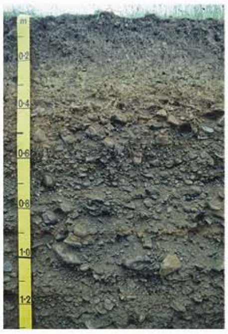

Land versatility classification for Rural 3 Land in Tasman District

Envirolink 921-TSDC57

Landcare Research
Manaaki Whenua

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Contents

Summary

Project and Client

- Landcare Research Ltd was commissioned by Tasman District Council (TDC) to review the Agriculture New Zealand 1994 report in which land within Tasman District was classified into areas with similar productive potential and to produce maps of land-use potential within the Rural 3 Zone that can be applied at 1:8000 scale. Envirolink advice grant funding was provided by the Ministry of Science and Information (formerly the Foundation for Research, Science and Technology).

Objectives

- To provide a brief review of the existing classification system.
- To produce land-use potential maps for the Rural 3 Zone that are more appropriate at a property scale than previous mapping.

Methods

- The Agriculture New Zealand 1994 report (ANZ 1994 Report) was reviewed to determine the appropriateness of their method of classifying productive potential in the Tasman District.
- Where assessment criteria were considered to be obscure or lacking in predictive value, new criteria and class boundaries have been developed. The new criteria were then applied to define and map productive potential in the Rural 3 Zone.
- Filtered LIDAR data was used to map five slope classes and two climatic zones based on a model of soil temperature. These detailed digital maps were used as inputs to map land classes for the Rural 3 Zone based on the new criteria or new class boundaries. Mapping was done by on-screen digitising of boundaries based on an overlay of slope and climatic layers.

Results

- A review was made of the ANZ 1994 Report with particular emphasis on the land classes and criteria used to identify the classes.
- The intent of the classification to rank land in terms of a 'hierarchy of suitability to a range of enterprises' was considered to be an appropriate system.
- The ANZ 1994 Report provided a table to match land classification criteria with land classes. It appears that the boundary conditions in this table were used as a guide and were not applied as rules when classifying individual land parcels. This has led to a large degree of uncertainty in determining how different areas of land have been allocated to land classes.
- Assignment to classes in the ANZ 1994 Report has an excessive amount of expert judgement that is not readily accessible to users.

- New criteria and boundary conditions for all land-use classes are presented for discussion.
- We recommend separating land suitable for dairying from other intensive pastoral uses.
- We recommend placing land suited to forestry above land suited to extensive pastoral use.
- Land in the Rural 3 Zone was classified and mapped according to new criteria developed in this report.
- The application of filtered LIDAR data and new classification criteria provided a more precise and defensible map of land classes in the Rural 3 Zone.
- The new map indicated large areas of land with horitcultural potential extending beyond the area previously recognised. The maps also identify significant areas of steeper or colder land within the former horticultural areas that are not well suited to horticultural development. The new map identifies large areas with topgraphy that is suitable for grazing dairy cattle.

Conclusions

- This report has highlighted a number of technical issues with the land classification used in the ANZ 1994 Report. These issues create uncertainty or lack of transparency in the classification of specific land areas.
- The new set of climate and land-resource criteria developed in this report provides a more objective and defensible land evaluation system and is suitable to provide a sound technical base for wise and more consistent decision making within this zone.
- The basis for the classifiction is clearly described and the more detailed data upon which the classification is based can be made availabe for scrutiny by Council staff and landowners. Ready availability of soundly-based land resource information should lead to wise decision making and may lead landowners in this area to use the land more productively.
- The use of digital elevation models based on LIDAR data has improved the accuracy of land classification for the Rural 3 Zone based on more accurate identification of slope classes and climatic zones.
- Where LIDAR data is available, the application of digital elevation models can provide data that are capable of mapping land-use classes at the land-holding scale. Where LIDAR is not available, less accurate digital elevation models could be used to analyse climate and topography for land classification in the remainder of Tasman District.

Recommendations

- That an improved report and map of land-use classes be generated by applying the new criteria recommended in this report.
- That Tasman District Council consider producing a computer-generated land classification system that is accessible as maps and data over the World Wide Web.
- That more accurate maps to depict soil drainage, rooting depth and profile available water content are obtained before applying the criteria developed in this report to the whole district.

1 Introduction

Landcare Research was commissioned by Tasman District Council (TDC) to review the Agriculture New Zealand 1994 report in which land within Tasman District was classified into areas with similar productive potential and to produce maps of land-use potential within the Rural 3 Zone that can be applied at 1:8000 scale. Funding was provided by the Ministry of Science and Information (formerly the Foundation for Research, Science and Technology) under its Envirolink advice grant fund.

2 Background

The Tasman Resource Management Plan Rural 3 Zone has been in place since 2003. It is a zone that covers a specific part of the coastal Tasman area. It contains land with a mix of values including land of high productive value. The rules for this zone have been specifically developed to accommodate a level of residential development but with a policy framework that seeks to recognise and protect the more productive land. However, the pattern of development unfolding in the zone appears to be compromising the highly productive land in the zone. One of the main reasons for this pattern is that the currently available land productivity assessment tools are too coarse and inaccurate at a property scale and are not well enough understood to be effective. Also, applications are viewed in isolation and, in spite of the policy framework, do not tend to be put in context of the productive potential of the zone as a whole.

The development of an accurate and more refined classification system to be applied at a property scale is one part of a current study Council is undertaking to assess the effects of subdivision in this zone and consequently policy effectiveness. This study is also looking at another associated issue, being the landscape character and amenity effects of subdivisions. Current lot size and the potential productivity of different-sized lots will also be assessed.

The Council currently relies on a productivity classification system that was developed in 1994. That system was based around soil and climate data that are of a scale and accuracy that may have been suitable for the more regional-scale work for which it was developed but it is found wanting for the purposes it is put to today. To aid the development of the classification system the Council has recently purchased LIDAR coverage of the Rural 3 area. Commitment to purchase LIDAR coverage for the majority of the region's intensively farmed areas has been made by Council and will progress over the next few years. The development of the classification system in the Rural 3 area through this project is seen as a means by which the Council can gain the skills so that it can develop and manage, in-house, a region-wide classification.

Application of the classification system, particularly in this Rural 3 Zone, has highlighted that it is not simply an improvement of the base data that is required. Other factors, some physical (e.g. current block or holding size) as well as social and economic factors, are having a significant influence on land-use options. Assessing the intricacies of these influences requires a fundamental review of the classification criteria. Council does not have the skills in-house to carry out this type of proposal and sees those skills available through Landcare Research staff, in particular their land evaluation research expertise, as necessary to complete this project successfully.

3 Objectives

1. Provide a brief review of the existing classification system.

- With respect to Rural 3 land, provide a critical analysis of the existing land productivity classification system: 'Classification System of Productive Land in Tasman District', prepared by Agriculture New Zealand in 1994.
- Are there any fundamental flaws to the criteria used to group the land units into the classes used?
- Is the number of classes adequate to provide a useful system for mapping at a more detailed level?
- Can other factors such as current block or holding size, dwelling density, aspect and topography be effectively incorporated into the classification system?

2. Produce classification maps for the Rural 3 zone at a property scale

- This would approximate a scale of 1:8000 with a minimum size of delineation of one hectare. It is expected that the LIDAR data will play a significant role in providing the detail for this scale of mapping.

4 Methods

The Agriculture New Zealand 1994 report (ANZ 1994 Report) was reviewed to determine the appropriateness of their method of classifying land on the basis of productive potential. Each criterion used in the classification was assessed in relation to its importance, objectivity, and application to the project.

Where assessment criteria were considered to be obscure or lacking in predictive value, new criteria and class boundaries have been developed. The new criteria were then applied to distinguish productive potential in the Rural 3 Zone.

LIDAR data was used to map slope classes and climatic zones based on a model of soil temperature. These detailed digital maps were then used as inputs to map land classes for the Rural 3 Zone developed with new criteria or new class boundaries. The LIDAR data as supplied has a spatial resolution of one metre, and a vertical resolution of approximately 15 cm. At this precision microrelief features ('ground clutter') can obscure the general shape of the landscape. To get a useable digital elevation model (DEM) and hence slope and aspect maps for classifying land, the raw LIDAR DEM was filtered to 5-m resolution and the slope and soil temperature maps were derived from the filtered DEM. Mapping of land use versatility class was done by on-screen digitising of boundaries based on an overlay of topographic and climatic layers.

