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Versatile Soils - Productive Land

Report for Hawke's Bay Regional Council

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An opinion to assist the council in understanding the issues associated with defining 'versatile soils' or 'productive land' for the purposes of avoiding inappropriate use/subdivision/development.

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1. Brief:

To assist the council in understanding the issues associated with defining ‘versatile soils’ or ‘productive land’ for the purposes of avoiding inappropriate use/subdivision/development.

Specifically:

To provide opinion on:

1. the distinction between ‘soil’ and 'productive land'
2. the properties which describe a soil resource; and of those properties, those that would determine a soil to be high value and/or versatile
3. various terms used to describe soil that justifies protection, including high class, high value, elite, versatile, fertile. The Hastings District Plan refers to the life supporting capacity of the soil. What is the ‘industry best practice term’ that should be used to describe such soils.
4. a description of the symptoms of soil degradation that can arise from land use practices and the remediation measures that could be used to return the soil to its natural capacity. Is there a point where the soils could not be reinstated?
5. the elements of tension that need to be considered when considering how such high value soils / productive land should be protected. For example the productive capacity of two soils might be the same but one requires minimal external inputs and the other requires considerable inputs such as water, fertiliser or drainage.
6. approaches appropriate to protect high value soil / land, and specifically comment on the use of the Land Use Capability Maps as a planning tool
7. which soil maps are the most appropriate to use for planning purposes? If detail is lacking, how could the gaps in information be filled.

2. Summary

The Heretaunga Plains has an unusual proportion of its land being of very high value for primary production. Almost 90% of land outside urban areas fits within Land Use Capability Classes 1 - 3. A further area of almost 7% is in Class 7, but identified as very high value for viticultural production.

However, land on the Heretaunga Plains is in short supply for primary production and the secondary services that dominate Hawke's Bay's economy. The diversity and intensity of horticultural and viticultural production on the Heretaunga Plains creates high demand for land. Virtually every soil type boasts examples of intensive primary production.

The Heretaunga Plains Urban Development Strategy recognises the significance of the land based economy and encourages its further development. It recognises the productive values of its soil and water resources and provides for their sustainable use. It specifically seeks to protect the region's soil resource by minimising urban sprawl.

Highly versatile soil requires less mitigation to be productive than does less versatile soil. However, soil is but one factor of the production system and thus of productive land. Productive land integrates soil and many other physical and social factors.

A number of Court rulings relate to attempts to limit urban growth for the purpose of safeguarding productive land. The outcomes have been variable, but the protection of soil was not found sufficient justification to refuse sub-division. A narrow focus on protecting soil is unlikely to safeguard productive land from urban expansion.

Regardless of soil qualities, land may not be of high versatility given its setting. An extremely good (highly versatile) soil might not be viable for farming because of site or off-site factors. A relatively poor (low versatility) soil might exhibit high value because of proximity to other resources and services. Land with less versatile soil can be very productive if resources are available to address limiting factors.

The Resource Management Act refers to safeguarding the life-supporting capacity of soil, and provides some function to manage land for the purpose of soil conservation, but soil conservation in the RMA means avoiding, remedying, or mitigating soil erosion and maintaining the physical, chemical, and biological qualities of soil.

The act of subdivision does not affect the soil's productive capacity so much as it affects patterns of ownership. Sub-division may, by adversely affecting any of the factors of production, affect land's productive capacity. Sub-division for urban development removes land from agricultural production, and also impacts on the productivity of other land, in particular through reverse sensitivity.

The intent of the Heretaunga Plains Urban Development Strategy is to control inappropriate use, subdivision or development. That is important for the region's prosperity, but should be addressed directly.

Any strategy must include consideration of a wide range of factors of production. Singular focus, indirect measures have been successfully challenged in courts and may create unintended or perverse outcomes.

3. Background

3.1 Heretaunga Plains Urban Development Strategy

The Heretaunga Plains Urban Development Strategy (HPUDS) recognises the value of the area's soil and water resources in the following guiding principles:

Quality Living Environments with high levels of amenity and thriving communities

- Avoiding sensitive natural environments, (streams, wetlands, lakes, and rivers) and significant landscapes, and versatile soils for productive purposes.
- Maintain, enhance and create important ecological areas for the protection and enhancement of indigenous biodiversity.

A growing and Resilient Economy which promotes opportunities to live work and play

- Recognise opportunities to utilise the versatile soil resource of the Heretaunga Plains for production while minimising the loss of versatile soils from productive purposes to urban development
- Recognition of the significance of the land based economy and encourage its further development

Productive values of its soil and water resources are recognised and provided for and used sustainably

- Recognise versatile soils for productive purposes through minimising the need for urban development on such soils and providing for rural lifestyle development in other locations
- Ensure that the allocation and use of the water resources is efficient and sustainable
- Protect the Heretaunga Plains aquifer systems
- Protect and enhance the water quality of streams, rivers, lakes and wetlands.

The strategy seeks to protect the region's soil resource by minimising urban sprawl through compact urban design and taking a number of criteria into account in identifying areas for future growth. Those criteria included identifying areas where:

- Soils are of lesser versatility or,
- Productive capacity is compromised by:
    - Size and shape of land parcels that mitigates against productive use
    - Surrounding land uses and reverse sensitivity
    - Lack of water/poor drainage
- Clear natural boundaries exist or
- Logical urban edge greenbelts could be created.
- Greenbelts could provide opportunities for walking and cycling connections
- Sites can be serviced at reasonable cost and integrated with existing development.

As a result, a number of "Greenfield areas" have been identified around Hastings and Havelock North and in surrounding communities.

This strategy is to be incorporated into the Regional Policy Statement. This will require those areas for future urban growth to be identified, and policy direction for the use, subdivision and development of land outside those areas.

A number of submissions were received on the matter of the protection of the Heretaunga Plains' valuable soil and water resources. The key themes are summarised as follows;

- Ensuring that fertile soils in the plains are adequately protected by focusing development on the hills and within the extents of existing rural communities
- Recognising and protecting the productive capacity of the plains and recognising fertile soils as the basis of the Heretaunga Plains economy
- Recognising the importance of other land based industries to the Heretaunga Plains and the importance of protecting the soil resource for future generations
- Possibility of a 'food production zone' to protect the production versatility of soils and associated activities

One of the areas to be clarified through the Regional Policy Statement process is how to describe the soil / land resource that should be protected. The strategy does suggest the versatile soils worthy of protection as perhaps those being at the upper end of the soil values. However it also refers to the protection of productive land for food production.

This report informs that discussion, with particular emphasis on the key questions outlined in the Brief.

