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LAND RESOURCE INVENTORY SURVEY OF WAITANGI NATIONAL TRUST LAND

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Disclaimer:

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[***Please note that the maps and assessment may extend to land beyond the boundaries of the Trust Land***]

LANDFORM AND GEOLOGY[1]

The Waitangi Trust property surrounds the northern and western side of the Waitangi Estuary, the Waitangi River downstream of Haruru Falls. The river drains an extensive catchment from almost Kaikohe and Okaihau and from near Kerikeri Airport and flows in a confined valley between two greywacke (hardened sandstone and claystone) fault blocks, from Puketona Junction to Haruru Falls. The eastern fault block comprises the hill country of Opua Forest, and the northern block extends from near Bulls Gorge to Te Puke, the volcanic cones in Waitangi Forest, north of Mt Bledisloe.

Basaltic lava flows from volcanoes back towards Okaihau flowed over the edge of the plateau beyond Waimate North, 3 million years ago, and possibly from more recent volcanoes in the vicinity of Cottle Hill, down the valley along the course of the Waitangi River. The lava flow spilled out over the Haruru Falls area, creating a plateau extending beyond the Treaty House. Over time, the river has cut down through the lava, the waterfall over the flow working its way headwards to its present position at Haruru Falls. The river flows on top of the lava flow from just downstream of Puketona Junction.

Much more recent, about 1500 years BP, basalt volcanic eruptions formed craters in Waitangi Forest and the lava flow from these volcanoes created Brampton Shoal. Geologically recent (approx. 3,000 years BP) eruptions created scoria cones and very bouldery lava flows within and opposite Puketona quarry and would have blocked the Waitangi river for a time, creating the extensive basin upstream of Puketona Junction. They have left no obvious effect on the landform within the Trust land. That is, the 'volcanic' soils on the Trust land have developed on the older lava flows, not material from more recent and closer scoria and lava eruptions.

The Trust property is situated mainly on old, very deeply weathered greywacke, which forms the hills to and beyond the catchment boundary around Haruru Falls Road the ridge from the sports domain out into the estuary. The older, Horeke Basalt, lava flow has spilled over the greywacke near the domain and, some up onto the very inland end of the ridge between the Domain and the Treaty Grounds. It has flowed in greater depth and created the flat bouldery land behind, inland of, the golf course and Waitangi Bridge.

SOIL TYPES[2]

Soils on the Trust land have developed on three different parent materials.

Soils on Greywacke – Greywacke is a hard, indurated sandstone and claystone (argillite), rocks formed on the seabed some 250M years BP and raised to the surface as a series of fault blocks along the eastern side of Northland. Greywacke is the basement rock under the eastern part of the peninsula from Mangawhai to Doubtless Bay, extending westward for about half the width of Northland but at increasingly greater depths. It was originally capped by successive layers of sandstone, shale and limestone, in places coal, but these softer rocks have eroded off most of the higher hill country along the eastern seaboard.

While a hard rock, it has been fractured by faulting and tilting action, creating voids in the strata which store groundwater. This groundwater sustains stream flow, that is, streams

draining greywacke hill country are the last to dry up in a drought. Under Northlands war and moist climate, even this hard rock is weathered to a depth of up to 30 metres. The rock and its regolith (weathered or 'brown' rock) is firm and stable enough to form steep hill country. Softer rock would have long eroded away to create a much more subdued landscape.

Under Northland's warm and moist climate, and not having been affected by the last ice age, has resulted in the development of very old soils in Northland. Over tens of thousands of years, rain falling on the soil surface has percolated down through the soil, weathering the 'parent material', the upper layer on which soils have formed, breaking down rock to sand to silt and, eventually to clay. Even the clay, has been broken down to very fine particles, colloidal clays so fine that they do not settle out in still water, like in a settling pond; they remain in suspension.

Water percolating through the soil has not only broken the soil down into finer and finer particles, it has leached clay and plant nutrients from the soil, some clay being concentrated in the subsoil but some being lost, along with the plant nutrients, to streams and groundwater. This has resulted in low fertility, heavy clay soils. Only where soil is lost by erosion, which is a continuous process, even under dense native bush or scrub, is new parent material exposed and younger, more fertile soils develop, only to be further weathered and leached. In general, steeper hill country is more fertile (has more plant nutrients) and easier country has older soils which are of lower fertility.

The development of soils and the rate of weathering and leaching has been even faster under kauri forest. Kauri drop litter – they shed bark and drop needles which are very acidic. Because it is so acid, this material does not break down to form compost but, instead, builds up on the soil surface as acid litter, much like peat. Rainwater running down the tree trunks seep through this acid litter resulting in acid water percolating down into the soil. This acid leaches out all clay and nutrients and, because greywacke has a high silica content, all that may remain within the top 50cm of soil is white silica. It is sometimes referred to as 'pipe clay' although it is usually not clay but of silt or sand texture, depending on the type of rock making up the soil parent material. This structureless silica layer, which can be two or more metres thick on areas where there have been many generations of kauri, sets like concrete in summer and can become quite fluid in winter.