5 Results

5.1 Review of ANZ 1994 classification

5.1.1 General comments

Principles of classification

We think that sections 1.0 (Introduction) and 2.0 (Sustainable management and Resource Management Act) in the ANZ 1994 Report provide sound principles to classify land for its productive potential.

Intent of classification

The intent of the ANZ 1994 classification is to classify land to portray 'similar flexibility in terms of the activities that could be sustained by that land unit'. However, the classification is not strictly a flexibility of land use classification in terms of the number of crops that can be grown. For example significant areas of Class B land that are suitable for permanent horticultural crops are not suitable for arable crops. The ability to grow arable crops greatly increases the flexibility in terms of the number of crops that can be grown. This means that Class C (Intensive cropping) will often be capable of supporting a larger number of crops than some areas within Class B (Horticultural). Similarly some land identified as suitable for Class D through F will not be suitable for forestry (Class G) because of poor drainage or shallow rooting depth. Nevertheless, the classification does provide a general guide to potential productive value per hectare and versatility to a defined range of land uses. The value of production per hectare will however vary with the value of the crops grown so that forestry will sometimes be of greater value per hectare compared to sheep and beef farming.

Application of classifying criteria

The ANZ 1994 assignment of land units to land classes has not been done on the basis of a strict application of the criteria set out in their table 2 (matching land criteria to land classes). Rather they have classified land according to an expert evaluation of land units in relation to criteria set out in table 2. The note at the base of the table states 'No single factor can be taken in isolation. A number of factors are considered when deciding on the classification of a particular land unit. The final assignment is made using professional judgement'. Similarly, the authors comment on their methodology on page 20 of their report and state: 'Individual criteria cannot be considered in isolation. It is a balancing act.' Two examples to 'help users understand how different characteristics were balanced in classing an individual land unit' are provided on pages 20 and 22 of their report and this provides insight into their process. Their section 7.0 also provides an insight into the weighting of criteria within each land class. Further information on the rationale for changes in classification assignments are provided for each topographic sheet in appendix E. This appendix is very informative but is rather hidden from the user and difficult to apply to individual map units. The result of this balancing of criteria is to create uncertainty as to which criteria from table 2 were used to assign a particular land unit to a land class.

Versatility cf. flexibility

We suggest that 'versatility' is a more acceptable and informative word than 'flexibility'. We are not aware of use of flexibility in previous land classification systems. Versatility is commonly used in land evaluation systems and appears to be appropriate to apply here.

Number of classes

We suggest the addition of a new class to subdivide Class E (Intensive pastoral) into 'Dairying' and 'Intensive pastoral'. Dairy farming has become a significant land use in its own right and has more restricted requirements than other intensive pastoral uses. Otherwise, the number of land classes appears to be sufficient for the purpose of distinguishing land into general productivity classes within Tasman District.

Soil data source

The authors do not specify their data source for soil information. We presume that the map unit boundaries were mainly taken from the Land Resource Inventory (LRI) database (NWASCO 1975–1979) because LRI information is correlated with their classification in appendix B. This is also evident in appendix E. For example for Map Sheet N27, the Mapua soils were assigned to Class B and E on the basis of LUC units. (Class B = predominantly 4e5 and Class E = predominantly 6e16). The reference to 'predominantly' indicates that there is a mix of LUC units within their land classes. The authors sometimes applied local knowledge of soil characteristics where they considered the LRI data to be inaccurate or incorrect.

5.1.2 Analysis of classification criteria

In this section, each criterion and its use are discussed in the order presented in table 2 of the ANZ 1994 Report.

Altitude

There is little justification or discussion on the use of altitude as a classifying criterion. There is reference to snowline (not used), to the treeline (1200 m is used) and production forest limit of 600 m. There is no discussion of the use of 50-m and 300-m contours. Altitude by itself does not confer any effect on land use so altitude must be used as a surrogate for temperature.

> **Recommendation.** Use temperature parameters rather than altitude as a classifying criterion.

Length of growing season

The aim of this criterion is to estimate the frost-free period, which was considered to be correlated with mean annual temperature. The authors have subdivided the district into 11 regional groups arranged from longer to shorter growing season. No map is provided so presumably this criterion was applied from an 'experience of site' basis. The reference in their report to table 2 should be to table 3 (similarly for heat over summer).

> **Recommendation.** There is a need for an objective determination of climatic factors. Our recommendation for temperature-related criteria is provided in Section 5.1.3.

Heat over summer

The aim of this criterion is to estimate the growing degree days associated with microclimate. The authors have subdivided the district into 10 regional groups arranged from hot to cool. No map is provided to define the extent of these regions so presumably this criterion was applied in an 'experience of site' basis.

The regions listed for 'length of growing season' and 'heat over summer' are quite different so it is not clear how these two lists were applied. For example 'Dovedale' has hottest 'heat over summer' but is only ranked as number 9 for 'growing season'. Was Dovedale excluded from Class A because of this short growing season? On the other hand 'West Wanganui' is ranked 9 for 'heat over summer' but is ranked as number 2 for 'growing season'. Regions listed as number 2 for 'heat over summer' are assigned to numbers 1, 7, and 8 for 'growing season'.

Rainfall

High rainfall is considered to be a limitation to production of some horticultural and arable crops so this criterion seems to be appropriate.

Land with annual rainfall < 600 mm is recognised as requiring irrigation and is used to exclude cropping, intensive pastoral and forestry, presumably on the basis that these uses will frequently not be irrigated and will therefore present significant droughtiness. If dairying was considered as a separate land use, availability of irrigation would need to be assumed for land with annual rainfall < 1000 mm.

It is doubtful if ripening of grain is possible in most years with rainfall 1600–2400 mm let alone 2400–3200 mm as allowed in table 2.

> **Recommendation.** In future classifications, review rainfall ranges for horticultural crops and we suggest Land use Class C should have an annual rainfall range of 4–6 (<1600 mm) and Class D of 3–5 (800–2400 mm).

Wind

Windiness is divided into six regions. In table 2 wind is only used to separate the very windy 'west coast' and 'Pakawau' districts from the remaining area. There are no wind-run figures for this area so it is difficult to apply this criterion objectively. It is debatable whether intensive pasture should be excluded due to high wind run – although this may be true for areas with low rainfall and therefore high evapotranspiration.

Recommendation. In future classifications windiness could be limited to criteria to specify an excessively windy class to exclude Land Classes A–D, and Class E where rainfall is less than 800 mm.

Slope

Slope angle is an important criterion. We doubt that cultivation for cropping should extend beyond slope angles of 15°. Table 1 (below) provides critical slope angles for key land-use practices. Further investigation is needed on the definition of intensive pastoral compared to extensive pastoral classes before definite classes can be made. For example should intensive grazing be confined to areas that can be occasionally cultivated for pasture establishment and renewal? If so, then an upper slope class of 25° may be appropriate as a boundary condition.

Recommendation. In future classifications, limit intensive cropping and intensive horticulture use to slopes < 7° and cropping and dairying to slopes ≤ 15°.

Table 1 Commonly recognised critical slope angles for specified activities (Lynn et al. 2009)

Maximum angle (degrees)	Limiting factors
3	Negligible
7	Sight limitations for arable machinery
15	Limit for crop harvesting
20–25	Limit for cultivation safety and limit for rubber-tyred skidders
35	Limit for tracked skidders

Orientation (aspect)

We found the classification and discussion on orientation to be lacking in information. The ANZ 1994 Report just states ‘generally north facing slopes would be required for a land unit to be classed as very flexible’. We are not sure how orientation was used to separate Class E and B. In table 2, orientation is not used for Class A (presumably because slope angle is ≤ 3°) but north-facing slopes are used to identify Class B land. When reviewing the boundary between Class E and B in the Rural 3 Zone we noted that there is a significant area of land below 50-m altitude with slope ≤ 15° that has a southerly aspect assigned to Class B and a significant area of land below 50-m altitude with slope ≤ 15° that has a northerly aspect assigned to Class E. So this criterion has not been applied consistently to the Rural 3 Zone. Part of this is due to scale limitations associated with the ANZ project.

