukerenui and Wharekohe silt loams, and everything between.

When officially published by the Lands and Surveys Department in the 1980s as part of the New Zealand Land Inventory,[4] and to fit the published 1:100,000 scale, the number of soil type symbols was reduced to a maximum of two per polygon. The data used for the MWD Worksheets was similarly simplified from the raw data supplied by the Northland Catchment Commission,[10] data compiled by field mapping and publication of catchment surveys covering the Kaipara and Whangarei Districts and part Far North District. These catchment surveys were undertaken by soil conservators who also conducted farm-scale surveys and who were collaborating with practical farmers, orchardists and foresters.

MWD personnel from various parts of New Zealand undertook surveys of the balance of the Far North District, north of Turntable Hill, Moerewa. Unfortunately, while these staff had experience in other parts of New Zealand, they spent only a short time in Northland, observing the land, recording land resource data and assessing land use capability based on a single visit in one season. They did not observe the land in different seasons or spend time on the land or communicate with practical farmers, foresters or horticultural personnel who had long-term experience in the region. In some cases, these surveyors over-estimated the potential of the land and in others they failed to recognise its special attributes. The surveyors also lacked the knowledge or failed to consult knowledgeable sources on the frequency depth and duration of flooding

Anomalies/mistakes have been identified in the nzlri-luc data, including recording the wrong soil type in some polygons, in one case recording 'young' highly fertile soils where Soil Bureau maps and recent field inspections record old, very strongly leached and infertile 'ironstone' soils. The Voigt property is also an example of where the wrong soil types have been recorded on the nzlri-luc database.

The effects of flooding, winter wetness, summer droughtiness, iron and aluminium toxicity in old volcanic soils, and depth of soil profile have also been under-estimated. The effects of the extended wet period through 2022/23, which caused the soil to be waterlogged and without oxygen (anoxic), on indigenous and exotic trees, shrubs, vines and fruit trees show that the LUC assessments were, in places, over-optimistic.

4.3 Maintaining the nzlri-luc database

Despite some of these shortcomings being brought to the attention of Manaaki Whenua Landcare Research, the polygons with the wrong soil types listed in the metadata and the LUC assessments based on this listed data remain on the database.

4.4 Digital databases

The process of transferring land resource data from field maps to digital databases has involved:

1. Recording polygon boundaries in the field and viewing aerial photography. These boundaries are often directly related to landform, often rivers, the edges of lava flows, vegetation boundaries, or similar natural boundaries.

2. The polygon boundaries were drawn on aerial photographs in the field and then transferred to topographic maps in the office, usually by the personnel who collected the field data.

3. The boundaries on the topographic maps were then transposed, sometimes by different personnel, onto almost blank basemaps, topographic maps from which vegetation and contour lines had been erased. This created the polygon boundaries for the Ministry of Works and Development Worksheets on which the land resource inventory data was recorded in a formula including rock type, soil type, slope, type and severity of erosion and vegetation/ land use, and LUC Unit.

4. This data was later digitised to create the nzlri-luc electronic database.

Each of these steps resulted in some 'rounding off' of boundaries, and digitising the polygon boundaries often converted naturally curved boundaries to a series of linked straight lines. The process has transformed reasonably accurate depictions of organic polygon boundaries on the aerial photographs into diagrammatic representations which, is some cases, bear little resemblance to what is observed in the field. While valuable data at a regional or large catchment scale, this data is, at best, only indicative at a farm or local district scale.

4.5 A Land Use Capability Assessment is not a 'rule'

A land use capability assessment brings together information on the physical characteristics of the land and local climate to determine the suitability and versatility of land for sustainable primary production. Just like a soil type map, LUC does not tell you how land should or should not be used. but does, by way of subclasses, identify major limitations to land use, productivity and versatility, and advises on measures which will assist sustainable management.