Podzolised soil developed under kauri forest

This soil type is, technically, a podzol (Russian for 'grey soil') but is usually called gumland in

Northland because that is where dense kauri forests once grew, long before human settlement in Aotearoa and large areas were dug over in search of kauri gum in the late 19th Century and early 20th. There will be parts of the Waitangi whenua where the silica pan forms a continuous sheet but in general, there will be a complex of more and less podzolised soil, a continuous and deep silica pan where kauri grew more densely and for longer periods and areas where there were fewer kauri or the land was a bit steeper. While correctly referred by soil scientists to as a 'complex' of soil types, the author of this report prefers the term 'mosaic' as that is how it appears in the field; cultivate a paddock and it appears blotchy, patches of white soil in amongst areas of grey or yellow soil.

The slopes running down from Tau Henare Drive - Haruru Falls Road, west of the golf course and the easy ridge by the golf clubhouse have these podzolised or gumland soils, the steeper the land, the less podzolised it is because the silica pan has eroded, exposing the underlying clay and parent material on which younger soils have developed.

The youngest and steepest of the soils formed on greywacke, at the heads of steep gullies draining to the Waitangi Estuary from Mt Bledisloe, are a complex of **Marua light brown clay loam** (MRu) and **Rangiora clay loam and silty clay loam** (RA and RAH) [*Orthic Brown*], 'H' denoting a shallower 'Hill Soil'. Like the gumland mosaics, there are not discrete patches of the two soil types but a complex of soil types including both these soil types and, quite possibly, both younger Te Rangi steepland soils on very steep slopes and more podzolised Hukerenui soils on easier slopes.

Rangiora clay loam and silty clay loam

This steeper country is too steep for cultivation although much of it was disced and then sown to grass when first developed by Lands and Survey Department. Pastures on easier ridgetops could be direct drilled with special fodder species like chicory or plantain.

The DSIR Soil Bureau soil maps show easier land on the golf course and below Tau Henare Drive and Haruru Falls Road as **Hukerenui silt loam with yellow subsoil** (HKr) [*Albic Ultic*] and **Rangiora clay loam and silty clay loam**, in this combination a *Yellow Ultic* soil. Like the steeper country, these two different soil types will occur as a mosaic or complex of soils, depending on their location and the historical management of the land. On the very easy land lower slopes, there are patches of mature podzol soils, **Wharekohe silt loam** (WK) some with a dense silica pan, which in detailed mapping is classified as a *Densipan Ultic* soil.

While there are areas of easier contour where the soil has been cultivated to establish pasture, this is considered pastoral land on which could be cultivated and a fodder crop could

occasionally be grown as part of a pasture renewal programme, it is not considered arable land. Providing the soil surface is not heavily pugged and needing to be smoothed, crops should be established by non-tillage methods, direct drilling, and the land sown back to pasture early in the autumn to ensure a dense pasture cover and protection from erosion before winter. These podzolised soils are wet in winter and prone to pugging when heavily grazed by mature cattle.

Hukerenui silt loam with yellow subsoil

This same mix of soils on greywacke rock have formed on the ridge between the stockyards and the heart of the estuary.

Volcanic Soils

Deeper Waiotu friable clay soil near Domain

The lava flow that formed Haruru Falls extended down past the Treaty House, forming a flat to easy terrace behind the golf course and gentle slopes down towards the Waitangi Bridge. There is also a thin overlay at the entrance to the Haruru Falls Domain and splashing up the hillside over greywacke-based soils on the leased land adjoining the Domain. The soil type formed on these old lava flows, **Waiotu friable clay** (YO), an Orthic Oxidic soil, is much more mature than that formed on the recent flows and scoria cones within Waitangi Forest, on the Bayly property or adjoining the Puketona Quarry. They are deeply weathered and moderately to strongly leached, have a shallow, friable topsoil over a dense clay subsoil. The depth of subsoil is highly variable, 10cm or less on rolling hill country to 30cm deep on easy slopes and in basins.

Areas with deeper subsoil are suitable for seasonal cropping, a maize crop for example, but the topsoil does dry out and because of the dense subsoil, plant roots cannot penetrate to sufficient depth to access moisture during dry periods.

Shallow Waiotu soils on sheet basalt

The soil-forming process on soils that have developed on basalt lava flows, scoria and ash is quite different to that on high-silica rocks. Basalt is high in iron and aluminium and, as with soils on sedimentary and high-silica rocks, leaching carries clay, iron, aluminium and plant nutrients down into the subsoil. Instead of forming a silica pan, leached clay impedes drainage, creating seasonally anaerobic condition, because anaerobic soils are very acid, 'free' iron and aluminium ions abound at low pH and they fix nutrients like phosphorus, rendering them unavailable to plants. Free aluminium is also toxic to plants so plant roots do not penetrate to any depth, limiting the range of crops and trees which can be grown.

This soil type is only just starting to accumulate iron and aluminium but accumulated clay still impedes root penetration, limiting the range of crops which may be grown. The survey of land resources on this property suggests there is considerable variation in soil depth on areas of Waiotu soils. Topsoil may have been lost from the gentle slope immediately inland of the Treaty House during early land use. The terrace inland of the golf course and adjoining the bush and bushwalk, has some areas of deeper soil, but also has areas where sheet basalt and basalt boulders are on the surface. Sediment runoff from the gumland soils between this terrace area and Haruru Falls Road will have altered the texture of soils closer to the foot of the hill, but this could well be beneficial as it will have added silt to the volcanic clay Waiotu soils, improving its water-holding capacity. Graded banks, contour drains, constructed by the Water and Soil Division of the Ministry of Works and Development in the early 1960s now prevent runoff of water and silt from the gumland soils spreading onto this area of volcanic soil.