Recommendation. In future classifications use a digital elevation model to map aspect and apply the soil temperature model to predict the effects of aspect on plant growth related to heat and solar radiation.

Fertility

This criterion is defined in terms of the amount of fertiliser required to maintain productivity. There are five classes. Only one class (very low natural fertility) is used to separate D, E and F from the rest. Fertility-related criteria need further consideration but it is not likely that fertiliser requirement will limit the economic production of crops (Class D) or intensive pasture (Class E).

> **Recommendation.** Consider removing fertility as a criterion or retain it to separate distinctively unfertile land such as occurs on soils formed from serpentinitic or highly quartzitic rocks.

Water-holding capacity

This criterion should be called 'available water-holding capacity' (AWHC) because water-holding capacity is the percentage of water stored in a soil at field capacity, much of which may not be available to plants. We prefer to use the term 'profile available water' – which is the amount of water, in millimetres, available to plants within the soil profile to a nominated soil depth.

Profile available water is a very important criterion to apply in a crop versatility classification. However, application in table 2 is questioned. Class A and B land include soils with any AWHC ranging from <25 mm to >130 mm. Soils with less than 25-mm AWHC consist of soils that have less than 15 cm of silty soil material over rock or less than 30 cm of sand over rock or extremely stony soils with a sand matrix. This is inconsistent with the requirement to have a rooting depth greater than 0.8 m. Grapes can be grown successfully on land with AWHC of 25–50 mm but not many other horticultural crops would flourish on such land. We understand that high versatility for horticultural use needs to have soils with an AWHC in excess of 50 mm. High versatility in arable crops requires an AWHC in excess of 75 mm. Part of the issue here is the different understanding of AWHC for particular soils. The authors of the ANZ 1994 Report consider that older Tahunanui soils have an AWHC of < 25 mm but we would estimate this soil to have an AWHC of 50–75 mm.

Risk of leaching loss (and consequent water pollution issues) is a further factor to consider in soils with very low profile available water. It is very difficult to manage these soils under intensive land use – be it dairy, market garden, berries, grapes or fruit – without significant loss of nutrients or pesticides through leaching.

> **Recommendation.** In future classifications change the profile-available-water values for land classes. Consider whether risk of leaching of contaminants to groundwater should be added as a criterion.

Rooting depth

This criterion is clearly defined and is an important factor in land-use classification. There is some uncertainty over the allocation of rooting depth to separate Class A land from Class B land. It seems likely that land with a rooting depth of 0.8 – 1 m should be highly suited to intensive horticulture (Class A), including apples and pears, because this land will be carefully fertilised and irrigated. We also consider that rooting depth requirements could be reduced for other intensive land uses under irrigation. Also rooting depth by itself is of limited value; it is preferable to use root penetrability (Webb & Wilson 1994, 1995). However, application of this criterion is somewhat theoretical without improved soil data.

> **Recommendation.** In future classifications re-evaluate rooting depth (root penetrability) requirements for intensive horticulture, cropping and pasture.

Erosion

The ANZ 1994 Report defines erosion according to classes of erosion occurrence as used in the LRI system. Six classes of erosion are defined according to the percentage of area affected by sheet and wind erosion or to severity of slip or stream-bank erosion. The erosion criterion (table 2) is used to distinguish six of the eight land classes so it has been used as a sensitive defining criterion. It is important to understand that this rating for erosion is based on the severity of erosion as evident in the landscape and is not to be confused with erosion potential. The application of this erosion criterion is not very helpful in a number of areas. For example extensive areas of land on steep slopes are rated as having slight erosion on the LRI map sheets but are also classified as LUC classes 6e to 8e – land with moderate to high susceptibility to erosion when surface vegetation is disturbed. Also large areas of land on the plains are rated as having slight erosion but this does not affect their suitability for intensive horticulture (as is signalled in their table 2).

Evaluation of erosion potential is dependent on many factors, among which is the nature of land management, and therefore needs to be carefully applied in land-use classifications. On steep terrain, removal of vegetation or soil disturbance will exacerbate the risk of erosion. There are some settings where susceptibility to erosion may be a critical issue in determining land suitability. For example the growing of forestry on long, steep granite slopes and cropping on sloping land with low infiltration capacity. On most other landscapes erosion potential will be associated with the steepness of terrain and this is already taken account of in the classification.

> **Recommendation.** Do not use erosion occurrence as an index of potential erosion. In future classifications either restrict proneness to erosion as a classifying criterion to arable land and forestry land on sensitive landscapes or develop a well-defined erosion potential classification with a robust set of criteria.

Soil structure/texture

This is a very confusing criterion. A list of rock, clay, peat, silt, sand and stony is presented as soil-type descriptors (which are odd descriptions of soil types) and these are linked with descriptions that bear little relationship to the soil types. The descriptions include combinations of structure, organic matter, fertility, and drainage that are difficult to apply. For example, it is hard to imagine 'Rock' with strong structure and poor drainage, 'Sand' with strong structure or 'Peat' with good drainage. In table 2, most classes encompass a wide range of these soil types, so the reasons for assignments are difficult to understand. For example 'Intensive cropping' includes stony soils but 'Intensive pasture' does not. This is contrary to what is expected. It is difficult to envisage how this combination of criteria has been used. Also drainage, which is arguably the most important criterion listed here, is handled separately anyway.

> **Recommendation.** In future classifications do not use structure/texture criteria.

Drainage and permeability

This criterion appears to be defined according to the commonly defined soil drainage classes and needs a reference to clarify. The classification only uses drainage for Land Classes A–D to exclude poorly drained land and for Land Classes E–G to exclude very poorly drained land.

Drainage is accepted as a relevant criterion. We would recommend greater use of this criterion. It could be used to distinguish land suited to intensive horticulture from less intensive horticulture and dairy and cropping from intensive pastoral and intensive cropping respectively. Forestry is also sensitive to poor drainage.

Discussion under section 1.5 allows the natural soil drainage classes to be modified according to ease of drainage or the presence of drainage schemes. The application of the drainage class is therefore subject to alteration depending on local knowledge, where information is available. This is appropriate but there may be some debate and uncertainty over where modifications have, or have not, been made.

> **Recommendation.** In future classifications, soil drainage could be used for greater discrimination among land uses.

5.1.3 Use of climate

Pages 16–17, 'Summary of suitability for horticultural crops', classifies geographic areas according to climatic factors of importance to horticulture. A map depicting these areas is provided in appendix C2. These seem to be useful distinctions. However, the named geographic regions of 'length of growing season' and 'heat over summer' recorded in table 2 often differ from regions described in this section. Thus there is confusion as to how this section has been applied in the classifications used to assign flexibility classes reported in table 2.

> **Recommendation** Determine critical threshold temperature factors for horticultural crops and generate temperature factors with an objective method that takes account of aspect, slope and altitude.

5.2 Critique of previous mapping in Rural 3 Zone

The Rural 3 Zone generally spans the 0–100 m elevation range although there is a small area in the south-west that rises to 200 m at Cut Hill (Figure 1). Within Rural Zone 3, Class B land has been mapped on the lower, gentler, coastal side and Class E on the inland steeper side. Class B land generally lies below the 60-m contour. The most notable exceptions are the area to the south of Dominion Road where Class B extends to over 100 m and at the southern end of Marriages Road where it extends to about 80 m. This is in conflict with their table 2 where altitude for Classes A and B should be below 50 m.