3.2 Soils in New Zealand's economy

The report of the Parliamentary Commissioner for the Environment, "Growing for Good: Intensive farming, sustainability and New Zealand's environment", states that New Zealand is in the business of *"...exporting our foods, fibres, wines, films and delivering great visitor experiences. New Zealanders are highly dependent on our natural capital - our waters, soils and biodiversity - for sustaining these wealth generating capabilities."* The report considered *"... soils: the central engine room."* [1]

Seventeen per cent of New Zealand's gross domestic product depends on the top 15 centimetres of our soil (Sustainable Land Use Research Initiative, no date). Soils do underpin food and fibre production in New Zealand and protect our environment by:

- acting as buffers and filters to reduce nutrient loss
- limiting the need for irrigation
- breaking down pollutants
- regulating greenhouse gas emissions
- acting as a fundamental part of the water cycle

Thus the role of soils is greater than just "being productive" in terms of primary food and fibre outputs. They also provide eco-system services, notably in the Heretaunga Plains of buffering crop water and nutrient needs, filtering water, capturing and breaking down pollutants, providing amenity services of landscape and recreation and so on.

Soils do have a critical role in supporting urban living. Their prime role is providing platform services (a place to build roads and houses etc.) but they also provide amenity, recreation and home food production services.

3.3 National guidance

Urban growth can be achieved (in terms of addressing population increases or the changing household needs of an urban area) by extending onto 'greenfields' land or through increasing the density within an existing urban area.

Because urban growth commonly occurs on the rural periphery of urban areas, it is a subject that is frequently interrelated with other typically non-urban topics such as the value of productive land and landscape values.

3.3.1 Resource Management Act

The Resource Management Act refers to soils in Part 2, Section 5, paragraph 2:

> *(2) In this Act, "sustainable management" means managing the use, development, and protection of natural and physical resources, or at a rate, which enables people and communities to provide for their social, economic, and cultural well being, and for their health and safety while:*
>
> *a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems*

Soil is not listed in Section 6 RMA which lists matters of national importance.

There are requirements relating to regionally significant issues:

- Section 62(1) states: A regional policy statement must state the significant resource management issues for the region.
- Section 30(1)(b) makes it clear that any provision mandated for protection of land is where regional significance has been identified.
- Section 30(1)(b) The preparation of objectives and policies in relation to any actual or potential effects of the use, development or protection of land which are of regional significance.
- Section 30(1)(c) empowers regional councils to control land use activities for the purpose of soil conservation [Note: soil conservation in the RMA means avoiding, remedying, or mitigating soil erosion and maintaining the physical, chemical, and biological qualities of soil].

4. Distinction between soil and land, versatility and productivity

The terms "soil" and "land" are commonly mis-used interchangeably. There are accepted definitions for each of these words. In short, soil is one element of land.

Both soil and land are described as "versatile" and/or "productive", and agreed definitions of these words are needed. Other descriptors include, high class, high value, elite, and fertile. The Hastings District Plan (and the RMA) refers to "life supporting capacity of soil".

To define our best soils for food production, Palmer[2] offers two main concepts: *Versatility* and *Land Use Capability*.

4.1 Soil

Soil is a natural medium for the growth of plants, consisting of layers formed in a place over time through the combined effect of physical, chemical, biological, and human processes on soil parent material.

There are many formal definitions, some of which are included in the Glossary.

The Heretaunga Plains Urban Development Strategy (Section 5.22. Land and Soils) states;

> *"Repeated flooding means that soil is a renewable resource, but it takes a long time to get it back once it's lost."*

This is incorrect on the Heretaunga Plains. Firstly, the soil is not "got back"; once gone, it is gone, generally ending up as sea sediment. Secondly, it is not replaced.

Each Heretaunga Plains soil is the result of a unique set of conditions that is unlikely to be repeated.

- Extensive engineering works (stop banks and other flood control systems) direct parent-material-containing flood-waters direct to the ocean, and prevent river sediments from encroaching on the settled plains. The supply of alluvium, from greywacke and other sources, has been removed.
- Loess soils are derived from ice-age river sediments re-deposited by winds 15,000 years ago.
- The ash soils derive from volcanic explosions 1,200 years ago, mostly re-deposited as alluvium by river flooding that has now been prevented.

4.1.1 Soil classification

A soil classification can be used to trace the formation, or evolution, of soils through time. Under the New Zealand Soil Classification there are 73 major soil groups that can be aggregated into 15 different soil orders.

Soil orders are the highest and most generalised level of the classification. The soil groups can be divided into 272 subgroups with a further subdivision into soil forms. The top three levels of the classification (orders, groups, and subgroups) were described by Hewitt (1993)[3] and the fourth level (soil forms) by Clayden and Webb (1994).[4]

4.1.2 Productive soil

Definitions of productive include ability to produce and producing abundantly (see Glossary). Specific to soil, the Soil Science Society of America defines soil productivity, as *"the output of a specified plant or group of plants under a defined set of management practices."*

It should be noted, in the context of this report, that the act of property subdivision does not affect a soil's productive capacity, so much as it affects patterns of ownership. Subdivision or urban expansion, per se, does not lead to a "loss" of soil or soil productivity, even though it may make farming unfeasible.

4.1.3 Versatile soils

Versatile is defined by the Concise Oxford Dictionary as *"Turning easily or readily from one subject or occupation to another, capable of dealing with many subjects . . ."*

Hewitt[3] states that New Zealand's best soils are variously called "versatile" or "high-class". They supply the nutrients required for optimum plant growth, and are good for growing food.

> *"a versatile soil capable of many uses needs to be deep, fine-textured, moist, free-draining, loamy, and have an organic-rich topsoil. These properties best enable plant roots to take up nutrients, water and oxygen, and get enough support for rapid growth. Fertility is highest in soils young enough not to have been leached and old enough to have built up organic matter. They are also derived from parent rocks that are well supplied with essential nutrients."*

Versatile soils are rare in New Zealand, (accounting for only about 5.5% of New Zealand) and of high value for food production and where practicable should be reserved for horticulture and agriculture and protected from urban development.[3, 13]

4.2 Land

Land encompasses a wide range of attributes, of which soil is one. Generally it includes landform, soils, and ecosystems including native and exotic plant and animal communities and urban settlements. Definitions are presented in the Glossary.

4.2.1 Land Use Capability

The New Zealand Land Use Capability (LUC) Classification is defined as,

> *"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 after taking into account the physical limitations of the land."* [5]

There are eight classes with limitations to use increasing and versatility of use decreasing from Class1 to Class 8 (Appendix 1).

LUC Classes 1 to 4 are suitable for arable and vegetable cropping, horticulture (Including vineyards and berry fields), pastoral grazing, tree crop or production forestry use.