Walkway and bush reserve follow around edges of this volcanic soil area. The soils are less weathered and mor free-draining on these steeper slopes and the underlying greywacke rocks and soils are exposed at several places along the walkway. Water percolates through the volcanic material but is slow to penetrate the greywacke so seeps out as springs around the

steep hillside. Regenerating bush is an ideal land use/land cover for this potentially unstable slope.

Miscellaneous Soils

Swamps occupy the bottoms of several tributary valleys around the edges of Waitangi Estuary, both in the middle and upper reaches of the valley and at the interface between fresh and salt water. The sediment and, in places peat in these valleys cannot be described as a soil but each support vegetation performing important biodiversity and water quality filtering functions. There are also islands developing within the estuary, place where vegetation, first saline but later terrestrial plants have established. These islands of sand, silt and flood debris will grow and eventually develop soils but the material of which they are built cannot yet be classed as a soil.

Similarly, mangrove forests and drier intertidal area, some supporting Salicornia and only submersed on spring tides will one day develop soils.

VEGETATION

The Trust property was developed as or part of a farming unit (part of Wakelin's Block) by the Land Development Division of Lands and Surveys Department (L&S) in the late 1950s, early 1960s. Prior to development, most of the block would have been in scrub, manuka-dominant on the easier gumland soils with gumland scrub (Dracophyllum, rushes, manuka, umbrella fern, sphagnum moss and numerous other low fertility-demanding heathland plants). Most of it was frequently burned, accidently or intentionally, increasing the incidence of the exotic weed-species prickly hakea (*Hakea sericea*) with each fire, and some of it was severely eroded.

Small pockets of regenerating bush in the heads of gullies on the steep Marua soils would have escaped the fires but not expanded to any great extent. Burning and lack of any effective control would have also encouraged the spread of gorse and the larger willow-leaf hakea (*Hakea salicifolia*).

As was practice at the time, any land that could be cultivated was cleared of scrub and disced to create a seedbed. It was then sown to pasture and farmed as a sheep and beef unit. The Hukerenui and Wharekohe soils on easy slopes below Tau Henare - Haruru Falls Road would have suffered sheet and gully erosion, both before and during development, encouraging L&S to install graded banks (contour drains) to intercept downhill flow and channel it safely to fenced and planted (with poplars and willows) drainage depressions.

The steeper land was either left to revert to scrub and eventually bush or was planted in Radiata pine or Eucalyptus Spp. for timber. The present age of the exotic forests suggests that there has been more than one round of tree planting. While there were a few native trees planted, most of the successful reversion has been by natural, birds, native and exotic, spreading seeds of indigenous and, unfortunately, exotic tree and shrub species.

Healthy regeneration of native vegetation on steeper Marua and Rangiora soils

The Trust's animal pest control programme has accelerated that reversion process, increasing the population of kukupa, which spread the big forest trees like puriri, kohekohe and the like, and reducing goat and possum damage to both seedlings and bigger trees.

The land that was left to revert has, in the absence of fire, now reached a stage where taller forest trees like rimu, kahikatea, matai and kauri are appearing above the general forest canopy. Broadleaf trees like puriri, karaka, kohekohe and pohutukawa dominate the more free-draining edges of the volcanic terrace. The pohutukawa and kowhai are common around the edges of the Waitangi Estuary.

Some more recently logged exotic forest land and shorter scrub areas around the edges of the central ridge and adjoining Haruru Falls Road have dense stands of tobacco weed (woolly nightshade (*Solanum mauritianum*). Other weedy exotic tree species on the property but now an important part of the diet of native birds, particularly kukupa, are Taiwan cherry (*Prunus campanulata*), and privet (Tree privet, *Ligustrum lucidum*, and Chinese privet, L. *sinense*).

LAND USE CAPABILITY

Land Use Capability, the New Zealand Land Use Capability Database (nzlri-luc) and identification of Highly Productive Land

The New Zealand **Land Use Capability Classification** is ***a systematic arrangement of different kinds of land according to those properties that determine its capacity for long-term sustained production***. ***Capability*** is used in the sense of ***suitability for productive use or uses*** after considering the physical limitations of the land. Versatility of the land, its actual or potential use for growing a wide range of food, fuel and fibre crops, vines and trees, is a major determinant of Land Use Capability. Class 1 land, in the 8-Class LUC system is not only actually or potentially the most productive land, it is also the most versatile. Class 8 land is the least versatile, having no productive value but it may have high biodiversity and/or watershed protection values.

Land Use Capability (LUC) has been assessed for the whole of New Zealand and is published at a 1:50,000 scale on the New Zealand Land Resource Inventory - Land Use Capability database (nzlri-luc) [3], a digital database maintained by Manaaki Whenua Landcare Research. LUC is now (since 2009) assessed following the procedures and standards set out in the 3rd Edition (NZ) Land Use Capability Survey Handbook 2009[4].

The **National Policy Statement – Highly Productive Land 2022**[5], is a Government Regulation, under the Resource Management Act 1989, aimed at protecting actually or potentially highly productive land from non-primary production uses, in particular, to protect land suited to food production from urban sprawl. The default position, the database of 'highly productive land' until regional councils more precisely define 'Highly Productive Land' in their Regional Planning Schemes, is land identified as Classes 1, 2 or 3 on the NZLRI digital database.

