LAND CAPABILITY HANDBOOK

Guidelines for the Classification of Agricultural Land in Tasmania

Second Edition

Edited by
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Department of Primary Industries, Water and Environment
Prospect Offices
1999

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Tasmania
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ACKNOWLEDGEMENTS

This revised edition of the Land Capability Handbook has been put together over a lengthy period of time. It has been developed in response to an increasing demand for land capability information and a greater desire by non practitioners to understand the land capability classification process. Also, with greater numbers of DPIWE staff involved with land evaluation, it has been necessary to produce a document that will help to maintain consistency of approach between the various surveyors.

Much of this second edition has been taken straight from the original publication by Kathy Noble and her input is gratefully acknowledged. Other DPIWE personnel who have contributed significantly include Greg Pinkard, Rob Moreton, Bill Cotching, John Loy (DNR, Queensland), Peter Zund, Rob Musk and Ron DeRose.

Many farmers, land owners and property managers have provided information for this document through general discussion and conversation and there knowledge, even when only anecdotal, has been invaluable.

1. INTRODUCTION

The Department of Primary Industries, Water and Environment (DPIWE, formerly Department of Primary Industry and Fisheries) has, for some years, been involved with a land capability mapping program for the agricultural areas of Tasmania. To date this work has covered six 1:100 000 scale map sheets in the northern part of the State, with additional sheets underway in both northern and southern areas and plans to continue mapping throughout the major agricultural areas.

The last year or so has seen not only an increase in the demand for land capability information but also an increase in the number of practitioners involved in undertaking land capability classification. It was clear that a revised edition of the Land Capability Handbook, following on from the original work by Noble (1992), would greatly facilitate the task of ensuring consistency between surveyors across the State, as well as providing additional information for those people outside the Department who may be teaching or using the Tasmanian Land Capability Classification System. This edition of the Handbook goes a step further than the original by attempting to provide a selection of guidelines for the evaluation of individual soil and land characteristics for land capability classification.

As well, the system itself has evolved somewhat since it's early development and this handbook sets out to explain these changes. One of the more obvious changes is the upper limit for slope steepness for Class 4 land. Initially set at 30% in older reports, this limit increased to 32% in some reports before the current limit of 28% was adopted. While this is recognised as an inconsistency in the mapping approach the changes are not considered to have any significant impact on areas or class boundaries of previously classified land.

In Tasmania, the land capability system in general, and the guidelines in particular, have been developed in consultation with a wide range of land owners, growers, managers, industry and DPIWE personnel. The guidelines draw heavily upon similar guidelines from around Australia, New Zealand and the UK and the various classes and categories of land have been adjusted, after considerable consultation with those involved in the agri industry, to suit Tasmanian conditions.

Despite the inherent subjectivity in the methodology, land capability remains an internationally accepted form of land evaluation. In Tasmania it should be an essential input to all planning decisions in order to ensure that the long-term sustainability and correct management of agricultural land is achieved. This principal applies at the State and regional level, down to planning at the farm scale.

In the context of this work *Land Capability* may be defined as a ranking of the ability of land to sustain a range of agricultural land uses without degradation of the land resource. Until now it has been an interpretive, and somewhat subjective, assessment based on the physical limitations and hazards of the land, potential cropping and pastoral productivity, and the versatility of the land to produce a range of agricultural goods without damage to the land resource.

The 1:100 000 scale land capability mapping program currently being undertaken by DPIWE personnel assesses only private Freehold and leased or unallocated Crown land. It does not include designated State Forests, National Parks, State Reserves, Crown Reserves, HEC or other similar areas or reserves. It should be noted that land capability is the result of an evaluation of a variety of other land resource information. It is an end product and does not in itself contain basic resource information. It is therefore difficult to derive other products, such as land suitability for various enterprises, from land capability maps.

The aim of this handbook is two fold. Firstly, it sets out to explain land capability to potential users and the public in general. Secondly, it presents a series of guidelines for the quantitative assessment of land capability in Tasmania and seeks to address some of the practical survey problems that have been encountered over the past five years in the hope that this will enable a more consistent approach to land capability evaluation in the State. It is emphasised that the class limits defined for a variety of land characteristics and qualities later in this text are **not** rules but guidelines and that some degree of flexibility must be allowed for. There is a lack of specific, quantifiable knowledge relating to the management and use of the State’s land resources and there remains the need to physically check the accuracy of class limits through research, observation and practical experience under conditions specific to Tasmania.