LUC Subclasses identify main kinds of physical limitations or hazards to use.

4.2.2 Productive land

Assessments of land and soil value often focus on presence or absence of limitations. The best land is that with no or few limitations.

Current legal consideration of productive land references the opinion of Environment Court Judge Treadwell [6]. A comprehensive list of factors that require consideration was given by Judge Treadwell in *Canterbury Regional Council v Selwyn District Council [W142/96]*, and guides much argument and decision in this area (Appendix 2).

Treadwell's range of factors to be considered is much broader than Land Use Capability. It lists a wide range of bio-physical, social and economic factors to be taken into account in recommending or otherwise a particular site for a particular crop.

Productive land, and even more specifically highly productive land, will be fertile and capable of producing abundant yields of plants and other primary products. But more than this, the other factors that together make an agricultural production system viable will also be present.

4.2.3 Versatile land

Chapman defines *"versatile soil/land"* as the ability of land to support production and management of a wide range of crops. It is mainly assessed in terms of soil and land physical characteristics, which have few limitations, such as poor drainage or slope instability. The assessments assume that soil nutrients are not a limiting factor. [13]

This definition mixes soil and land, and as already noted the two terms are not interchangeable. For land to be productive in an agricultural sense, it needs productive soil, but also all the other factors of successful production including such things as proximity to services and transport. The Treadwell list is relevant and is considered further in Section 8.3.

Extending the wider definition of *productive land* along the lines of Treadwell, versatile land will have a range of soil, climate, water resources, transport and industrial services, labour, and other resources, and absence of conflicts, that make it suitable for the production of a wide range of agricultural and horticultural products.

5. Properties that describe soil and land resources

Soil and land resources are described with some purpose in mind. Geologic surveys may focus on underlying rock types, perhaps for resource inventory and identification of potential mining sites.

Soil surveys are almost exclusively undertaken as resource inventory for identification of agricultural potential. The properties used to discriminate different soils will have agricultural relevance.

It is generally accepted that the specific properties of a soil, and the ecosystems services it can provide, are a function of climate, organisms, relief, parent material and time, and the influence of human activity.[7, 8]

Soil properties relevant to plant growth and protection are presented by Hewitt.[9]

In general, soil provides plants with water, air, nutrients and stability that are necessary for growth. The ability of a soil to provide these services may be evaluated by key soil attributes (see Table 1).

Table 1: Soil attributes and their relevance to plants. from Hewitt (2004)[3]

Key soil attribute	Relevance to plants
Wetness	Water supply, exclusion of air and, consequently, exclusion of oxygen
Root barrier	Controls the depth of soil available for roots to extract water and nutrients, and to anchor the plant
Stoniness	Stones and rocks dilute the volume of soil within the root depth that is available for water storage and nutrients
Porosity	Promotes stability by allowing deep rooting. Drains excess water, and circulates air to roots
Natural nutrient status	Controls nutrient supply and reserves
Drought proneness	An interaction between climate and soil attributes

In reporting the properties of Heretaunga Plains soils, Griffiths[10] includes further attributes including resistance to degradation or loss from factors such as compaction and erosion.

6. Symptoms of degradation

The capacity to nurture and sustain plant and animal productivity is a key function of high quality soils. Indicators of soil quality reflect the key properties and processes that support this function and can be used to assess the fitness of soils for production.[11]

In addition to extrinsic factors (climate, access to other resources such as water, services, transport), productivity is influenced both by the intrinsic characteristics of a soil (i.e. inherent soil quality) and those properties or processes that are affected by its use and management (i.e. dynamic soil quality).

Sustainable production depends on selection of land uses that are suited to the capability of the soil (and wider environment) and on maintaining soil conditions that minimise the risk of productivity decline.

Degraded soils exhibit a range of changed properties that reduce capacity to nurture and sustain plant and animal productivity. In an agricultural context, quality parameters for soils are described by Shepherd[12] in the Visual Soil Assessment guidelines.

Key indicators include:

- structural condition
- wind erosion potential
- compaction
- porosity
- soil organic matter
- worm numbers
- evidence from relative crop growth

These indicators integrate a number of bio-physical factors, including:

- aggregate stability
- aggregate size distribution
- bulk density
- oxygen diffusion rate
- water infiltration, permeability and holding capacity
- root penetration ability
- ion exchange capacity
- microbial activity
- micro- and macro-flora and fauna activity

In the Visual Soil Assessment system, soil indicators are supported by plant indicators that link soil condition to plant performance, farm production and management practices.

6.1.1 Degradation from land use practices

Agricultural soil degradation is commonly associated with intensification of land use and impact on physical properties (structure, aggregate stability and porosity). Associated with physical degradation will be changes in chemical (nutrient and pH) and biological (organic matter, micro-fauna activity). Potential productivity and resilience are reduced.

On the Heretaunga Plains, the most intensive uses include arable and vegetable cropping. Degradation follows repeated cultivation, trafficking especially under wet soil conditions, and removal of organic matter as crop and by-products and as a result of increased oxidation following cultivation.

As stated in HPUDS (s 5.22.1),

> *"Continuous cultivation and compaction from machinery means many paddocks have not maintained their original structure or natural fertility. Careful management is essential for the land to sustain high levels of production."*

Agricultural and arable soils of the Heretaunga Plains do show signs of reducing quality and in a few cases, relative productivity. They are however, still highly productive.

The rate of degradation is exacerbated by increased demand for horticultural and arable production, the intense competition for existing land resources and the high economic value of peri-urban and rural land.

To remain economically viable, farming has reduced or removed "restorative phases" in crop rotations. Grass pasture phases no longer have sufficient time to rebuild natural capital. Further loss of land to urban development can only make this situation worse.

Subdivision or indeed urban expansion does not, per se, lead to a loss of soil or soil quality or productivity. As Keenan notes, the act of subdivision does not affect the soil's productive capacity, so much as it affects patterns of ownership[16]. Subsequent activities, such as clearing soil for roading and building foundations, may lead to a loss of some soil.

Subdivision or urban expansion may lead to a reduction of agricultural land productivity as noted in Section 1 and Appendix 2.

6.1.2 Remediation measures

Remediation of agricultural soils involves restoration of the properties that enable normal function. A traditional crop rotation system achieved this through changing species and incorporating pasture phases. Short term degradation was remediated though biological activity and "resting" from cultivation.

A long term cropped, or otherwise degraded soil can also be effectively remediated. Immediate action will usually involve mechanical shattering of mid and upper soil layers to remove compaction and restore ability for water and air to permeate.