Until regional councils introduce more detailed maps of 'highly productive land' in their regional plans, it is this database that is being used to delineate areas of 'highly productive land' and will, most likely be the base map on which Northland Regional Plan rules will be based. The nzlri digital database is a convenient method of identifying land which may be 'highly productive land' and should be protected for the production of food (and fuel and fibre).There are several proviso's, some explained below, when using this database:

- Most importantly, maps in the database should not be enlarged beyond the scale at which the data was mapped, that is, at best 1:50,000. The minimum size of a polygon identified on the database is 10hectares, that is, the data is 'coarse' and considerable variation can occur within mapped areas;
- There are both errors and doubtful assumptions/assessment of land use capability within the recorded data; and
- The data on which the LUC assessments are based was collected in the late 1970s. Some land identified as Class 1, 2 or 3, and therefore 'highly productive land', has already been urbanised, the topsoil removed, or it is, for what ever reason, no longer available for food production.

In assessing land use capability, it is assumed that the land manager will implement available management practises to achieve and optimise sustainable land use. This will include established 'good practice' or field husbandry methods, land drainage measures, nutrient management and soil conservation methods. While some of the potentially highly productive land, for example LUC Class1, 2 or 3 land, may not currently be used for intensive market gardening, horticulture, arable and/or pastoral farming, it has the potential to be used that way by application of known technology and management practices, including the use of irrigation, for example.

Land Use Capability, as described in the 3rd Edition of the Land Use Capability Survey Handbook, the recognised manual for assessing land use capability in New Zealand, is an 8-Class method of ranking New Zealand land according to its capability for sustained primary production. The system uses four arable classes, Classes 1 to 4, with Class 1 being the most versatile and potentially productive land, and Class 4 suited to much fewer crops or horticultural uses, and only marginally suited to arable use. Classes 5, 6 and 7 are not suited to arable uses but are suited to pastoral farming, some tree crops, and to forestry. Class 8

land, by definition, has no productive value, being too steep, stony wet or erosion-prone, but may have important watershed protection or biodiversity values.

Land Use Capability Classes are subdivided into '**Subclasses**' according to the major limitations to production, those being '**e**' (erosion), '**w**' (wetness), '**s'** (a soil limitation such as stoniness or some other inherent characteristic of the soil) and '**c**' (climate).

The most detailed level of LUC assessment is the **LUC Unit**. This level identifies land types that have the same potential level of production, other attributes and limitations, and require the same forms of management. While an attempt was made initially, to place the LUC Units within a region in some order of productivity, that is Class 4e1 has the potential to produce more primary products than Class 4e2, and so on, this has proven impractical, and even more so to attempt a national 'order of merit'. Unfortunately, LUC unit numbers in one class do not necessarily match Unit numbers in another class, that is, Class 2e1 does not lead on to Class 3e1 and then 4e1 as the land becomes steeper. It is, therefore, very important to read the Unit descriptions and take note of the LUC succession shown in extended legends as LUC 'sub-suites'. **A detailed description of Northland LUC units is found in Harmsworth[(6)], but the unit number needs to be correlated with the latest national nzlri-luc (nzcu) unit numbers.**

Assessment of Land Use Capability is a field mapping process which involves delineating 'polygons', often landscape units, areas of land with the same or very similar soil type(s), similar aspect, slope, erosion risk, soil water and drainage characteristics, potential productivity, current vegetation/land use, etc. An inventory of land features and attributes, a land resource inventory, is recorded for each polygon including rock type, soil type(s), slope, active and potential erosion and the seriousness of active erosion, and the current land use and vegetation cover. Other information measured or assessed in the field, by research of records and by consultation, particularly with those who have lived and worked on the land, experiencing in all seasons, and includes susceptibility to flooding (depth, duration and velocity), soil drainage characteristics, evidence of boulders or a soil pan, exposure to salt-laden winds – anything which influences the potential use and sustainability of use of this land – is gathered.

Using this land resource inventory data, the land is assessed as to its land use capability (LUC) Class and Sub-Class and, at the most detailed level, an LUC Unit. As noted above, the land use capability units recorded in the survey of Northland (North Auckland Peninsula) are described in detail in an extended legend by Harmsworth. Since the some of the original LUC survey work:

1. Land Resource Inventory and land use capability surveys, first published as hard-copy maps between 1973 and 1976 as the Ministry of Works and Development Land Use Capability Worksheets, have been digitised to create national coverage in the nzlri-luc database;

2. The 3rd Edition of the Land Use Capability Survey Handbook has been published (2009), updating earlier handbooks and establishing a consistent method/standard of LUC assessment across the whole of New Zealand;

3. Whereas the eight LUC classes were previously written as Roman numerals (I, II, III, IV, etc), the Handbook now requires the eight capability classes to now be written as Arabic numerals (1, 2, 3, 4 etc.). Harmsworth's extended legion was published prior to the change to Arabic numerals, that is, it still has the LUC Classes in Roman numerals – Class IVe1, rather than 4e1;

4. Whereas Class 5 was rarely used because of previous very restricted definitions, the Handbook provides an opportunity to record, for example, Class 5e. Class 5e is land too steep to cultivate or too erodible when under cultivation, providing a logical progression from Class 3e to 4e to 5e, 6e and 7e as the land becomes progressively more erodible; and

5. Consultants working in the Auckland and Northland Regions have introduced several new land use capability Units to fill gaps in Harmsworth's legend. These include LUC Units to subdivide some of Harmsworth's Units, Units able to be defined by more detailed farm and orchard scale mapping, and so on. [See surveys in Northland by Cathcart[7], Hicks[8] and Hanmore[9] - each have mapped and described new LUC units when working at a 'farm scale' or 'orchard scale' in the Auckland, Northland and Waikato Regions.]