Amongst the metadata collected and used in assessing LUC is rock type or the parent material on which soil has developed/what underlies the soil, soil type, slope, erodibility and vegetation/land use at the time of survey. Other data used includes local climate records, depth, duration and velocity of flooding (on floodplains), soil drainage characteristics, and anything else which may affect the productivity and the versatility of land use. Close liaison with farmers and personnel who have worked with the land over a period of time and through different seasons helps to develop an understanding of the practicality of cropping, grazing, orcharding, or managing production forests on the different types of land.

LUC assessment also does not have regard to whether the land can be used to its theoretical potential. An example often quoted is an area of recent alluvial terrace soil on the right or west bank of the Whanganui River where the river is deeply entrenched in a gorge and there are no bridges. This is land mapped as Class 1 land but with no practical access, its theoretical productivity cannot be realised.

4.6 'Age' and Scale of LUC Surveys

The age or time since the metadata was recorded and on which LUC assessment is based and the scale at which it was mapped can influence the value of the LUC database being used. Of the first five Kerikeri-Waipapa properties re-surveyed at a more detailed scale by the author of this report to assist with decisions as to whether they were, indeed, highly productive land, the whole soil profile (topsoil and subsoil) had been stripped from four and the fifth was an outcrop of large boulders within a large polygon of less bouldery soils. While the soil had been stripped from the first four properties sometime between when the field data was collected (circa 1975) and the present time, the maps had not been updated.

The bouldery patch was too small (or had not been observed by the mappers) to record on the 1:50,000 scale database. The smallest area that can be separately mapped on a 1:50,000 scale map is 10 hectares.

In short, LUC maps at an appropriate scale and prepared to an appropriate standard provide essential information when defining areas of highly productive or potentially highly productive land, but they are just part of the process.

While the current digital or online databases are convenient and easily accessible, they should not be enlarged beyond their field-mapped scale (should not be used for urban or small lot planning). Interpretation of the data on these databases also requires a level of training and understanding of the limitations of the data. There is a common belief that if it appears on screen, it is correct.

An Environment Court decision[7] and a recent amendment[8] to the NPS-HPL take this belief one step further – it makes it legally so. If the land is shown as Class 1, 2 or 3 on the nzlri-lc database, 'it is highly productive land', despite any evidence to the contrary. This will remain the case until the Northland Regional Council more clearly defines what is 'highly productive land' in Northland and identifies this land on a map of suitable scale. Regardless of the scale of mapping, the distribution of soil types in Northland is so diverse and complex that, even using very detailed maps, there may still be small patches of land which differ markedly from the majority of land within a polygon.

The NPS-HPL requires the regional Council to have adopted this new policy and produce the maps within the next 11 months, that is, before October 2025.

5. THE VOIGT PROPERTY

The Voigt property is a mainly-cattle grazing holding comprising almost 87 hectares of flat to strongly rolling land south-east of Kerikeri, extending from the edge of the lava flow on which the area's horticultural industry has been based towards Cottle Hill, a greywacke ridge separating Kerikeri from the lower Puketona-Waitangi River basin.

Volcanic activity from craters in the vicinity of Cottle Hill resulted in a lava flow down into the Kerikeri Inlet. This activity is younger than the old Okaihau lava flows which cap the ridges around Kerikeri airport, Waipapa and Kapiro and underly the Kerikeri flows, and has Kerikeri friable clay soils rather than the older Okaihau and Pungaere gravelly clay ('ironstone') soils of the older flows. A more recent lava flow from Te Puke, in Waitangi Forest, is believed to be the most recent volcanic activity in Northland (1500 yrs BP), causing lava flows across lower Kerikeri Inlet Road and more directly to the sea through the Bayly property at Waitangi.
A stream from Cottle Hill follows the eastern edge of the Kerikeri lava flow, separating it from the lower sedimentary rock foothills and terraces on the easy northwestern dip-slope of a greywacke fault block, the stream running on a basalt rock bed for some of its length. Sediment from both the greywacke hills and the volcanics has been deposited in basins along the valley floor, forming alluvial soils on low terraces and in basins.