Despite the limitations of the system and the lack of scientific rigour resulting from limited data availability, land capability classification is still a valuable tool for all those involved in evaluating the capability of the land. The value of land capability classification in Tasmania has been recognised by the State Policy on the Protection of Agricultural Land which now requires councils to consider the capability of the land in the development of strategic plans. The guidelines presented in this report should enable people from a range of backgrounds to better understand the value of the system and allow others to make consistent interpretations of land capability when presented with the same resource information. Hopefully, with increasing research and knowledge, the guidelines can be improved and class limits tightened.

The applications of land capability information are very varied and depend on the mapping scale and the level of detail of information collected. At the 1:100 000 scale, the main aim is to identify and map the distribution and extent of different classes of agricultural land in order to provide a more effective base for land use planning. As well, the intention is to ensure that the long-term productivity of Tasmania’s agricultural resources is maintained, through the promotion of compatible land uses and management practices.

Figure 1 outlines the completed, current and prospective mapping program until 2001, within the State.

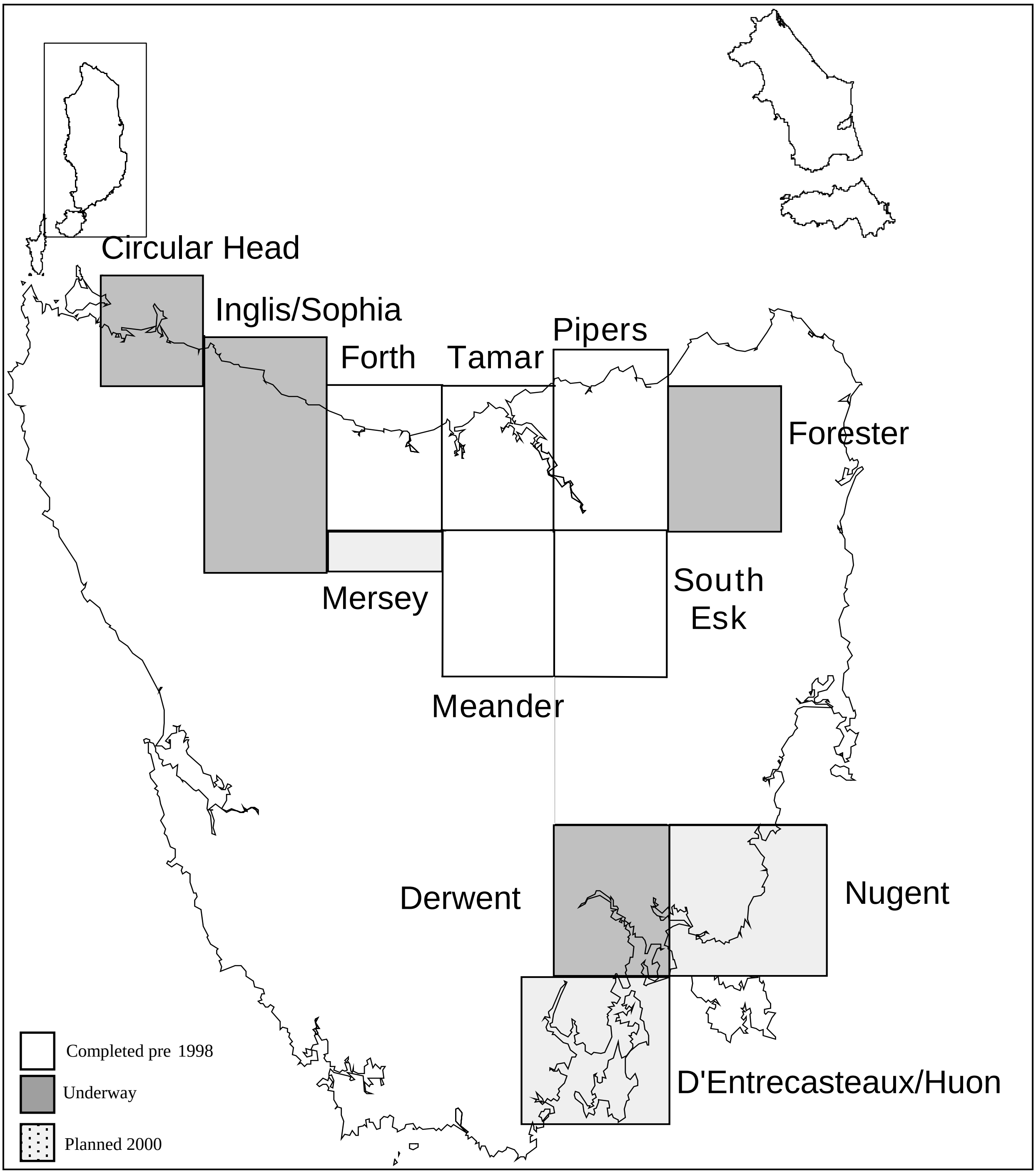


Figure 1. Land Capability Maps Completed, Underway and Planned

2. LAND CAPABILITY CLASSIFICATION

Land capability classification is an internationally recognised means of land classification, used to evaluate the capability of land to support a range of land uses, on a long-term sustainable basis.

For the Tasmanian classification, agricultural land uses only are covered, and are defined as broadscale grazing and cropping uses. Land capability ratings for specific land uses are not evaluated, nor is the capability of land for forestry use incorporated into the classification system.