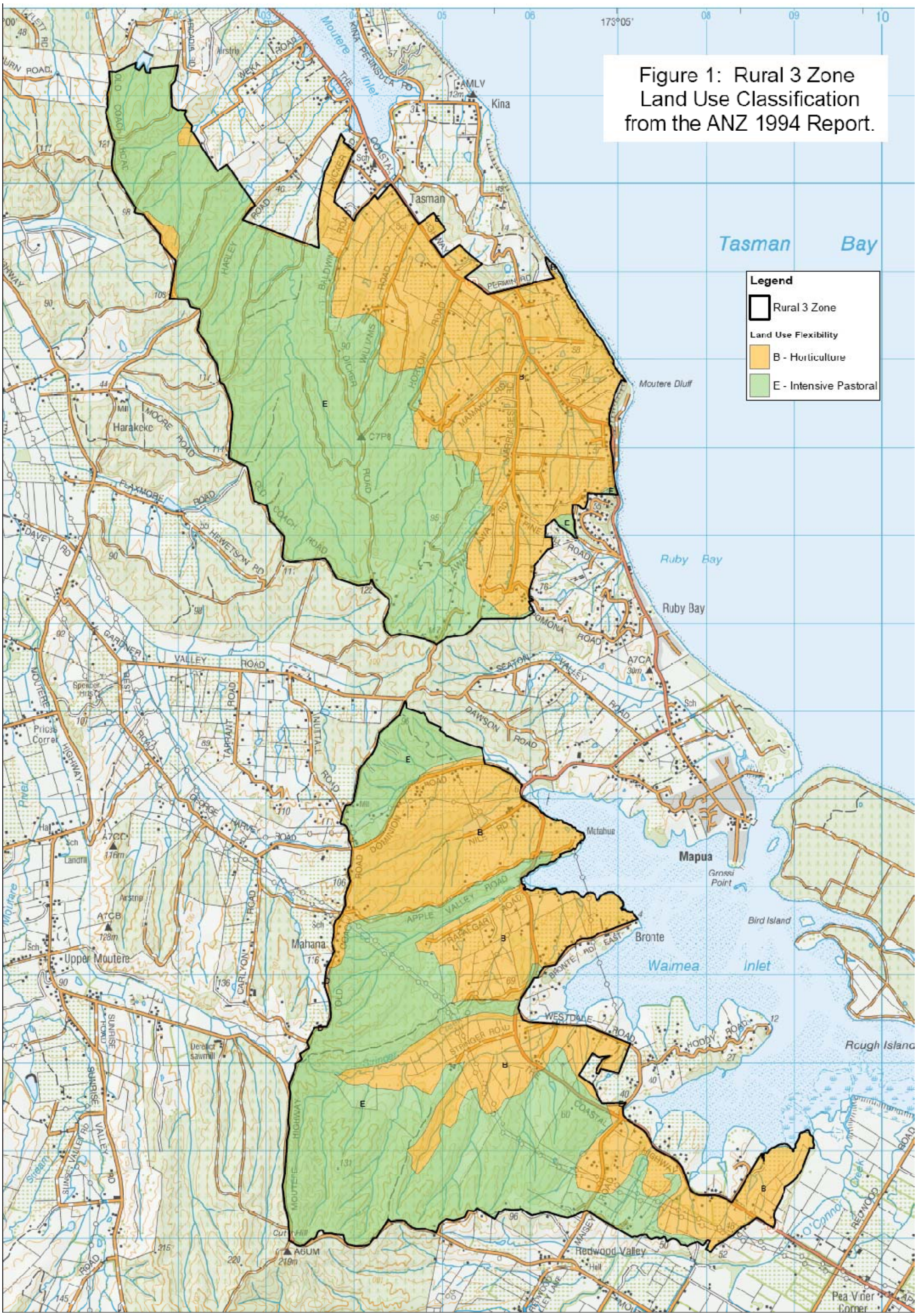
Figure 1: Rural 3 Zone
Land Use Classification
from the ANZ 1994 Report.
Legend
Rural 3 Zone
Land Use Flexibility
B - Horticulture
E - Intensive Pastoral
Tasman Bay
Ruby Bay
Mapua
Waimea Inlet
Moutere Inlet
Tasman
Kina
Harakeke
Mahana
Upper Moutere
Bronte
Redwood Valley
Rough Island
Bird Island
Moutere Bluff
173°05'

Comments in appendix E for Map Sheet N27B (which encompasses the northern half of the Rural 3 Zone) indicate the rationale for separation of Classes B and E for Mapua soils.

> *Class B is currently mostly in orchard and Class E in forestry. Many of the north facing slopes lie adjacent to all the small ephemeral streams, that run from Old Coach Road to the coastline. If we were to mark these in as separate areas, then the map would be very difficult to read. The boundary therefore in this situation to some extent reflects existing land use. In the area just west of the Inland Moutere Highway, generally south facing slopes have been taken out and classed as E with the flatter northerly facing slopes as B. Topography has been a determining factor. Steep slopes were graded E, gentle slopes to B.*

Similar comments were made for Map Sheet N27D which encompasses the southern half of the Rural 3 Zone. Appendix E describes the rationale for separation of Classes B and E for Mapua soils.

> *In the Moutere hills the south facing generally steeper slopes end up as class E where as the more gently northerly facing slopes appear as Class B.*

From this information it is evident that the intent of the ANZ 1994 Report was to confine Class B land to flat to very gentle slopes, or to gentle slopes with a sunny aspect. The detail to which this information could be applied in mapping was hampered by the 1:25 000 scale of the mapping.

5.3 New classifying criteria

The brief given for this project was to provide a ‘brief review of the existing classification system’ and to focus on critical anlysis of the Rural 3 Zone. There was not scope to interrogate the application of criteria for the whole district. However, in this section we suggest new criteria, or new boundary-conditions for the criteria used by the ANZ 1994 Report, that could be applied to improve the definition of land-use classes in the whole of Tasman District. Some of these changes need to be considered as draft criteria. In particular we suggest that the criteria distinguishing intensive from extensive pastoral land and the criteria use to distinguish forestry land need further evaluation and discussion with advisors and practitioners in the productive sector before adoption.

Table 2 (below) lists proposed versatility classes together with their most productive land use suitability classes. Two new classes are proposed: Versatility Classes B’ (horticultural land – poorly drained soils) and E’ (Intensive pastoral – dairy land). At this stage we have subdivided classes B and E into B’ and E’ rather than assigning them new letters so that the proposed classification can be more easily compared with the former classification. We also suggest that Forestry land (Class G) needs to be placed above Extensive pastoral land (Class G) in the matching table because it has more stringent requirements. If it is not placed above extensive pastoral land then land suited for forestry will all be classified as extensive pastoral land.

Table 3 records our recommendations for a new set of climatic criteria to define land-use versatility classes. Table 4 records our recommendations for new sets of soil and topographic criteria to define land-use versatility classes (with erosion potential measures explained in

Table 5). The rationale for using a number of the criteria in the tables has been referred to in previous sections. The criteria from these tables were used to classify land in the Rural 3 Zone.

The tables are to be used as a key – land is classified according the first row in the tables that fits the attributes of land being considered. For this reason we have placed E` (Dairy land) before E (Intensive pastoral land) and G (Forestry land) before F (Extensive pastoral land).

Table 2 List of land-use suitability classes

Land-use versatility class	Most productive land-use suitability class
A	Intensive horticultural land
B	Horticultural land
B`	Horticultural land – poorly drained
C	Intensive cropping land
D	Cropping land
E`	Intensive pastoral – dairying
E	Intensive pastoral land
G	Forestry land
F	Extensive pastoral land
H	Non-productive land

Table 3 Matching table relating climatic qualities to land versatility ratings

Versatility class	Mean annual soil temp. at 0.3 m depth (°C)	Min. frost free days	Min. annual rainfall (mm)	Max. average rainfall (mm)	Max. windiness
A	>14.5	300	na	1200	high
B	>14.5	250	na	2000	high
B`	>14.5	250	na	1600	high
C	12	200	800	2400	high
D	12	200	800	2400	high
E`	9	200	800	3200	na
E	9	na	na	na	na
G	8	200	800	na	high
F	8	na	na	na	na
H	na	na	na	na	na

Climate

Criteria in Table 3 are standard climatic characteristics that may be derived from measurements at major climate stations. Mean annual soil temperature was selected because it represents an index of accumulated heat in the soil and may be considered to be an approximate surrogate for growing degree days (Webb & Wilson 1995). It may also be possible to develop a correlation with frost-free period but this is likely to be difficult because of the importance of temperature inversion effects acting on timescales not well characterised by mean soil temperature, and being most important at specific times of year (e.g. spring).