5.1 Soil Types and Land Use Capability

The nzlri-luc database records the soil types on the property as Kerikeri friable clay (KE) and Kerikeri friable clay with large boulders (KEb), with a small area of Hukerenui silt loam (with yellow subsoil). Because the Northland Regional Council's 'Soils Fact Sheet Finder' maps[4] use a database derived from the nzlri-luc database, it too has these soil types and shows the property comprising 73% Kerikeri friable clay with large boulders, 26% Kerikeri friable clay and 1% Hukerenui silt loam (HKr).

The published DSIR Soil Bureau (non-digital) maps[5] of the area paint a very different picture with most of the property having Hukerenui silt loam (HKr), the 'Hill soil' variant of Hukerenui soils (HKrH), and some steeper land on the southern or Cottle Hill end having Rangiora clay, clay loam and silty clay loam (RA) and Marua light brown clay loam (MRu) and hill soils of these two on steeper slopes. All of these soils have developed on greywacke, a relatively old sedimentary rock, and some on sediment washed downslope from the greywacke hills.

The Soil Bureau maps show a very small strip of the large boulder phase of Kerikeri friable clay on the edge of the lava flow at the very northern end of the property. A field survey confirms the accuracy of the Soil Bureau maps (and the inaccuracy of the nzlri-luc database and, therefore, data accessed via the nrcgis.maps.arcgis site). The field survey also enabled more detailed soil type identification and LUC assessment on the easier and sheltered land on the lower part of the farm.

5.2 Findings of the Field Survey (September 2024)

NB: - A LUC unit with an *, like Class 6e23* is a Northland LUC Unit identified and described by Cathcart[11], not one described by Harmsworth.[9]

5.2.1 Undulating to gently sloping land - The field survey confirmed the dominance of Hukerenui silt loam (with yellow subsoil) (HKr) on the gently sloping to rolling hill country, the majority of this property. This is a moderately podzolised soil but, as is common with this and Northland soils of a similar stage of development, there is a wide variation in 'age' or development depending on the density of kauri forest cover, in most cases prior to Maori and European settlement in New Zealand. The mosaic or complex of soils range from a mature Wharekohe silt loam(WKl), with a dense silica pan, through to only moderately podzolised land.

Generally, the easier the land the 'older' or more podzolised is the soil, the easier stable land supporting dense stands of kauri trees which podzolised the soil over thousands of years. These podzolised or 'gumland soils' have patches of very podzolised soils, Wharekohe silt loam (WKl), which has a silica pan so dense that it is often difficult, if not impossible, to drive posts to erect fences. There will also be less podzolised patches, often on steeper areas, where kauri have not been so dense or have not been the dominant vegetation for so long. As well as accumulated soil moisture in the sticky yellow clay subsoil and the poorly drained podzolised upper soil layers, the land suffers from seepages where water stored in the underlying weathered rock seeps to the surface.

More podzolised Hukerenui silt loam, Tending towards Wharekohe silt loam

'Younger', less podzolised Hukerenui silt loam

These gumland mosaic soils are wet in winter and drought-prone in summer. Careful grazing management with the lighter class cattle to minimise pugging and soil compaction will quickly build up soil organic matter and improve soil structure and drainage. The organic matter can be just as quickly lost, and soil structure destroyed if the land is cultivated too frequently or is over-cultivated. While the easier land may support an occasional fodder crop or maize-for-silage as part of a pasture renewal rotation, care is required to avoid soil erosion and ensure the land has a well-established pasture cover before winter. Seepage areas prevent early seedbed preparation so only short season/early maturing crops can be grown.

The best of the Hukerenui soils have been re-assessed as Class **4e12**, as described by Harmsworth. While Harmsworth[9] does not include soils developed on greywacke in this LUC Unit and Taylor[5] does not include a Wharekohe-type podzol in his Marua Suite (soils on greywacke), for consistency, they have been shown as such when mapped by

Hanmore[12] and Cathcart[11] on more detailed farm-scale maps, identifying such soils as Wharekohe silt loam(WKl), yellow subsoil phase, and included them in Class 4e12.