Caution with respect to the nzlri Digital Database

Scale of Map Data - As a general rule, LRI and LUC information in the nzlri-luc database should not be enlarged beyond the scale at which it was originally collected. As is explained in the Handbook, problems will arise when personnel untrained in resource inventory and luc assessment use Geographic Information Systems (GIS) when seeking information on small areas of land enlarge the imaging beyond the scale at which it was originally captured/mapped. Significantly enlarging the scale can produce unreliable and misleading results or may result in information that is at best nonsense.

The minimum size of a polygon or discrete parcel of land that can be safely delineated on a 1:50,000 scale map is 10 hectares. 1:50,000 rural reconnaissance maps should not be used to definitively assess the soil type, geology or land use capability, on 800m^2 urban sections.

Date on which the data was collected – While there have been some minor changes to the nzlri – luc online data, these changes have largely relied on the original resource inventory data on which LUC assessments were made. The data does not, for example, identify land use changes or significant modifications to the land or its use in recent years.

LAND USE CAPABILITY ON THE WAITANGI TRUST LAND

A land inventory survey has been undertaken on the Waitangi National Trust property according to the procedures set out in the LUC Assessment Handbook, involving a walk over, definition of polygons, assessment of slope, erosion type and severity (both active erosion and signs of historic erosion) and recording vegetation/land use. Several holes were dug or augured, and soil profiles checked in each polygon type to identify soil types, in most cases to confirm that the soil types recorded at a farm scale are in accordance with those mapped by Taylor and Sutherland[(2)] on the DSIR Soil Maps for Northland.

Using the Land Resource Inventory Data, the LUC Handbook decision-making process and the authors 58 years' experience in assessing and mapping land use capability, over 52 years of that in Northland, the land use capability of each polygon is assessed and recorded on the spreadsheet. Wherever possible, the Land Use Capability Units described by Harmsworth are used. At this more detailed scale of mapping, there are some 'new' Northland LUC units, identified by an *, units used by the author in mapping for farm plans, the National Policy Statement for Highly Productive Land, and when undertaking urban capability mapping at various locations in Northland.

In mapping Land Use Capability on the Trust property, 12 land use capability classes have been recorded. They include:

Class 3s2 - Flat to gently sloping 'old' volcanic friable clay on around the Treaty house and neighbouring buildings and the grassed slopes between the golf course and the Waitangi Estuary. This Brown Loam (Orthic oxidic) soil has a shallow friable topsoil over a dense clay subsoil, the subsoil limiting plant root penetration and reducing the depth of plant root penetration, increasing the risk of drought. It is suited to an occasional fodder or arable crop as part of a pasture replacement programme and is suited to some shallow-rooted vine and tree crops. Being an older soil, it has been leached of nutrients and often has low carbon levels in the topsoil. This land is be suited to viticulture and to growing fruit trees such as citrus, pip fruit(apples and pears) and other trees planted by early settlers. [*Is there an opportunity to grow heritage fruit trees, those cultivated by the early European settlers?*]

Land Use Capability Class 3s2 land

Class 4e7 – Gently rolling greywacke country prone to sheet, rill and gully erosion when cultivated. These are heavy clay soils, in places podzolised, suited to pastoral farming with an occasional short-season summer crop as part of a pasture renewal programme but not to general arable use. Careful grazing management is required to avoid pugging in winter. It is also suited to production forestry, with patches suited to tree crops like olives, and to viticulture.

Class 4e12 foreground, easing onto Class 4s4 on lower slopes, Class 4s2 (volcanic) in middle distance.

Class 4e12 – Easy to gently rolling gumland, subject to sheet , rill and gully erosion when cultivated or when heavily pugged. Like Class 4e7, this land may grow a short-season fodder crop as part of a pasture renewal programme but is not generally suited to arable use.

Class4s2 – Strongly to very strongly leached Brown Loam (Orthic oxidic) soils with a shallow but friable topsoil over dense clay subsoil. This land is suited to an occasional summer crop, but care will be required when cultivating to avoid basalt boulders and patches of sheet basalt. It should not be overcultivated when dry as it has a weak structure, and it is important to get pasture well established before late autumn to avoid sheet and rill erosion. Some patches of deeper soil may be suited to shallow-rooted orchard crops or vines.

Class 4s4 – Flat to gently sloping gumland soils on the lower slopes below Tau Henare Drive - Haruru Falls Road, bordering onto the old volcanic 'terrace'. These mature podzols, soils with weak structure prone to serious sheet and gully erosion when cultivated or heavily pugged. Similar soils have been used for viticulture and for apple orchards in the Henderson area, but care is required to avoid fungal root diseases. Like the other Class 4 soils, Class 4s4 can support an occasional summer crop but new pasture needs to be well established before winter to prevent soil erosion.