Table 4 Matching table relating land qualities to land versatility ratings

Vers-atility class	Min. rooting depth (m)	Min. profile available water[1] (mm)	Min. root penetr-ability	Min. drainage class	Max. salinity class	Max. slope angle (degrees)	Max. potential for erosion[2]	Max. flood frequency (years)
A	0.8	50	High	Imperfect	V. low	7	na	1 in 20
B	0.8	50	Moderate	Poor[3]	Low	15	Moderate[4]	1 in 20
B`	0.6	75	Moderate	Imperfect	Low	15	Moderate[4]	1 in 10
C	0.5	75	Moderate	Poor[2]	Low	15	Slight[4]	1 in 10
D	0.5	75	Limited	Poor[2]	Medium	15	Moderate[4]	1 in 10
E`	0.4	75	Limited	Poor[2]	Medium	15	Slight	1 in 5
E	na	na	na	Poor	Medium	35	Moderate	na
G	0.8	75	Moderate	Imperfect	Low	28	Moderate	na
F	0.2	na	na	V. poor	High	na	Severe	na
H	na	na	na	na	na	na	na	na

[1]Profile available water is the preferred terminology, which is generally referred to as available water holding capacity.

[2]Defined in Table 5.

[3]Land can be readily drained.

[4]Erosion potential when cultivated.

na = not applicable

Table 5 Potential for erosion, based on Van Berkel (1983)

LUC Class	Potential for erosion (not cultivated)	Potential for erosion (when cultivated)
1	Negligible	Negligible
2e	Slight	Slight
3e	Slight	Slight to moderate
4e	Slight	Moderate to severe
6e	Moderate	na
7e	Moderate to severe	na

5.4 Remapping of land within the Rural 3 Zone

5.4.1 Key principle undergirding the classification

In this section we follow the same principles of land evaluation as are outlined in sections 1.0 and 2.0 of the ANZ 1994 Report.

The key principles from that report are to develop a land evaluation system that:

- provides a quantifiable structure that people can interpret and understand
- focuses on information on the potential, and not the current or conservation, use of land
- focuses on inherent land characteristics that may be considered permanent
- classifies land in terms of its versatility to productive use as a proxy for land value
- takes account of long-term issues such as erosion that can impinge on productive land use

5.4.2 Critical criteria used to identify land-use classes

Soils

This Rural 3 Zone contains a simple soil pattern consisting of Mapua soils formed on dissected glacial-outwash fan deposits, and Braemar soils formed from alluvium in valley bottoms (Chittenden et al. 1966). Use of the LIDAR-derived DEM enabled more accurate separation of Mapua and Braemar soils.

Soil characteristics for the Mapua and Braemar soils were derived from Fox (1952), Chittenden et al. (1966), Adams (1970) and the Landcare Research National Soils Database.

Slope angle

The Slope Class map (Figure 2) was derived from the DEM and shows an intricate pattern of slope classes typical of dissected terraces.

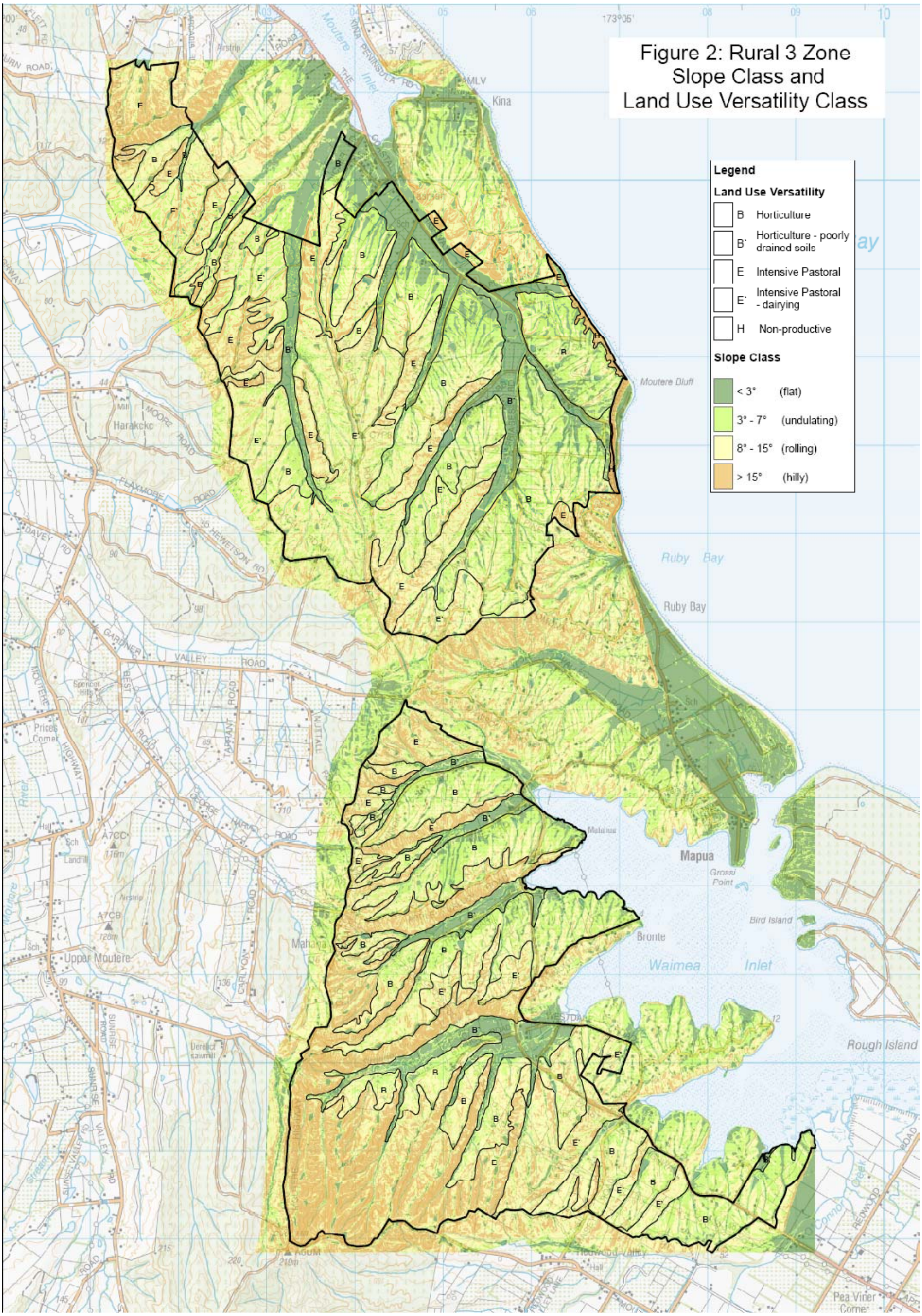
Figure 2: Rural 3 Zone
Slope Class and
Land Use Versatility Class
Legend
Land Use Versatility
B Horticulture
B' Horticulture - poorly drained soils
E Intensive Pastoral
E' Intensive Pastoral - dairying
H Non-productive
Slope Class
< 3° (flat)
3° - 7° (undulating)
8° - 15° (rolling)
> 15° (hilly)
Ruby Bay
Mapua
Waimea Inlet
Rough Island
Moutere Bluff
Kina
Bronte
Bird Island
Upper Moutere

Potential for erosion

Potential for erosion was based on association of susceptibility to erosion with land use capability classes (Tables 4 and 5). LUC classes and associated erosion potential (after Van Berkel 1983) were as follows:

- Class 2w land contains Braemar soils that are wet in winter (imperfectly drained?).
- Class 3w1 land contains poorly drained Braemar soils.
- Class 3e6 land contains Mapua soils with slope angles 9–15° dominant (parts < 9°) and with slight potential for sheet and slip erosion but moderate potential for sheet and rill erosion when cultivated.
- Class 4e5 land contains Mapua soils with slope angles 9–15° dominant (parts up to 20°) and with slight potential for sheet and slip erosion but moderate to severe potential for sheet and rill erosion when cultivated.
- Class 6e16 land contains Mapua soils with slope angles >15° dominant and with moderate potential for sheet, soil slip and gully erosion.