This Class 4e12 land could sustain an occasional crop, like direct-drilled maize for silage, but there is a serious risk of sheet, rill and gully erosion if the soil is cultivated or left fallow for too long or over winter. As noted, this can only be short-season crops as the soil is to wet to cultivate until the seepages have ceased weeping in early summer and must be back in a well-established, dense pasture sward before winter.

5.2.2 Steeper valley sides and ridges - The sides of the ridges are too steep to be safely cultivated, and steeper parts are prone to shallow slipping during high intensity, short duration rainstorms. They have a mosaic of soil types from Rangiora silt loam (RA) through to Marua light brown clay loam (MRu) and their equivalent hill soils, and have been reassessed as Class 6e9, safe grazing land but also suited to plantation forestry. A detailed far-scale LUC survey of the hill country would identify a range of LUC units, from Class 4e12 on the broader ridges, through some steeper slopes with Class 5e3* land and Class 6e9 on the even steeper slopes.

Given the size and shape of some of these different patches, it may be impractical to fence and graze them all separately. Slip-prone areas on grazing land can be stabilised with open planted poplars. Not only will the roots of the trees bind the soil to the deeper subsoil, the trees will provide shade for stock.

There are small areas of even steeper and potentially unstable land with Marua and Rangiora soils, which could be identified on a more detailed environmental farm plan and grazed separately using electric fencing or electronic halter-grazing or could be established as woodlots. These areas are assessed as Class 7e6. They have shallower and younger Marua light brown clay loam (MRu) and Rangiora silt loam and their shallower 'Hill soils.'

5.2.3 Bouldery ridge and north-facing slope - There is a dry, bouldery cap to this south-eastern ridge where scoria, ash and lava from the former Cottle Hill volcano spilled over the greywacke. That is, it has a soil developed mainly on greywacke, Marua and Rangiora soils, but with some Waiotu friable clay (YO) on basalt scoria and ash. While the soils are not considered to be 'volcanic,' the topsoil is redder than Marua or Rangiora soils and there are basalt boulders scattered over the surface. This bouldery area with more free-draining soils and exposed to the wind produces less pasture and dries out in summer. It has been assessed as Class 6e23*, a new LUC Unit, observed in other parts of Northland but not previously mapped. It is not highly erodible but, because it has shallow soils, is north-facing on a high ridge and is exposed to wind, and is strewn with large boulders, neither is it highly productive.

5.2.4 'Front Flats' - In the valley bottom, on the flat land surrounding the entrance to the farm, there are soils which have a friable dark grey-brown topsoil, becoming greyer with depth, indicating seasonal wetness. Soil profiles exposed in road banks and dug or augered at several sites show that there are, in places, Hukerenui silt loam-type soils which, most likely, underly these flats. That is, this area is a complex of

basaltic and sedimentary soil alluvium with a fluctuating water table, overlying weathered sedimentary rocks and sedimentary alluvium terraces.

A study of the darker soil profile shows that there is a usually high but fluctuating soil watertable, near the soil surface and depriving the soil of oxygen in winter and spring, lowering in a drier summer, only to rise again in winter. The edges of this area are old alluvial terraces and heavy Hukerenui clay material on the footslopes of adjoining hills and they receive both runoff and seepage from the surrounding land. Streams draining through these flats occasionally flood and further add to the wetness problems to parts of the flats. While the northern part of these flats grow productive pastures, the southern or upstream end has infestations of rushes, a symptom of persistent soil wetness. These Hukerenui ('gumland') soils have been assessed as Class 4s4.

The patches of basaltic alluvium, washed off the Kerikeri soils within the catchment, are also effected by waterlogged and anaerobic conditions for at least part of the year, causing acid conditions and the formation of iron, manganese and aluminium nodules. Under anaerobic and acid conditions, iron and aluminium are 'free' in the soil, forming insoluble compounds with and binding to most macro and micro-nutrients, particularly phosphorus, and making them unavailable to plants. Elevated levels of free aluminium are toxic to plant roots, restricting growth or even killing plants.