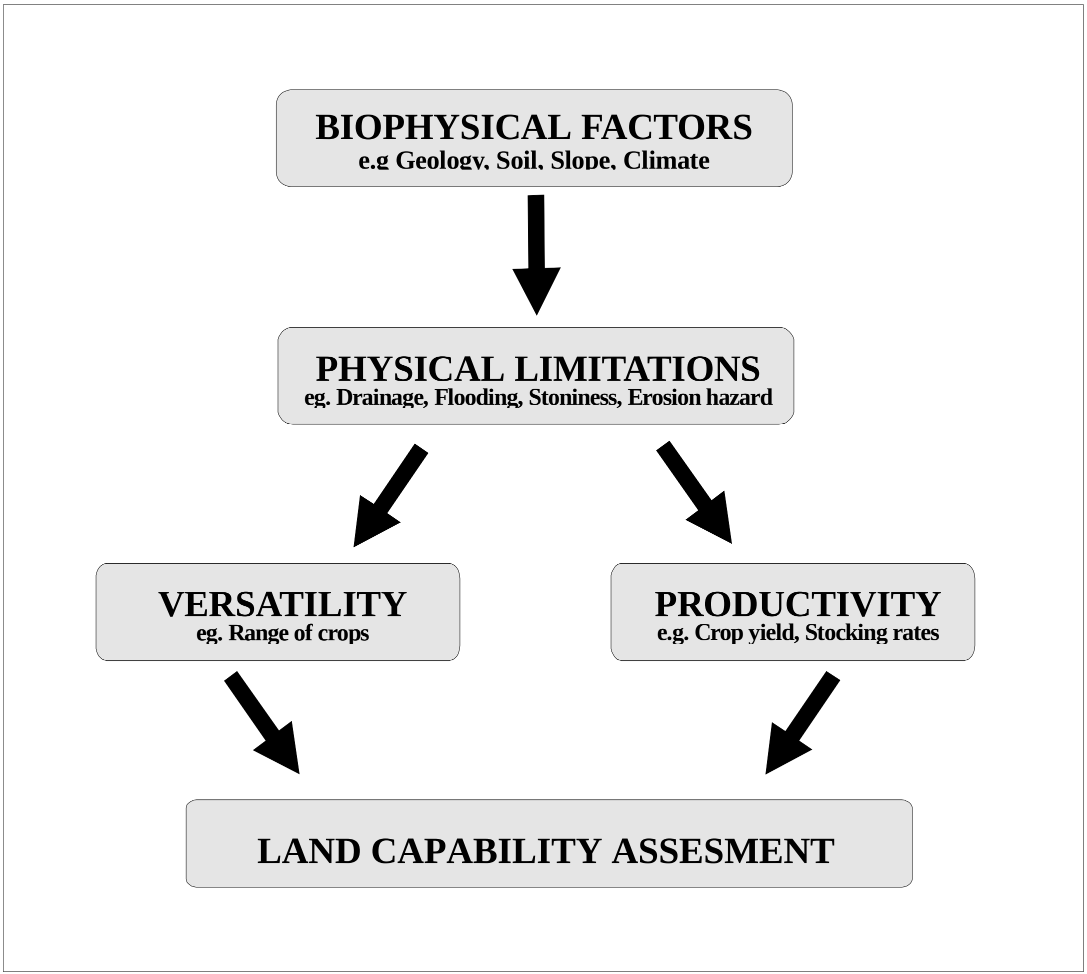


Figure 2. Factors in land capability assessment.

Land capability assessment takes into account the physical nature of the land (eg. geology, soils, slope) plus other factors (eg. climate, erosion hazard, land management practices) which determine how that land can be used without destroying its long-term potential for sustainable agricultural production. It also takes into account limitations that might affect agricultural use, eg. stoniness, drainage, salinity or flooding. Land capability assessment is therefore based on the permanent biophysical features of the land (including climate), and does not take into account the economics of agricultural production, distance from markets, social or political factors.

Land capability assessment should not be confused with land suitability assessment which, in addition to the biophysical features, does take into account economic, social and/or political factors in evaluating the 'best' use of a particular area of land. Land capability classification gives a grading of land for broadscale agricultural uses, whereas land suitability is applied to more specific, clearly defined land uses, such as land 'suitable' for carrots.

Land suitability also requires much more detailed collection of land resource information, pertinent to the particular land use eg. soil nutrient status. This level of detail is outside the scope and resources of the 1:100 000 scale series.

The land capability classification system for Tasmania gives an indication of the inherent capability of the land for general agricultural production and does not attempt to portray specific land uses, or rank the value of any particular agricultural land use above another. Neither does it attempt to give an indication of land values.