Establishment of vegetative cover, especially pasture grasses begins to increase soil organic matter, rebuild and strengthen soil aggregates and enhance macro- and micro-porosity. Several years of

pasture phase and avoidance of further stress is normally sufficient to restore most to the potential of soils on the Heretaunga Plains.

6.1.3 Tipping point for reinstatement

There is little evidence of soils that have "passed a tipping point" as a result of agricultural use. Even those in the most degraded states can be remediated, mainly by removing imposed compaction, establishing pasture and allowing the natural processes to rebuild the soil condition.

Factors that may render a soil "un-remediable" include removal of topsoil or addition of toxins or other pollutants. These factors may make soils unsuitable for urban use as well, unless extensive artificial site remediation was undertaken. In some cases, weed infestations have made soil difficult to farm successfully. This may not limit urban use.

When land is used for roading and construction, such as for urban sub-division, soil is generally destroyed. However, the portions of land not subjected to such intense modification, residential lots and public reserves, retain much of their natural productive capacity.

7. Terminology to describe soils that justify protection

7.1 Soils worthy of protection for their productive capacity for future generations

Soil types that cover some 89% of Heretaunga Plains already support a range of intensive primary production activities. A further 7% support a world recognised viticulture and wine industry.

7.1.1 Versatility and Land Use Capability

Chapman [13] is one of a number of people that link versatile soils to the New Zealand Land Resource Inventory. He states,

> *"versatile soils are classified as Land Use Capability 1, 2 or 3e, on the New Zealand Land Inventory Worksheets (as amended in the 1986 Second Edition), provided that land classified as Class IIIe is further described as containing well drained and moderately well drained soil, in accordance with the Soil Description Handbook (Milne et al [14])."*

Many Councils use the LUC classification to define soils worthy of protection for their potential life supporting capacity and protection for future generations. They define these soils variously as either being high quality, elite, prime agricultural or versatile. One description of these soils is the term versatile soils, as defined by Chapman above.[13]

A singular focus on soil alone is unlikely to provide legal protection for their productive capacity (see Section 8.3), and is not sufficient to determine their productive capacity in an economic sense.

7.1.2 Highly versatile Heretaunga Plains soils

Versatile soils (Class 1, 2 and 3e) are of high value for food production and where practicable should be protected from urban development. This definition covers about 55% of soil area on the Heretaunga Plains, but does not include many important soil resources in the Heretaunga Plains.

7.1.3 Less versatile Heretaunga Plains soils of high value

Substantial areas of financially successful intensive cropping takes place on Class 3w and 3s soils to the west and south of Hastings (Turamoe, Ngatarawa, Poporangi and Pakipaki soils), and around Napier (Meeanee, Te Awa and Ahuriri soils). These soils, which are outside the versatile soil definition above, account for a further 34% of Plains land.

These soils have lower versatility because of limitations such as wetness, potential droughtiness or restricting layers within the soil. So they require a higher level of management, and higher inputs of drainage and irrigation, to achieve yields of higher versatility soils.

But because of their combination of land productivity factors, they have high value and are deserving of protection. They are known to produce well when suitable drainage and/or soil conservation practices are in place. They have ready access to irrigation, and they are close to labour, further processing facilities and farm services.

The Heretaunga Plains also include of very low versatility soils with high economic viticulture value. These are most notably the "Gimblett Gravels" (Class 7) which have achieved terroir status. This incongruity is noted in the 2009 Land Use Capability handbook (Lynn et al)[5]. These Class 7s soils account for 7% of Plains soils.

7.1.4 Less versatile soils of lower value

The question for the Heretaunga Plains is, *"Which soils, if any, are not worthy of protection for their productive capacity for future generations?*" The answer is not clear.

The diversity and intensity of horticultural and viticultural production on the Heretaunga Plains creates high demand for land. Virtually every soil type boasts examples of intensive primary production.

The profitability of different enterprises and sectors changes according to climatic and market factors. All exhibit a cyclic nature, usually shorter than a decade. Having eggs in many baskets supports stability.

Those soil types on land that is at higher risk through wetness and flooding (e.g. Pakipaki) are also less suitable for urban development. Less versatile land around Napier (Ahuriri etc) is in identified liquefaction zones.

8. Protection of High Value Soils and Productive Land

The Heretaunga Plains Urban Development Strategy [15]recognises (S5.22.1) that

> *"soil is essential for the extensive cropping and farming enterprises that are the core of the Hawke's Bay economy."*

Key approaches identify actively minimising the loss of versatile land by reducing need for green-field urban sites, and support for maintaining highly productive land for food production purposes. The Strategy stops short of protecting that essential soil (or land). It also omits the production of other primary products (fibre and fuel) and provision of ecosystem services.

Environment Court rulings caution against a single focus on protecting soil of a particular class. The ruling in the Environment Court case, *Becmead Investments v Christchurch City Council (A88/96)* states:

> *" . . . One should not blithely proceed to introduce blanket objectives and means of attaining them on the basis of some exclusively conceived approach or outlook. Rather, consideration must be afforded to the full range of factors need to be weighed in the circumstances of the case, so that enlightened resource management options, merited in the promotion of the Act's purpose, may be identified and pursued."*

Keenan [16], arguing against protection of versatile soils, stated:

> *"An underlying premise is that the soil resource contributes to the wellbeing of the region. While that may, in essence, be correct, the statement fails to recognise that there needs to be a production system to enable wellbeing to be created. The growers and their operations are that production system, without which the soil resource would not be able to be utilised to create benefits for the district. That production system requires many components, not just suitable soil.*
>
> *A sole focus on soil means that all landowners with so-called 'versatile soils' are locked into a type of production system that may be neither possible, reasonable or economic."*

While a particular soil may be capable of producing food, there are many factors that also need to be available for the land to be used for productive capacity. This leads to the fuller consideration of factors given by Judge Treadwell (Appendix 2).

8.1 The effects of agriculture

The last century of farming in New Zealand has changed many soils that were originally poor. Acidity has been corrected by adding lime, low fertility by using fertilisers, drought by implementing irrigation, wetness by drainage, and poor drainage by breaking up subsoil 'pans' with deep-pronged equipment. These and other interventions have contributed to the country's wealth, and an increasing intensity of land use.

More intensive production, whether by horticulture, cropping or dairying, raises the issue of sustainability.[3] Agriculture on the Heretaunga Plains has impacted on soils in negative ways,

particularly through repeated cultivation weakening soil structure and by contributing to wind erosion losses.

Cultivation pans have formed and reduce internal drainage and root penetration. These need not be permanent changes. Remediation is straight forward; requiring little but "resting" the land. But this often viewed as not economically viable in the short term.