The soil on basaltic alluvium is Otaha clay, with patches of Otaha gravelly clay loam, both heavy soils with nodules of iron and aluminium. Even with an extensive subsoil drainage network, the soil watertable could not be held at a low enough level throughout the year, rising each winter as groundwater seeps up from beneath the edge of the adjoining hills.

While some areas with these 'ironstone soils' have sufficient depth of friable topsoil overlying the 'gravel' layer to support pasture, the soil on this section of the Voigt property is too shallow to grow vine and orchard crops and most vegetables. Bamboo shelterbelts were planted around paddocks on the flats during the during the horticultural boom stimulated by the Kerikeri Irrigation Scheme, but no orchards or vines were planted, or if they were, none have survived. This land has been assessed as Class 4s2, land unsuited to horticulture and too wet for heavy cattle during winter and spring. Kiwifruit vines on this soil type west of Pungaere have died over the last two years, both from anoxia (drowning due to a lack of oxygen) and disease brought on by waterlogging.

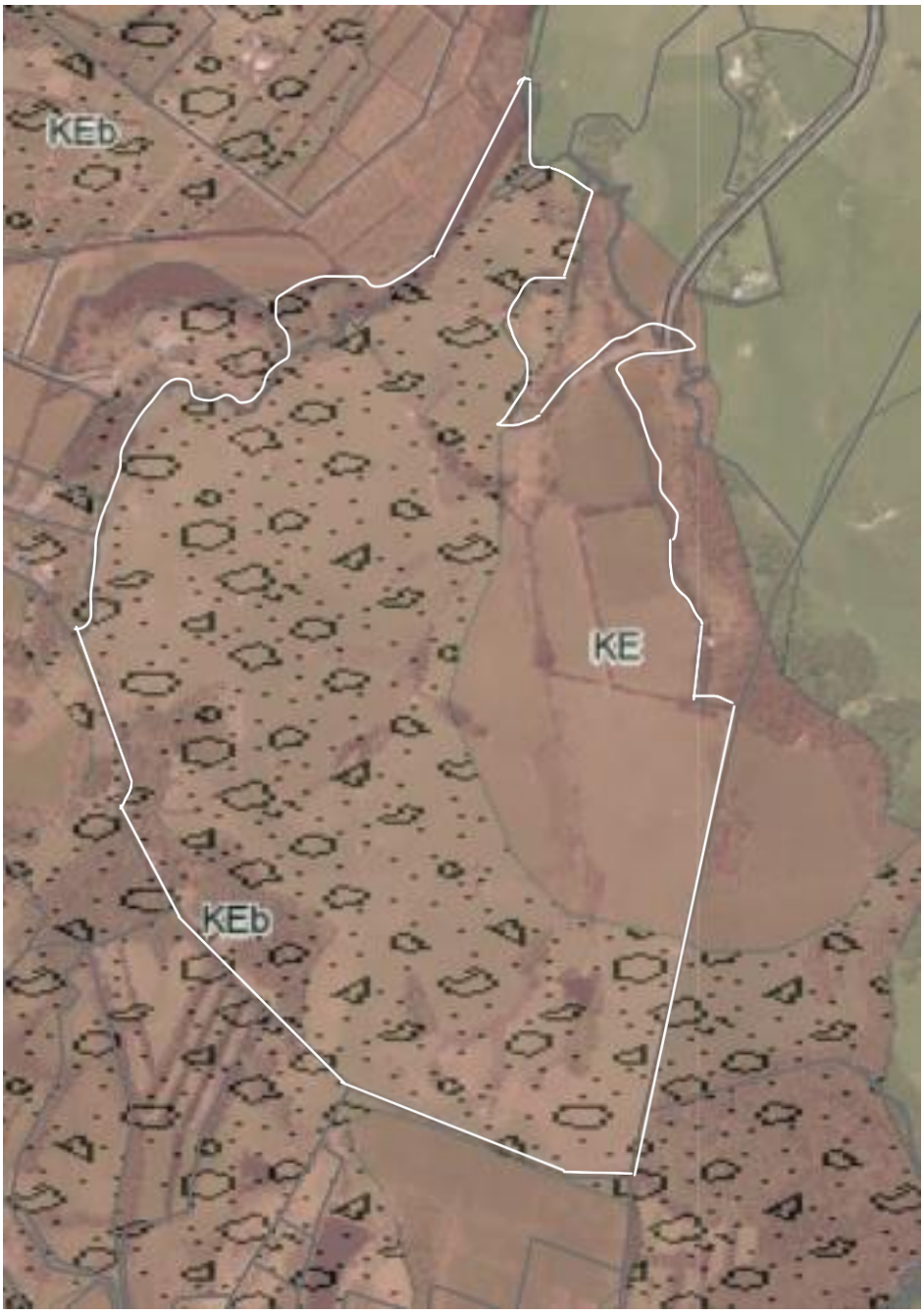
5.2.5 Swampy Valley Bottoms – Streams draining the greywacke hill country within the farm have swampy bottoms. The stream forming the western and northwestern boundary is in places free-flowing over basalt rocks and in other places has swampy edges, blending into seepages draining from the greywacke hills. Where not already fenced, these swampy areas should be fenced to exclude and protect stock, retired as wetland sediment traps or planted with trees able to cope with wet soils, which can include timber and ornamental species. While fenced, there should be access points where machinery can access the streams to maintain the channel, removing