The system of land capability classifies land into a number of classes according to the land's capability to produce agricultural goods (based on broadscale grazing and cropping uses). The system for Tasmania is based on the USDA (United States Department of Agriculture) approach to land capability, as opposed to the FAO (Food and Agricultural Organisation) system which emphasises land suitability.

There are generally three levels to the land capability classification:

- The land capability **class** - which gives an indication of the general degree of limitation to use;

- **subclass** - which identifies the nature of the dominant limitation;

- and the **unit** - which group together similar types of land requiring the same kind of management, the same kind and intensity of conservation treatments, and which occur on soils which are adapted to the same kinds of crops, with similar potential yields.

At the 1:100 000 scale of mapping it is only possible to record and map land at the class level. However, for more recent maps, subclass information has been recorded for many map polygons and this information is stored on the DPIWE’s Geographical Information System (GIS) database and is available to the public on request. The information is recorded simply as a limitation code for each limitation identified within the map polygon and no attempt has been made to identify the extent or boundaries of individual subclasses.

The system can also be used and applied at more detailed scales by mapping to the subclass and unit level, depending on the purpose of the survey. A scale of 1:50 000 is considered the minimum for subclass mapping and 1:25 000 for mapping to unit level. The levels of the land capability classification system are shown in Figure 3. A more detailed description of the land capability classes, subclasses and units, are found in Section 3. DPIWE staff are currently undertaking mapping programs at 1:100 000 scale for regional planning and 1:25 000 scale for more detailed local area planning.