Changing cultivation practices are showing positive changes in soil quality on the Heretaunga Plains, even under continuous cropping regimes. LandWISE[17] research, on strip tillage and minimum tillage and more latterly on controlled traffic farming systems, shows very significant benefits can be accrued to both soil quality and economic performance.

8.2 Elements of tension

Hawke's Bay has about 17,500 ha of class 1 soils and 26,500 ha of class 2 soils. These represent 9.4% and 2.2% of the national total respectively.[18]

As noted in Section 2 of this report, Heretaunga Plains primary production uses these soils, but is also dependent on class 3, 4 and 7 soils. Together these soils account for over 95% of Plains area, and because of **land** versatility they are highly valued.

The links between soil type and Land Use Capability are further discussed in Section 6. A map of soil type and LUC areas of the Heretaunga Plains is presented in Appendix 3 and as a Table in Appendix 4.

8.2.1 Competing demands

Land is a finite and critical resource for the future of New Zealand currently fulfilling a range of roles. These include meeting demands from production, urbanisation and recreation:

- agriculture and forestry,
- housing,
- recreation and tourism
- and increasingly renewable energy

as well as providing ecosystems services

- wildlife habitats,
- clean water,
- iconic landscapes, and for
- cultural and spiritual purposes.

Rutledge[19] identified that the conversion rate of productive land to non-productive uses were highest for highly versatile soils (LUC class 1 and 2).

Climate change also has implications for the use of the land, both in mitigating the drivers of change, and in adapting and responding to those changes likely to occur.[20]

8.2.2 Land use conflicts

Rands[21] suggests that,

> *"Left alone, land use choices are unlikely to provide optimal solutions for the provision of public benefit from the use of land."*

The implication is that planned solutions are necessary. The increased market value of land developed for urban use is considerable and beyond agricultural returns to sustain. Urban expansion on to agricultural land will continue unless controlled, because the financial incentives are strong.

Once developed, the economic value of urban and industrial infrastructure normally means this land is permanently removed from primary production.

Within agriculture, land use conflicts can occur around short-term economic incentives and the future sustainability of the soils.

In the Heretaunga Plains, there is a requirement for post-farm processing of crops, and for service industries and a labour pool. Land is required for food processing and storage/cool storage facilities and transport infrastructure. This demand occurs both on farm, and at designated regional facilities such as factories.

Guidance will also be increasingly important around the future possibilities for land - possibly for as yet unknown or regionally insignificant crops. And recognition must be given to the potential costs from the collapse in local ecosystem services including bio-diversity, water retention and natural water treatment. Protection of the Heretaunga Plains artesian aquifer is one example.

8.2.3 Protection for agriculture

Discussing Resource Management Act impacts on urban development of rural land, McShane[22] suggests,

> *"… It would appear that the intention of the Act was to protect soil as a natural resource, but by a process of argument which draws on other sections of the Act regarding the efficient use of resources, (arguments which may or may not be legitimate) this need to safeguard the life-supporting capacity of soil as a resource has been translated into a need to protect traditional farming as a use."*

Palmer[2], submitting for the protection of high value soils and productive lands, presents the cases for and against protection.

He notes and refutes the following points offered against protection:

- The free market will provide positive resource management under the RMA
- New technology can improve poor quality soils
- Because of new technology there is now more potentially valuable soil
- Reduced social well being when citizens are not permitted to sell or purchase as they desire
- The increased cost of subdivision on poor quality land

Arguing for protection, Palmer notes:

- Versatile soils are scarce in NZ
- The cumulative effects of sub-division (If the current rate of loss is only 0.5% /yr [in Manawatu], versatile soils will all be gone in 200 years)
- Versatile soils once built on are a non-renewable resource
- The market cannot predict future values and needs
- In almost every case, planning could see poorer quality soils subdivided in preference
- The natural attributes of versatile soils cannot be replaced without much cost and energy
- Versatile soils grow better food more cheaply and with fewer environmental consequences
- Retaining versatile soils close to urban areas lowers transport costs, creates local economy

Keenan[16] argues:

- *"While Section 30 (1) (c) does appear to provide some function to manage land for the purpose of soil conservation, soil conservation in the RMA means avoiding, remedying, or mitigating soil erosion and maintaining the physical, chemical, and biological qualities of soil."*
- *"Urbanisation has no significant effect on the soil resource – rather it has effects on the productive capability of the land in question. The production system is what required protection, not the soil."*

Independent Hearings Commissioners hearing evidence of Keenan and Palmer concluded that the Proposed Horizons One Plan should include the following statement:

> *Allowing urban expansion, including development of rural residential lifestyle blocks onto the more versatile soils adjacent to urban areas, results in a reduction of options for their productive use*
> (proposed One Plan Ch 3.1)

8.2.4 Heretaunga Plains Urban Development Strategy

The Heretaunga Plains Urban Development Strategy does recognise the significance of the land based economy and encourages its further development. It recognises the productive values of its soil and water resources and provides for their sustainable use.

The strategy seeks to protect the region's soil resource by minimising urban sprawl through compact urban design and taking a number of criteria into account in identifying areas for future growth.

Those criteria included identifying areas where:

- Soils are of lesser versatility or,
- Productive capacity is compromised by:
    - Size and shape of land parcels that mitigates against productive use
    - Surrounding land uses and reverse sensitivity
    - Lack of water/poor drainage
- Clear natural boundaries exist or
- Logical urban edge greenbelts could be created.
- Greenbelts could provide opportunities for walking and cycling connections
- Sites can be serviced at reasonable cost and integrated with existing development.

So the Heretaunga Plains Urban Development Strategy already acknowledges that soil versatility is only one factor to consider.

8.3 Court rulings on Versatile Land

A number of Court rulings relate to attempts to limit urban growth for the purpose of safeguarding productive land. The outcomes have been variable, but the protection of soil was not found sufficient justification to refuse sub-division.

A comprehensive list of factors that require consideration was given by Environment Court Judge Treadwell in *Canterbury Regional Council v Selwyn District Council [W142/96]*, and guides much argument and decision in this area (Appendix 2). These factors include natural resources and human infrastructure and their relationship to the land in question.

Regardless of soil qualities, land may not be of high versatility given its setting. In the decision above, Judge Treadwell commented that *"an extremely good soil might be disqualified for a farming use by one or several of the factors"*.

Conversely, a relatively poor soil might exhibit high value because of proximity to other resources and services.

8.3.1 Environment Court urban growth cases

The Ministry for the Environment reviewed case law relating to design-related decisions made before July 2008 by the Environment Court (the Court) under the Resource Management Act 1991 (RMA)[23].