blockages caused by weeds, otherwise, the developing wetland will spread beyond its fences.

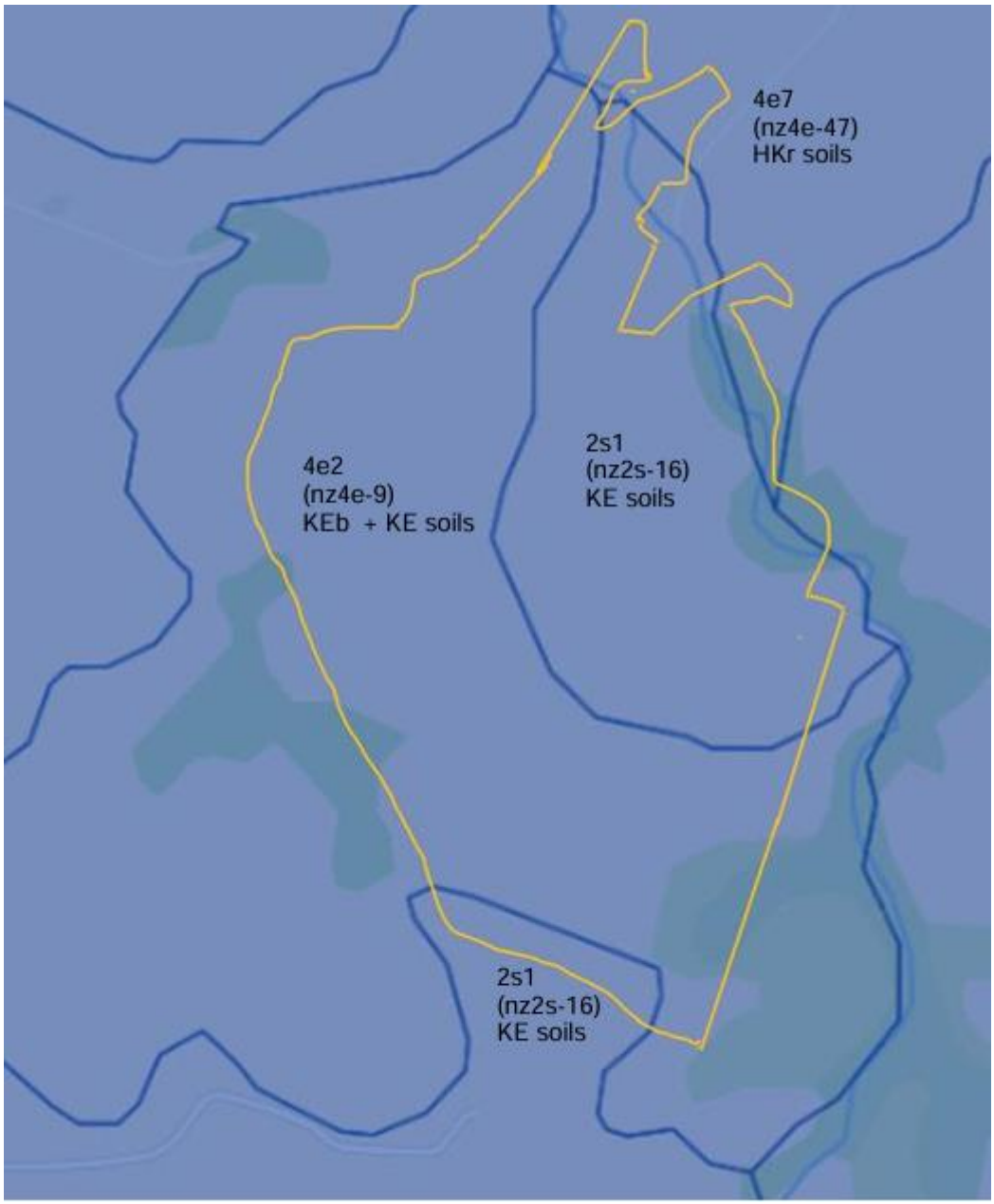
This land has been assessed as **Class 7w5***, a Unit described by Cathcart in farm surveys in Northland. It has little productive value, except for carbon sequestration and timber but can have water quality and biodiversity values.