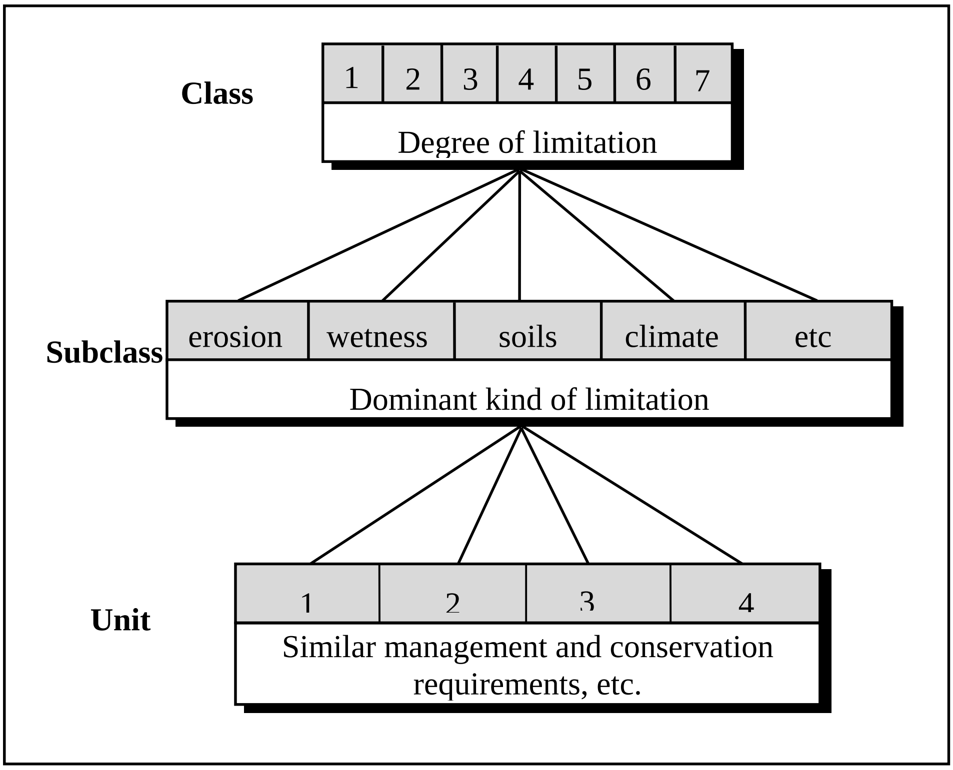


Figure 3. Levels of the land capability classification system.
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land Resources. (NWASCO), Wellington, New Zealand.)

In Tasmania land capability evaluation is undertaken primarily through field observation although various modelling and computer techniques, such as the use of digital elevation models are being increasingly used to supplement fieldwork.

Photo 1. Checking capability boundaries in the field.

3. FEATURES OF THE TASMANIAN LAND CAPABILITY CLASSIFICATION SYSTEM

3.1 Introduction

The classification system in Tasmania is based primarily upon three permanent *biophysical* features of the landscape - soil, slope and climate, and their interactions. These three factors have a major influence in determining the capability of the land to support various levels of agricultural production. Other factors which must be taken into account are rock type, erosion hazard, range of crops that can be grown, management practices, soil conservation treatment, risk of flooding and past land use history.

The system assess the versatility of the land to produce a range of agricultural goods that are considered typical for Tasmania, and not just those that are specific or suited to localised areas. Nor does the system take into account forest productivity. It is based on cultivation of the land for cropping purposes and not other land use systems which can sustain 'crops' on steeper land with longer rotations, and less risk of erosion (eg perennial horticulture, tree crops, orchards). The range of crops that can be grown on classes 1 and 2 land would be wider than the range of crops grown on classes 3 and 4 land and would include a wide range of vegetables and allied crops, cereals, essential oils and forage crops.

The system is hierarchical and comprises seven classes, ranked in order of increasing degree of limitations to use, and in decreasing order of versatility. Class 1 land can produce a wider variety of crops and pastures at higher levels of production with lower costs, or with less risk of damage to the land, than any of the other classes of land. Class 2 land is similarly superior to classes 3 to 7, and so on. Class 4 land is considered the limit for cropping. It is restricted by severe hazards or limitations to production such that cropping can only occur one or two years out of ten without leading to degradation of the soil resource or is limited to only one or two crop types which require low inputs and management but which allow more frequent cropping. The capability class is therefore an indicator of the degree of versatility, level of productivity and risk of degradation for a particular area of land.