Class 5e3* - Rolling slopes at the Haruru end of the central ridge, adjoining the Domain. This land is too steep to cultivate but a fodder crop could be established by direst drilling provided the land is back in pasture before winter. It has a thin 'skin' of basaltic soil over an older greywacke soil, improving the drainage of the topsoil but with moisture in the underlying 'soil'

available for deeper-rooted pasture species. This land is suited to pastoral farming or to production forestry. (* denotes a LUC Unit first described by Cathcart[7])

Class 6e4 – Bouldery basalt volcanic soils on the edge of the 'terrace' below the golf course. The banks of the walkway through the bush reserve show patches of basalt-derived soil, often with large boulders, and patches of soil on greywacke (Class 6e9). While the basaltic Class 6e4 is free-draining and relatively stable, even on steep slopes, the greywacke soil is prone to slipping, particularly where water is draining from under the basalt along the terrace edge. Generally, this land is too steep and potentially erodible to be used for pasture and is too close to the edges of the estuary for production forestry. Its current use, as regenerating mixed broadleaf-podocarp and kauri forest is the best use.

Class 6e9 – Strongly rolling to steep, even very steep greywacke hill country, prone to slipping during high intensity rainfall events. While it will still slip during such storms, the current uses of regenerating indigenous forest or production forestry, within environmental management guidelines are optimum land uses.

Class 7w2 – A freshwater wetland formed in a basin, somewhat removed from the estuary or up the valley above the limit of saline and tidal effect. It will be developing peat but will generally have high fertility-demanding freshwater species like raupo, Te kouka (cabbage tree) and flax (harakeke). These wetlands perform as filters trapping nutrients and sediment from natural erosion and from runoff from housing, roads farmland and production forests.

Class 7w5* - Seepage and springs from basalt draining out at the interface with underlying greywacke rock, creating wetlands in a basin above the limit of tidal effect. This area (polygon 32), while developed to pasture, would be better re-established as a wetland to filter sediment and nutrient runoff.

Class 8w3* - This is a large wetland in the valley bottom below production forest, farmland and regenerating bush, impractical to effectively drain and performing important environmental filtering and biodiversity functions.

Note: The mangrove forests, intertidal islands and adjoining saline herb fields have not been assessed. This is land still forming and much of it will be affected by rising sea levels and remain as intertidal. It is a very interesting area in that it has a range of species, some of which are terrestrial, recording the progression of sediment deposits in the estuary from sea/riverbed to an island.

RECOMMENDED LAND USES

This report, while identifying some potential land uses within each of the land use capability units, stops short of recommending land use. Instead, a range of potential land uses can be considered having regard to the descriptions of the land use capability units and to the wishes of the 'owners'. This would be Stage 2 of the process of matching environmentally, culturally and economically sustainable land uses to the inherent characteristics of the various land types.

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APPENDIX 1. Land Resource Inventory Map (*separate pdf*) and Extended legend, including description of LUC classes (In *this document from page 17*)

The legend records the landform, rock type, soil type, slope, current active erosion type and severity, current land use/vegetation and land use capability.

APPENDIX 2 - Potential Partners, Mentors and Advisors in Stage 2 when considering Land Use Options (*In this document from page 23*)

EXTENDED LAND RESOURCE INVENTORY LEGEND

	Landform	Parent Material	Soil Type	Slope	Erosion Forms	Vegetation/Land Use	Land Use Capability	Area (ha)
1	sideslope	greywacke	HKr - WKl	B^C	sheet Θ	pasture	4s4	3.12
2	ridgetop	greywacke	RAH - HKr	D	sheet Θ	pasture	5e4*	1.32
3	sideslope	greywacke	HKr - WKl	C	sheet & gully Θ	pasture	4e12	7.32
4	easy slopes	greywacke	HKr-WKl	BC	sheet	pasture	4s4	16.73
5	gullies	greywacke	HKr - WKl	B-E	gully 1	pasture + poplars	6e9	3.25
6	footslope	greywacke	WKl - HKr	B^C	sheet Θ & gully	pasture	4s4	7.42
7	plateau	basalt lava flow (boulders)	WKl -> YO	A^B	depositi on Θ	pasture	4s2	9.00
8	broken hill country	greywacke	RAH - HKr	DE^F	soil slip 1	regenerating native bush	6e9	96.25
9	mudflats	marine sediment	non-soil	A	depositi on 2	mangrove forest	not assessed	89.66
10	edge of plateau	basalt/greywacke	YO + RAH-HKr	C- F	slip & gully Θ	regenerating native bush	6e9 + 6e4	21.67
11	sideslope	greywacke	HKr	D	slip Θ	pasture	5e4*	6.35
12	footslope	greywacke	HKr	B	Θ	pasture	4s4	2.38
13	ridge	greywacke	HKr	BC	sheet Θ	pasture	4e12	4.38
14	gully head	greywacke	RAH	E	slip, sheet 2	recently logged	6e9	1.56
15	ridge	greywacke	RAH + HKr	CD	Θ	residential	4e7	4.98
16	gullies & sideslopes	greywacke	RAH + HKr	DE	Slip Θ	regen and planted native bush	6e9	8.64
17	mudflat	marine sediment	non-soil	A	Θ	mangrove & estuarine veg,	not assessed	8.58
18	island	greywacke + basalt lava	HKr - RAH	DE	Θ	regen native bush	6e9	8.17
Green Dump	footslope, terrace	alluvium	non-soil	AB	Θ	soil and waste vegetation	not assessed	1.89
19	freshwater wetland	sediment	non-soil	A	Θ	fresh and estuarine wetland veg.	8w3*	2.31
20	eroded lava flow	old basalt lava	YO	B	sheet Θ	mown lawn	3s2	4.96
21	undulating sideslopes	greywacke	HKr + WKl	BC	sheet Θ	mown golf course	4s4	50.84
22	coastal sideslope	greywacke	RAH - HKr	CD	Θ	kikuyu + regen.	6e9	4.2
23	ridge	greywacke	RAH - HKr	C - E	Θ	pines	5e4*	32.45
24	sideslope	greywacke	RAH-HKr	C - E	Θ	scrub weeds, manuka-kanuka & regen bush	6e9	12.00