Climate

Mean annual soil temperature was estimated by a Landcare Research empirical model that estimates mean soil temperature at 30 cm, annually and monthly (Barringer & Lilburne 2000). This model takes account of the effects of latitude, elevation, aspect, slope and distance from coast to estimate soil temperature. Because, over periods of a month or more, soil and air temperatures are closely correlated, this soil temperature map can be used to provide an approximate representation of microclimate. However it may not account for some local affects such as air flow (turbulence) and temperature inversions that affect air temperature over short periods (hours). These latter factors may need to be accounted for, on the basis of local knowledge as in the ANZ 1994 Report, particularly for land in narrow valleys.

The estimated mean annual soil temperature was mapped for a range of soil temperature classifications until a value was found that matched with the location of orchards in the Rural 3 Zone. An annual soil temperature of 14.5°C coincided with the location of orchards and made a satisfactory distinction between sunny and shady slopes (Figure 3). This land has the required heat and solar energy conditions to grow a wide range of horticultural crops.

5.4.3 Rationale for land-use class assignment

Land within the Rural 3 Zone was allocated to land-use versatility ratings according to criteria listed in Tables 3 and 4. The tables are used as a key with land keying out into classes progressively from the top of the table. Note: Rainfall and windiness within the Rural 3 Zone do not fall within the ranges that were used for class assignment so are not discussed here.

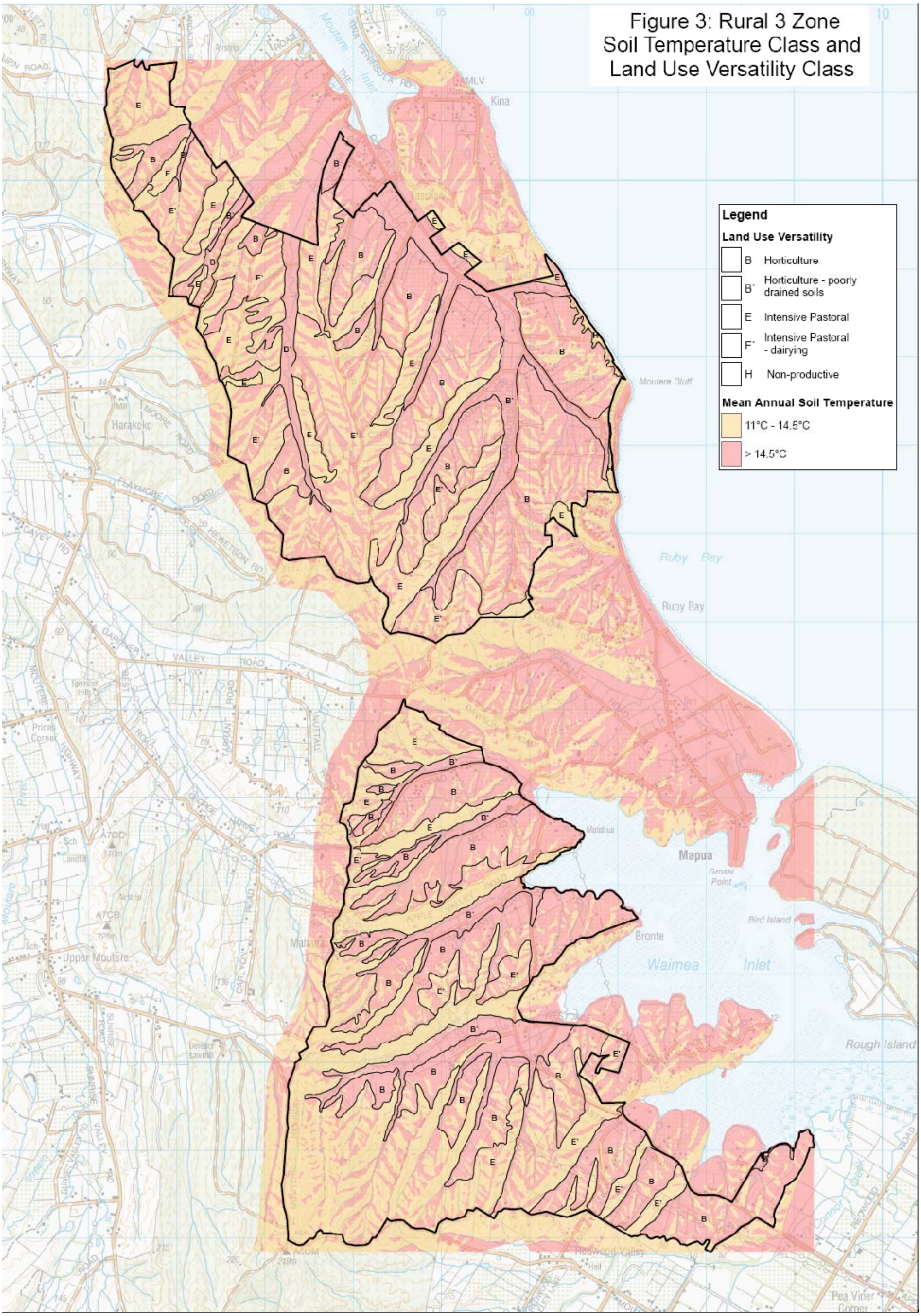
Figure 3: Rural 3 Zone
Soil Temperature Class and
Land Use Versatility Class
Legend
Land Use Versatility
B Horticulture
B` Horticulture - poorly drained soils
E Intensive Pastoral
F` Intensive Pastoral - dairying
H Non-productive
Mean Annual Soil Temperature
11°C - 14.5°C
> 14.5°C
Ruby Bay
Mapua
Waimea Inlet
Rough Island
Moutere Bluff
Kina

Class A (suitable for intensive horticulture)**.** No Class A land was identified. Mapua soils were excluded from Class A because they only have moderate root penetrability related to dense subsoils (Adams 1970; profile SB09292 in the NSD database). Braeburn soils were excluded from Class A because of poor drainage.

Class B (suitable for horticulture)**.** Mapua soils qualified for Class B when they occupied land with slope angle ≤ 15°, were not poorly drained, and soil temperature at 0.3 m was >14.5°C. The slope angle of 15° was selected as the maximum slope suited to wheeled tractors operating up and down slope. (Note: Webb and Wilson (1994) suggested that a slope angle of 11° was the cut-off slope for horticulture, but apple orchards in this area have historically extended to around 15°).

**Class B`** (suitable for horticulture – poor drainage)**.** All areas of Braeburn soils qualified for Class B` because they occurred on land with soil temperature at 0.3 m > 14.5°C. Poorly drained land was assigned to Class B' when the land could be 'readily drained'. Ability to be readily drained is defined here as having a very good to moderate response to drainage as defined in table 4 in Webb & Wilson (1994). This land is commonly used for apple and berry orchards so it is expected that it is able to be readily drained. This may not be the case for small areas of land below 1–2 m above sea level where they may also be excluded from Class B` due to medium salinity.

Class C (suitable for intensive cropping). This land-use class did not occur. Land with slopes > 15° was excluded from Class C due to slope limitations. Land with slopes ≤ 15° was excluded because of moderate root penetrability, and moderate to severe erosion potential under arable use (LUC Class 4e).

Class D (suitable for cropping). This land-use class did not occur. Land with slopes > 15° was excluded from Class D due to slope limitations. Land with slopes ≤ 15° was excluded from Class D because of moderate to severe erosion potential under arable use.

**Class E`** (suitable for dairying)**.** Mapua soils qualified for Class E` when they occupied land with slope angle ≤ 15°.

Class E (suitable for intensive grazing)**.** Mapua soils qualified for Class E when they occupied land with slope angle > 15° and ≤ 35°.

Classes F (suitable for extensive grazing) **and G** (suitable for forestry)**.** All land in the area with slope angles ≤ 35° qualified for higher classes so these classes are excluded.

Class H (unsuitable for productive use). Small areas of very steep marine cliffs qualified as Class H.

5.4.4 Digitising map units for land-use classes

Figures 4 and 5 present maps of land-use classes mapped in the Rural 3 Zone . The map units were digitised on the basis of a combination of overlays of the soil temperature and slope angle (Figure 6).