The Court has been critical in the past of the lack of regional direction in managing urban growth (*Canterbury Regional Council v Waimakariri District Council*[24]).

Several of the cases reviewed were between regional and district councils. An issue that emerged from these cases was the desire, at a regional level, for regional planning matters to be resolved prior to new zoning provisions being introduced at a district level.

Several cases reflected attempts to limit urban growth (at least for a certain planning period), particularly to areas within reach of employment centres, schools and other amenities. In the case of *Canterbury Regional Council v Christchurch City Council*[25] several different blocks of land were

considered by the Court under a proposed re-zoning and it made various findings as to the appropriateness of the blocks, depending on their relationship to the existing urban area.

Another case that supported urban containment was *North Shore City Council v Auckland Regional Council*,[26] in which the Court found that limits to a new urban area needed to be drawn to take into account the need to protect landscape and ecological values.

In a case where a greenfield area with landscape values and ecological sensitivities was proposed for urban growth, the Court considered the growth could be differentiated (and declined) in the area when compared with growth proposals (in the same case) in another greenfield area that had landscape values of less importance and less sensitive ecology (*North Shore City Council v Auckland Regional Council*)[27].

The Court found that the loss of a site in an industrial zoned area to a large format retail activity could not promote sustainable management of such a scarce resource, observing that retail activity – unlike noxious industry – might have alternative location opportunities. It observed that while the RMA is permissive, plans allocate zones in recognition of the likely effects of types of activities and the zoning in this instance intended to preserve an industrial character that could sustain industrial needs[28].

The Court has recognised that, despite the intentions of councils to apply structure plans and new zoning to achieve new growth nodes as part of their provisions for planned urban growth, the existing environment also needs to be taken in account.

Given that landscape values and ecology are grounds upon which urban growth on greenfields sites can be differentiated (and declined), it seems soil quality and land productivity might also provide grounds for differentiation.

However, the protection of soil was not found sufficient justification to refuse sub-division in the cases of *Becmead Investments Ltd v Christchurch City Council [1997]* NZRMA 1[29], and in *Canterbury Regional Council v Selwyn District Council [1997]* NZRMA 25[30].

The Court found in both cases[31], where developers sought rezoning of rural land for housing expansion, that the protection of versatile soils under the RMA was not an overriding objective and the rezoning of the land was approved on the basis of housing need. Other cases indicated that in isolated rural areas, where sound reasons could support rezoning to allow large lot lifestyle blocks or the development of resources, approval would be given.

In *Canterbury Regional Council v Selwyn District Council*, the Court acknowledged that a rural site proposed for urban expansion already had low productive value because of reverse sensitivity effects from its existing residential urban neighbours.

The central issue concerned protection of land versatility. The Court found evidence of growth in demand for residential activity, with only two to seven years of suitably zoned land available to meet this demand (partly because of resistance to infill/intensification). It found that the removal of this land from productivity would not affect the ability of future generations to feed themselves.

In considering the appeal, it took into account the difficulties the landowner had experienced farming the land because of the sensitivity of adjacent residential activities, and found that soil quality is not a deciding factor on its own. Regardless of soil qualities, the land was not of high versatility given its setting. The Court held that Section 5 RMA provides for the protection of the environment for human beings as much as protecting resources for human beings.

It would seem, that if the intent of a regional policy is to ensure agricultural productive capacity is not excessively compromised by urban expansion, restrictions based solely on soil type or versatility are insufficient.

The focus should be on limiting the urban expansion directly, or by identifying food production zones, not attempting to do so by controlling use of one factor that affects productive capacity.

9. Maps as a planning tool

Land Use Capability and Soil Survey maps present information about the potential productivity, or limits to productivity, of soils in a district.

However, as noted, soil alone is insufficient to determine the value (in terms of either productivity or versatility) of any particular piece of land. That requires consideration and integration of a raft of factors.

Both land use capability and soil maps have inherent limitations of accuracy, scale and veracity.

9.1 Land Use Capability Maps

Land Use Capability maps available for the Heretaunga Plains (Land Resource Inventory) were mapped at a resolution of 1:63360 (1 inch to 1 mile). They have not been substantially reviewed for some four decades.

Lines (polygons) appearing on LRI Maps are only indicative. They show the likely extent of areas with a predominance of land with similar use capabilities. Mapping was based on limited soil assessments, and interpretations relied on observations of ground covers existing at survey date and assumptions about the relationship between soils, soil properties and position in the landscape.

Land Use Capability maps do offer a good first assessment tool when considering the likely versatility status of an area or areas. As with all maps, their veracity should be determined through ground truthing carried out at an appropriate scale.

9.2 Soil Maps

The Heretaunga Plains soils maps by Griffiths[32] offer a newer set of maps at higher resolution. These maps also have limitations for planning as the soil polygon boundaries are interpolated and drawn at a certain scale (1:25,000). Soils are far more variable than this.

The variability of soil and the accuracy of maps have been, and continue to be, the subject of litigation. Mapped polygons show only the dominant soil, or note complexes in a broader sense. Actual in-situ assessment, particularly of smaller areas, will often identify variation from the mapped soil types.

Griffiths also provides thematic maps for the Ruataniwha Plains[33], a concept that could be extended to the Heretaunga Plains. The maps show ratings for soils according to a range of potentially limiting factors:

- water holding capacity
- drainage capacity
- susceptibility to compaction
- permeability
- risk of wind erosion

The thematics could be extended to include other relevant factors (e.g. including from Treadwell's list).

9.3 Correlation of Land Use Capability and Soil Types

There is not absolute agreement between the available Land Use Capability and Soil Type maps.

On the Heretaunga Plains, a good correlation between soils or groups of soils and land capability classes might be expected. Climate, topography and vegetation are broadly similar. The main variations will flow from parent material, deposition history and soil age. These will affect classification by soil type and by land use capability (limitations) in similar ways.

A GIS assessment was completed by Hawke's Bay Regional Council GIS staff for this report[34]. It shows that while there are areas of commonality, there are also areas of disagreement (Appendix 4).

Appendix 4 is a comparison of GIS polygons showing intersects between Heretaunga Plains soil type and Land Use Capability from GIS layers. It shows the number of hectares with each combination of soil type and LUC. So, for example, 2,414 ha of Ahuriri soil fits within the Class 3 land use class.

It is clear that there are significant areas where one soil type crosses a number of LUCs. Flaxmere soil, for example, appears in Classes 1, 2, 3, and 7. Moteo soil appears in Classes 1, 2, 3 and 4. Both examples cross the boundary of what would commonly be considered highly versatile and less-versatile soil.