5.2.6 **Bouldery Kerikeri soils** – There is a narrow tongue of land extending northwards near the entrance of the property. This is a piece of the Kerikeri lava flow and, being on the edge of the flow, comprises large boulders with very little soil. While not suited to horticulture or grassland farming it could grow trees for timber for carbon sequestration. This land with Kerikeri bouldery clay soils has been assessed as **Class 6s1**.

6. COMPARISONS BETWEEN SOILS AND LUC DATABASES AND MAPS

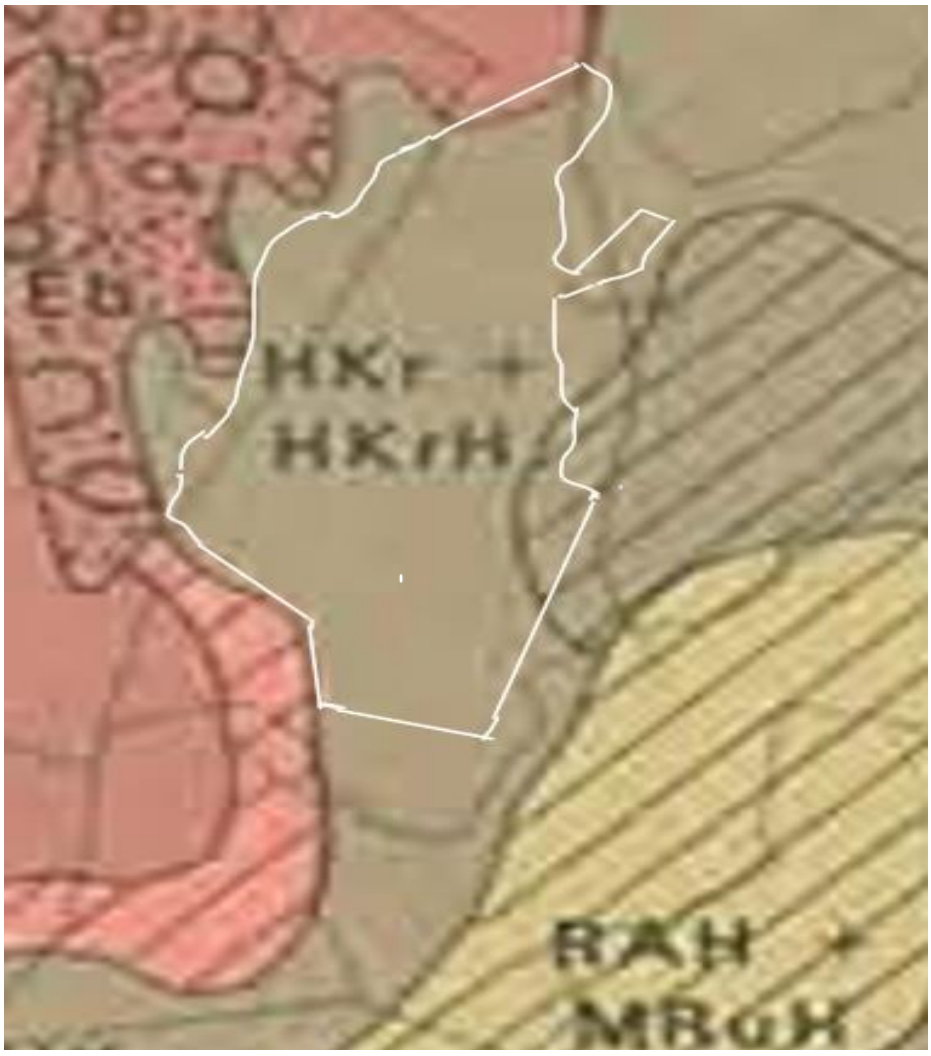


6.1 Voigt Property on Northland Regional Council's Soils Fact Sheet Finder map
(Soils shown are KE, Kerikeri friable clay, and KEb, Kerikeri bouldery clay.)



6.2 Voigt Property on nzlri-luc database

[Northland LUC Unit, national luc unit, soil type]



6.3 Voigt Property on DSIR Soil Bureau Map

Soil types 'H' = hill soil

HKr	Hukerenui silt loam with yellow subsoil
RA	Rangiora clay, clay loam and silty clay loam
MRu	Marua brown clay
KE	Kerikeri frible clay
KEb	Kerikeri friable clay with large boulders

7.1 LAND RESOURCE INVENTORY SURVEY MAP OF VOIGT PROPERTY