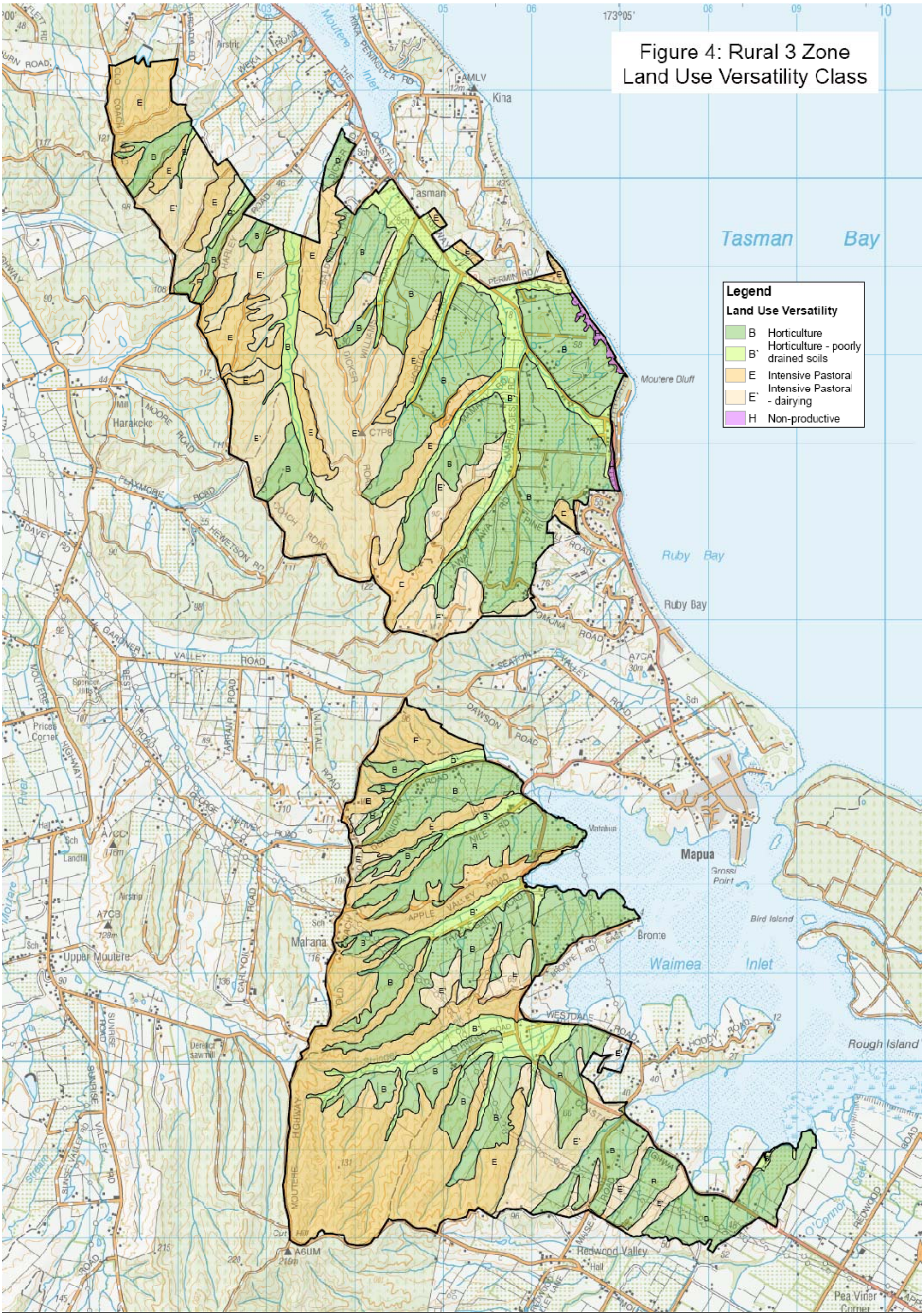
Figure 4: Rural 3 Zone
Land Use Versatility Class
Legend
Land Use Versatility
B Horticulture
B` Horticulture - poorly drained soils
E Intensive Pastoral
E` Intensive Pastoral - dairying
H Non-productive
Tasman Bay
Ruby Bay
Mapua
Waimea Inlet
Rough Island
Kina
Tasman
Mahana
Upper Moutere
Redwood Valley
Harakeke
Moutere Bluff
Bird Island

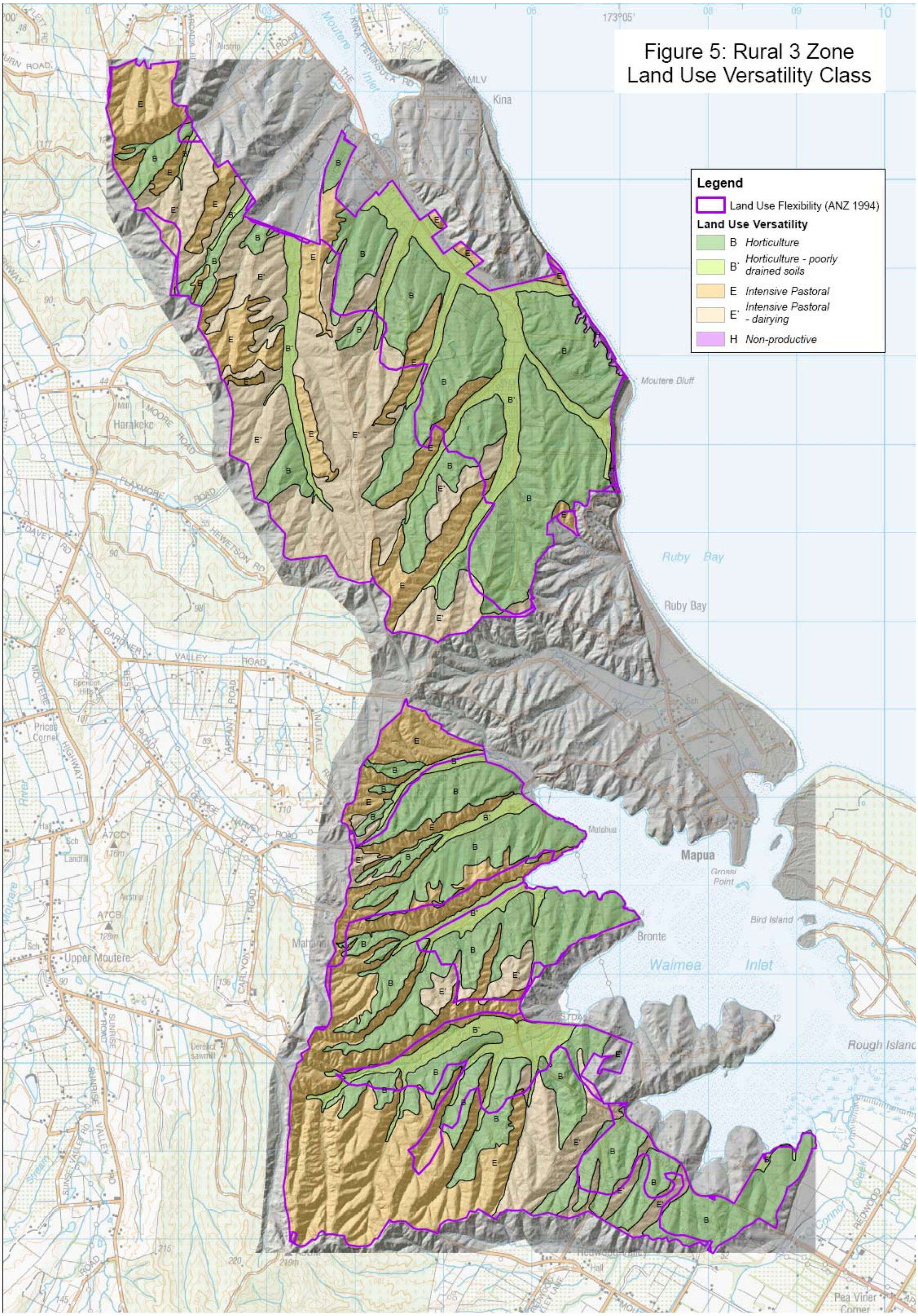
Figure 5: Rural 3 Zone
Land Use Versatility Class
Legend
Land Use Flexibility (ANZ 1994)
Land Use Versatility
B Horticulture
B' Horticulture - poorly drained soils
E Intensive Pastoral
E' Intensive Pastoral - dairying
H Non-productive
Kina
Moutere Bluff
Ruby Bay
Mapua
Waimea Inlet
Bronte
Bird Island
Rough Island
Harakeke
Upper Moutere
Mahana
Pea Viner Corner