In addition, there are many minor variations, most likely reflecting the scale of mapping and even the scale of base maps and the map projections used when mapping was undertaken.

Appendix 1: Land Use Capability

The New Zealand Land Use Capability (LUC) Classification is defined as,

> *"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 after taking into account the physical limitations of the land."* [35]

There are eight classes with limitations to use increasing and versatility of use decreasing from Class1 to Class 8.

LUC Classes 1 to 4 are suitable for arable and vegetable cropping, horticulture (Including vineyards and berry fields), pastoral grazing, tree crop or production forestry use.

- Class 1 is the most versatile multiple-use land with minimal physical limitations to arable use (deep, resilient, easily worked, well drained, fine textured, naturally fertile and flood free).
- Class 2 is very good land with slight limitations to arable use, readily controlled by management and soil conservation practices. Slight limitations include texture, moderate soil depth, structure and difficulty in working, potential erosion, potential flooding.
- Class 3 has moderate physical limitations to arable use. These may restrict the choice of crops and the intensity of cultivation, and/or make special soil conservation practices necessary. Limitations may include susceptibility to erosion under cultivation, shallow or stony soils, wetness or water logging after drainage, occasional damaging overflow, low moisture holding capacity, structural impediments to cultivation or low natural fertility.
- Class 4 land has severe limitations to arable use. These limitations substantially reduce the number of crops that can be grown, and/or make intensive soil conservation and management necessary. Some Class 4 land is suited to vineyards and berry fields.
- Classes 5 to 7 are not suitable for arable or vegetable cropping but are suitable for pastoral grazing, tree crop or production forestry use, and in some cases vineyards and berry fields.
- Class 8 is unsuitable even for grazing or production forestry, and is best managed for catchment protection, and / or conservation or biodiversity.

LUC Subclasses identify main kinds of physical limitations or hazards to use. Four limitations are recognised;

- erodibility
- wetness
- soil limitations within the rooting zone
- climate.

Appendix 2: Factors to be considered in regard of land versatility

The case in W142/96 Canterbury Regional Council v Selwyn District Council related to an unsuccessful appeal by Canterbury Regional Council against a suggested change to the [then] Selwyn Transitional District Plan from 5ha of farmland to permit residential development adjacent to Lincoln township.

In the decision on this matter, Environment Court Judge Treadwell stated:

The factors, which I take into account in recommending or otherwise a particular site for a particular crop, are as follows:

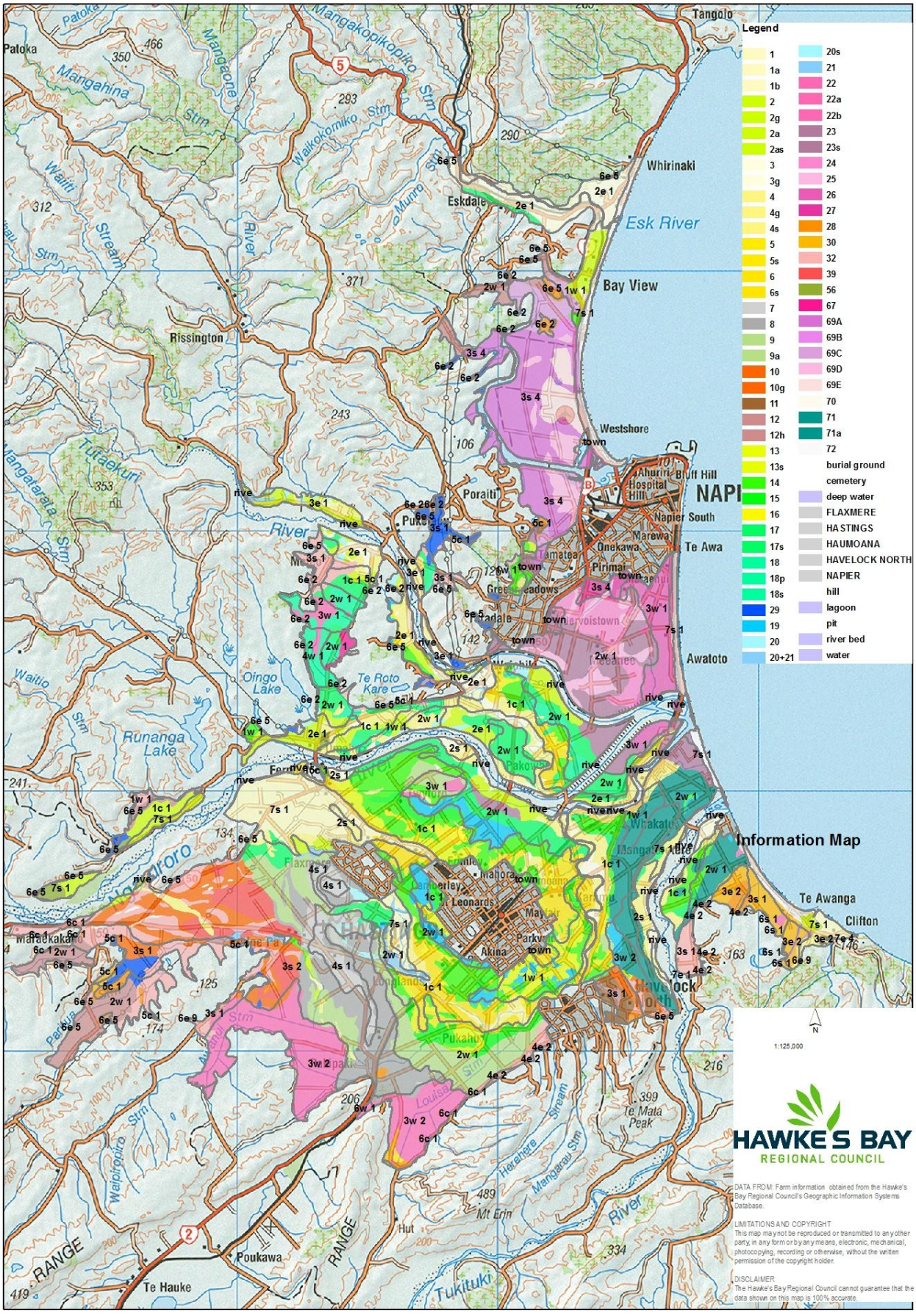
- Soil texture
- Soil structure
- Soil water holding capacity
- Soil organic matter stability
- Site's slope
- Site's drainage
- Temperature of the site
- Aspect of the site
- Storm water movements
- Flood plain matters
- Wind exposure
- Shelter planted
- Availability of irrigation water
- Transport, both ease and distance
- Effect of the use on neighbours
- Effects of the neighbours on the use
- Access from the road
- Proximity to airport
- Proximity to port
- Supply of labour
- Quality of that labour
- Previous cropping history
- Relevant contamination
- Sunlight hours
- Electricity supply
- District Scheme
- Economic and resale factors

This list demonstrates the real relevance of the soil on its own. Obviously one can have an extremely good soil which would be disqualified for a farming use by one of several of the factors above."