7.2 LAND RESOURCE INVENTORY DATA FROM SEPTEMBER INSPECTION

(*Key to polygons on above Land Resource Survey Map*)

Polygon	Landform	Rock Type	Soil Type	Slope	Land Use Capability
1	low ridge	basalt lava	KEb	BC	6s1
2	easy ridge	greywacke	HKr	C	4e12
3	side slopes	greywacke	HK - HKrH	CD	4e12 + 6e9
4	side slopes	greywacke	HKrH – RA	E	6e9
5	top of ridge	greywacke	RAH + MRuH	D	5e3
6	ridge & face	basalt over greywacke	YO/MRuH	EF	6e23*
7	gullies & gully bottoms	greywacke & mud	RAH -HKrH + mud	C-E + AB	7e6 + 7w5
8	gully bottom & drain/stream	greywacke + sediment	HKr	BC + AB	4e12 + 7w5
9	flats	alluvium/ greywacke	ODg / HKr – WKl	A	4s2 (Otaha soils) 4s4 (Wharekohe & Hukerenui soils)
10	streambed & banks	alluvium & basalt lava	OD – ODg	A + EF	7w5*

No soils which could be considered 'highly productive land,' or land suited to horticulture were identified on the property.

7.3 Slope groups

A	0 to 3°	flat to gently undulating
B	4 to 7°	undulating
C	8 to 15°	rolling
D	16 to 20°	strongly rolling
E	21 to 25°	moderately steep
F	26 to 35°	steep
G	> 35°	very steep

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