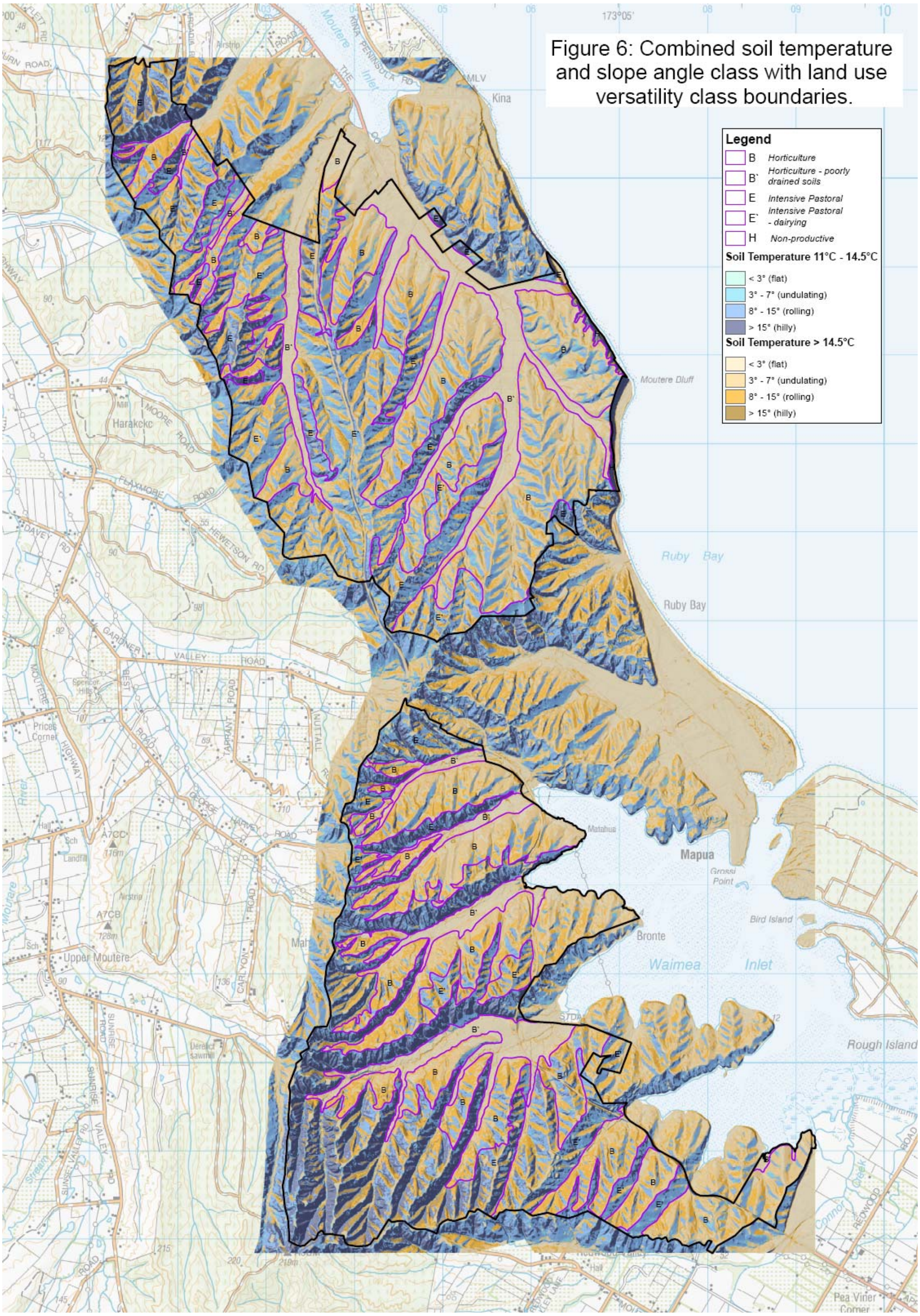
Figure 6: Combined soil temperature and slope angle class with land use versatility class boundaries.
Legend
B Horticulture
B` Horticulture - poorly drained soils
E Intensive Pastoral
E` Intensive Pastoral - dairying
H Non-productive
Soil Temperature 11°C - 14.5°C
< 3° (flat)
3° - 7° (undulating)
8° - 15° (rolling)
> 15° (hilly)
Soil Temperature > 14.5°C
< 3° (flat)
3° - 7° (undulating)
8° - 15° (rolling)
> 15° (hilly)
Moutere Bluff
Ruby Bay
Mapua
Bronte
Waimea Inlet
Rough Island
Bird Island
Harakeke
Upper Moutere
Kina

Class B` comprised all land on the valley floors and contained all the area of Braemar soils.

Class B occupied land where >70% of the area within a polygon had mean annual soil temperature > 14.5°C and >85% of the area had slope angles ≤ 15°.

Class E` occupied land where >70% of the area had slope angles ≤ 15°. Also, each polygon needed to have a minimum area of 15 ha because smaller areas are unlikely to be managed separately for dairy grazing.

A small area of Class H land was mapped on land with very steep slopes – confined to sea-cut cliffs.

The remaining land qualified for Class E – land suitable for intensive pastoral use.

The location of land classes B and B` accords well with the location of orchards. There are a few areas classified as Class E` (Dairying) that currently have or have had orchards. There are large areas classified as B that do not have orchards and represent potential for more intensive land use.

Figure 5 displays the boundaries of the 1994 mapping as an overlay on the new mapping. Class B on the 1994 map mainly contains land of Class B or B`, but includes significant areas of Class E` and E. The new map identifies large areas of Class B and B` land that were not mapped by the ANZ 1994 Report. Most of the differences can be related to the use of detailed LIDAR data to generate slope and soil-temperature maps. These resources gave confidence to map Class B beyond the area currently used for orchards.

Property size

> The brief asked: 'Can other factors such as current block or holding size, dwelling density...be effectively incorporated into the classification system?'

We did not attempt to incorporate these factors into our analysis because this is beyond the scope of our competency. TDC staff would need to make policy decisions regarding the rationale for the minimum property size in relation to land versatility classes. To do this, reference would need to be made to land-use advisors, land valuers, etc. Should these policy decisions be made, then the maps and data we provide here should be an adequate basis upon which to overlay property sizes to make a new classification.

Map presentation

The digital data for soil temperature and slope classes are provided and can be used by Council staff and others to 'see' the composition of individual map units or to make decisions regarding land attributes within individual properties.

Landcare Research is currently developing web-based formats to present similar data to users of soil and land cover information.

6 Conclusions

- This report has highlighted a number of technical issues with the land classification used in the ANZ 1994 Report. These issues create uncertainty or lack of transparency in the classification of particular land areas.
- The new set of climate and land-resource criteria developed in this report provide a more objective and defensible land evaluation system.
- The use of digital elevation models based on LIDAR data has improved the accuracy of land classification for the Rural 3 Zone based on more accurate identification of slope classes and climatic zones.
- Where LIDAR data are available, the application of detailed digital elevation models can provide data that are capable of mapping land-use classes at the small land-holding scale. Where LIDAR is not available, less accurate digital elevation models could be used to analyse climate and topography for land classification in the remainder of Tasman District.

7 Recommendations

- That an improved report and map of land-use classes be generated by applying the new criteria recommended in this report.
- To generate a more detailed 'versatility of land-use'' map will require more accurate maps depicting soil drainage, rooting depth and profile available water content. It will also require more effort to define boundary criteria for a number of land-use classes.
- That Tasman District Council consider producing a computer-generated land classification system that is accessible as maps and data over the World Wide Web.

8 Acknowledgements

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9 References

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