In this case, the Court concluded:

- *"protection of versatile land is no longer recognised by the RMA as of national importance"*
- *"land/soil is a resource and must be considered in terms of s5 and s7 of the Resource Management Act in relation to both present and future generations..."*
- *"Resource Management Act Part 2 matters in a regional context are broad based and a regional council should not concern itself with matters of minor significance such as five hectares of land."*

Appendix 3: Map of Soil Type and Land Use Class



Appendix 4: Soil Type by Land Use Capability

Table 1 : Area in hectares of Soil Type by Land Use Capability on the Heretaunga Plains

	Land Use Capability Class									
Soil Name	1	2	3	4	5c	6	7	Rivers & town	Grand Total	% of Area
Ahuriri	49	3	2414		1	28	31	62	2587	7.5
Awatoto	3	9	8				416	79	514	1.5
Esk	195	1034	79		1	10	101	57	1477	4.3
Farndon	9	1962	130			2	17	124	2244	6.5
Flaxmere	443	743	232		1	11	223	64	1717	5.0
Hastings	2112	432	70		4	5	30	53	2707	7.8
Havelock	109	678	123		3	40	5		958	2.8
Irongate	48	171	135	19		6	47	4	431	1.2
Kaiapo	191	397	59			5		3	654	1.9
Karamu	675	129	2					10	816	2.4
Mangateretere	589	826	102				18	1	1537	4.4
Matapiro	1	19	142	2	63	58			284	0.8
Meeanee		52	651				29	35	767	2.2
Moteo	102	332	99	144		16		3	695	2.0
Ngatarawa		3	970		5				977	2.8
Okawa	29	54	298	4	13	36		2	436	1.3
Omahu	66	44	24			2	1153	13	1302	3.8
Omarunui	911	842	252		4	7	194	54	2264	6.5
Ormond	193	32				2			227	0.7
Otane		1	162					3	166	0.5
Pakipaki	11	47	1485	500			5		2048	5.9

Pakowhai	476	1244	134	13		6	32	3	1909	5.5
Poporangi	120	302	1265	43	32	61	3	5	1831	5.3
Rotoatara		46	3	1		3			54	0.2
Takapau			541		0				541	1.6
Te Awa	113	721	708	12					1554	4.5
Tukituki	21	18	4			2	61	11	118	0.3
Turamoe		26	1844	25	5	27			1927	5.6
Twyford	1249	83	15		1		44	27	1420	4.1
Waipukurau		16	363		23	15	32		449	1.3
Washpool	18	4	27						49	0.1
Grand Total	7736	10270	12341	763	155	342	2442	611	34659	100.0
LUC Unit % total	22	30	36	2	0	1	7	2	100.0	

Source: Hawke's Bay Regional Council GIS database - NZ LRI and Heretaunga Plains Soil Map layers

Table 1 is a comparison of GIS polygons showing intersects between Heretaunga Plains soil type and Land Use Capability from GIS layers. Each table cell shows the number of hectares with a combination of soil type and LUC. So, for example, 2,414 ha of Ahuriri soil fits within the Class 3 land use class.

Glossary

Ecosystems services — *a multitude of resources and processes that are supplied by natural ecosystems. May be grouped into four broad categories: provisioning, such as the production of food and water; regulating, such as the control of climate and disease; supporting, such as nutrient cycles and crop pollination; and cultural, such as spiritual and recreational benefits*.

Wikipedia, http://en.wikipedia.org/wiki/Ecosystem_services

Land$_1$ — *(i) The entire complex of surface and near surface attributes of the solid portions of the surface of the earth, which are significant to human activities; water bodies occurring within land masses are included in some land classification systems. (ii) (economics) One of the major factors of production that is supplied by nature and includes all natural resources in their original state, such as mineral deposits, wildlife, timber, fish, water, coal, and the fertility of the soil.*
Soil Science Society of America

Land$_2$ — *Land is considered to include:*

- *the aesthetic components of landform and landscape including the vegetation cover*
- *the physical components of soil and parent material (the soils and underlying rock types that give rise to soil)*
- *the plant and animal communities in the soil, such as insects, mites, springtails, nematodes, worms, fungi, bacteria, and algae*
- *the exotic and native ecosystems resident on the land, such as exotic forestry, urban settlements, native forests, and tussock grasslands.*

Williams and Mulcock [36]

Land use capability — (LUC)

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 after taking into account the physical limitations of the land.

Productive $_1$ — *1. producing, tending to produce;*

2. producing commodities of exchangeable value;
3. producing abundantly (a productive soil, mine, writer)
Concise Oxford Dictionary

Productive $_2$ — *Producing or capable of producing, producing abundantly, fertile, yielding favourable or useful results; constructive, involved in the creation of goods and services to produce wealth or value, effective in achieving specified results*
on-line Free Dictionary[37]

Productive land	See Treadwell in Appendix 2
Productive soil	See soil productivity below
$Soil_1$	*the unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants, . . . that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and micro-organisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics.* Soil Science Society of America (SSSA) [38]
$Soil_2$	*Soil is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical, and mineralogical characteristics.* Birkeland[39]
$Soil_3$	*Soil is composed mostly of particles of broken rock that have been altered by chemical and environmental processes including weathering and erosion. Soil differs from its parent rock due to interactions between the lithosphere, hydrosphere, atmosphere, and the biosphere.* Chesworth [40]
$Soil_4$	*Soil particles pack loosely, forming a soil structure filled with pore spaces. These pores contain soil solution (liquid) and air (gas).* Taylor and Ashcroft [41]
Soil formation	The effect of processes involving additions, losses, transformations and translocations of material that compose the soil. Minerals derived from weathered rocks undergo changes that cause the formation of secondary minerals and other compounds that are variably soluble in water, these constituents are moved (translocated) from one area of the soil to other areas by water and animal activity. As a result, layers or horizons develop in the soil profile.
Soil productivity	*the output of a specified plant or group of plants under a defined set of management practices* Soil Science Society of America
Soil type	The basis unit of soil mapping, a unique combination of chemical, physical, biological and mineralogical characteristics and site features. Often designated by a geographic name and/or topsoil textural and depth qualifier.
Versatile	*Turning easily or readily from one subject or occupation to another, capable of dealing with many subjects* Concise Oxford Dictionary

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