25	wetlands	sediment	non-soil	A	Ɵ	Interface of fresh & saline wetland species	8w3*	5.96
26	sideslopes	greywacke	RAH - HKr	C - E	Ɵ	regen kanuka-manuka	6e9	7.28
27	basin	greywacke/basalt	RAH-HKr-YO	BC	Ɵ	eucalypt plantation	5e4*	2.47
28	islands of sediment on tidal flats	sediment	non-soil	A	deposition 2	mix of saline and emerging terrestrial plants	not assessed	6.27
29	ridge	greywacke	HKr - RA	CD	sheet Ɵ	pasture	5e4*	13.61
30	rolling hill country	greywacke (with traces of basalt overlay	HKr-RA + YO	CD	sheet 1	pasture	5e4*	1.50
31	easy sheltered basin	basalt over greywacke	YO/HKr	BC	Ɵ	pasture	4s2	14.54
32	seepage area in basin	basalt over greywacke	wet YO	AB	deposition 1	pasture and rushes	7w5*	3.87
33	wetland in basin	mix, boundary of basalt & greywacke	wet HKr & RA	A	Ɵ	raupo and freshwater wetland veg	7w2	2.04
34	side and footslope	basalt over greywacke	YO + HKr-RA	BC	Ɵ	planted and regen natives + woody weeds	5e3*	1.7
35	ridge & sideslope	basalt over greywacke	YO/HKr - RAH	DE	Ɵ	rank pasture	5e3*	3.41
36	manmade basin	Fill	(artificial 'soil')	A^{+B}	Ɵ	mown lawns	not assessed	4.86

Areas of Land Use Capability Classes

3s2	gently sloping old volcanic soil	4.96ha
4e7	easy to gently rolling but heavy clay soils	4.98
4e12	easy to gently rolling gumland soils	11.70
4s2	flat to easy rolling old volcanic soils	23.96
4s4	flat to undulating gumland soils	80.49
5e3*	rolling to strongly rolling greywacke clay soils	6.20
5e4*	rolling to strongly rolling mosaic of clay and gumland soils	57.29
6e9	strongly rolling to steep greywacke hill country	141.35
6e9 + 6e4	edge of lava flow with a mix of old volcanic soils and strongly rolling to steep greywacke soils	21.67
7w2	freshwater wetland soils	2.64
7w5*	wetland caused by water 'leaking' between basalt layer overlying greywacke	3.87
8w3*	wetland at the interface between fresh and saltwater	6.71

Areas where Land Use Capability Not Assessed

mangrove-dominant estuarine areas	89.66ha
tidal flat with estuarine plants and few mangroves	8.58
Green dump and maintenance yard	1.89
sediment island with terrestrial plants establishing	6.27
Domain	4.86

Key to Land Inventory Symbols

Soil Types ('H' denotes Hill Soil)

Marua Suite from Greywacke

RA	RAH	Rangiora clay. Clay loam and stony clay loam
HKr	HKrH	Hukerenui silt loam with yellow subsoil
WKl		Wharekohe silt loam

Kiripaka Suite from Basalt Lava Flows

YO	YOH	Waiotu friable clay

Slope Groups

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

Erosion Forms and Severity

Deposition	siltation - erosion products being deposited.
Gully	gully erosion
Sheet	sheet and rill erosion
Slip	slip erosion

Land Use Capability Units

*(All LUC Units are those described by Harmsworth and shown on the nzlri-luc database except for those with *, which denotes a unit not described by Harmsworth or recorded on the nzlri – luc database but first described by Cathcart, post-2010.)*

Class 3s2 Gently sloping old basalt volcanic soils with a shallow topsoil over a dense clay subsoil. While this soil is erodible when under cultivation, its major limitation to land use is the shallow topsoil, prone to drying out in summer, and the high clay content and compactness of the subsoil limiting root penetration. This area would be suited to vegetable production and to vineyards.
With careful soil husbandry, this area would be suited to kumara production.

Class 4e7 Heavy clay soils on easy to rolling greywacke hill country.

Class 4e12 Gently rolling gumland on greywacke hill country. Diversion drains, 'graded banks' or 'contour drains', were constructed by the Ministry of Works and Development Soil Conservation Service in the early 1960s to control runoff, gully and sheet erosion on the slopes below Bledisloe Road, a practice applied to some 3,000 hectares of similar soil types in Northland between 1960 and 1975. This has not only prevented erosion but has enabled a deeper topsoil to develop over the silica pan which developed under dense stands of kauri forest. See note on '**gumland soils'** in body of report.

Class 4s2 Flat to easy old (mature) soils on basalt old volcanics, often with basalt boulder and/or accumulations of iron and aluminium in the subsoil. On this property, this unit sits downhill of erodible gumland soils and would have previously received silica-rich silt sediment from these upper slopes, which would have modified the soil in some places. This source of water and sediment runoff was cut off my graded banks, as described above. The underlying sheet basalt is, in places, close to the surface, affecting both drainage and plant/tree root penetration. Given that this unit occurs on a relatively flat area sheltered by native bud around the eastern edges, a more detailed survey may identify, and careful water management may enable some orchard development, but not with crops requiring a deep, free-draining soil.

Class 4s4 Flat to easy gumland, with a dense silica pan which limits plant (and tree) root penetration and prevents water percolating through the soil profile. It is a wet soil in winter and can become a very dry soil in summer.

Class 5e3* Easy to rolling clay hill country with heavy clay soils developed on sedimentary and greywacke parent material, too steep for cultivation or machine harvesting of crops but some may be suited to limited cultivation to smooth the surface and establish pasture. Some may be suited to occasional non-tillage fodder cropping as part of a pasture replacement programme. In this survey, there is

an overlay of basalt-derived soil (over or mixed with the greywacke parent material) at the Haruru Falls end of the property.

Class 5e4* This is rolling to strongly rolling hill country with a mosaic or complex of soils ranging from strongly leached to moderately podzolised soils to patches of mature podzols, the older soils being where there once were stands of mature kauri. Like Class 5s3*, some of this land may be lightly cultivated to smooth the surface but, generally, it is too steep and potentially erodible for growing crops. Some limited fodder cropping using non-tillage methods may be possible but this land must be covered in pasture before winter to prevent soil erosion.

Class 6e4 Free-draining but bouldery soils formed on the edges of the basalt lava flow along the plateau edge between the golf course and the Waitangi Estuary. This strip of land, all in regenerating native bush, has patches where there is no or very little basalt, just greywacke, and place with basalt boulders.

Class 6e9 Strongly rolling to steep greywacke hill country with a complex of soils; younger soils on steeper land where erosion, even under bush, exposes new parent material on which soils are still developing, through to mature, even podzolised soils on easy ridge tops. While this land can be farmed, it is better suited to production forestry or retirement to bush to both stabilise the land and enhance the natural ecosystem, in this case forest-type diversity, in this locality.

Class 7w2 A freshwater wetland basin, above the saline influence, which acts as a filter to retain sediment and nutrients and to provide habitat for wetland biota.

Class 7w5* A freshwater wetland formed by groundwater oozing out of the ground at the interface of the basalt lava flow and underlying greywacke.

Class 8w3* While the land use capability of the mangrove and intertidal wetlands have not been assessed, sediment and debris carried by floods, which have formed islands and on which terrestrial plants have established, including flax, small shrubs and scrub species have been assessed as Class 8w3*, having no productive value but providing habitat for plants and animals native to the inter-tidal and sand island substrate.

APPENDIX 2 - Potential Partners, Mentors and Advisors in Stage 2 when considering Land Use Options

There are many people who could assist the Trust or who may wish to partner with the Trust in the future development of the Waitangi National Trust Land. These include but are not confined to:

Pastoral Farming

Beef and Lamb New Zealand Katrina Stead, Northern North Island Extension Manager
027 489 7343 katrina.stead@beeflambnz.com

Dairy NZ Alison Whiteford, Regional Manager
027 499 9021 Alison.Whiteford@dairynz.co.nz

Fonterra, Farm Source Mike Borrie, Head of Farm Source Northland
027 221 2042 mike.borrie@fonterra.com

Whangarei Agricultural & Pastoral Society CEO Chris Mason 022 090 0613
President Evan Smeath 027 449 8274

Bay of Islands Pastoral Society & Industrial Association 0210 918 8228
info@bayofislandsshow.co.nz

Forestry

Northland Farm Forestry Association Peter & Nancy Coates - 242 Nook Road, RD 4
Whangarei
0174
09 436 5774
nancyandpetercoates@gmail.com

Forest Industry Generally Peter Davies-Colley 09 433 1718 treepepl@xtra.co.nz

Horticulture

Avocado	Jerome Hardy	jeromeandfran@gmail.com	027 233 4380
	Ian Fulton	ian.fulton@clear.net.nz	09 406 8808
Kiwifruit	Marty Hansen	marty.hansen@seeka.co.nz	027 221 7852

Persimmon	Duane Wells	duane@ntlhorticulture.co.nz	021 361131
Tamarillo	Robin Nitschke	robin@tamco.co.nz	027 262 6949

Vegetables Contacts are being established with Balle Bros. Group and Wilcox and Sons, Pukekohe-based market gardeners who already operate in Northland.

Viticulture It is understood that Trust Officers have already made contact with viticulture representatives.

Horticulture Industry Generally - Contacts with a broad understanding of the wider horticulture industry and supply chains

Kiwifruit, berries, and labour management Patrick Malley 021 963 363
patrickpmalley@gmail.com

Kumara, vegetables Andre de Bruin 027 272 4239
andre.debruin@xtra.co.nz

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