The second level of classification, indicated by the subclass code, identifies the nature of the risk or the type of hazard or limitation present. Limitations may be defined as physical factors or constraints which affect the range of crops that can be grown or limit the frequency of cultivation. This information is usually only presented on maps of scale 1:50 000 or greater although limited subclass information is available for some of the more recently published maps. The subclass code is indicated by a letter following the class code. Initially the system identified four major limitation groups - erosion, wetness, soils and climate. However, this approach is considered to provide only limited information to potential users and that subclass information could be made more valuable by increasing the range of limitations identified. The identification of a wider range of limitations is a new approach to mapping adopted for maps published from 1999 onwards.

The third level of classification is the unit level, identified by a number following the subclass code. Unit level mapping is usually appropriate to 1:25 000 scale mapping or larger. The unit level takes into account the levels of production, management strategies and soil conservation requirements that the land may need in order to maintain that level of production without long-term degradation.

The system considers degradation of the soil resource and does not take into account the possible effects of agricultural land use on water quality, aesthetics, wildlife, etc.

3.2 Land Capability Classes

The land capability class is the broadest grouping of the land capability classification and gives an indication of the general degree of limitation to use and the versatility of the land (see Figure 4).

Figure 4. Land uses appropriate to different land classes
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land

INCREASING LIMITATIONS TO USE

CLASS	CROPPING SUITABILITY	PASTORAL SUITABILITY	LAND USE OPTIONS
1	High	High	Many
2			
3	Medium		
4	Low		
5	Unsuitable	Medium	Limited
6		Low	
7		Unsuitable	Extremely Limited

DECREASING VERSATILITY

Resources. (NWASCO), Wellington, New Zealand.)

<table>
<tr><th>CLASS</th><th></th><th>LIMITATIONS</th><th>CHOICE OF CROPS</th><th>CONSERVATION PRACTICES</th></tr>
<tr><td>1</td><td rowspan="4">Under cultivation</td><td>Very minor</td><td>any</td><td>Very minor</td></tr>
<tr><td>2</td><td>Slight</td><td>Slightly reduced</td><td>Minor</td></tr>
<tr><td>3</td><td>Medium</td><td>Reduced</td><td>Major</td></tr>
<tr><td>4</td><td>Severe</td><td>Restricted</td><td rowspan="4">Major
+
careful management</td></tr>
<tr><td>5</td><td rowspan="3">Under pastoral use</td><td>Slight to moderate</td><td>Grazing</td></tr>
<tr><td>6</td><td>Severe</td><td>Grazing</td></tr>
<tr><td>7</td><td>Very severe to extreme</td><td>No, or very minor agricultural value</td></tr>
</table>

Figure 5. Features of land capability classes.

The cut-offs used to define the classes (and used as class limits within the guidelines defined in section 4) are based primarily on observation, experience and information from other classification systems, and not on experimental results. It is expected that these class limits will be modified as our understanding of our soils, climate and topography, and their interactions, increases. Figure 5 outlines the main features of the capability classes. Classes 1-4 only are considered capable of supporting cropping activities on a sustainable basis; Classes 5 and 6 are suitable for grazing activities only although pasture improvement may be possible on Class 5 land (Class 6 land remaining as native pasture); Class 7 land is unsuitable for any form of sustainable agricultural activity.

Class Definitions

Land capability class definitions are as follows:

CLASS 1

Land well suited to a wide range of intensive cropping and grazing activities. It occurs on flat land with deep, well drained soils, and in a climate that favours a wide variety of crops. While there are virtually no limitations to agricultural usage, reasonable management inputs need to be maintained to prevent degradation of the resource. Such inputs might include very minor soil conservation treatments, fertiliser inputs or occasional pasture phases. Class 1 land is highly productive and capable of being cropped eight to nine years out of ten in a rotation with pasture or equivalent without risk of damage to the soil resource or loss of production, during periods of average climatic conditions.

CLASS 2

Land suitable for a wide range of intensive cropping and grazing activities. Limitations to use are slight, and these can be readily overcome by management and minor conservation practices. However the level of inputs is greater, and the variety and/or number of crops that can be grown is marginally more restricted, than for Class 1 land.

This land is highly productive but there is an increased risk of damage to the soil resource or of yield loss. The land can be cropped five to eight years out of ten in a rotation with pasture or equivalent during 'normal' years, if reasonable management inputs are maintained.

CLASS 3

Land suitable for cropping and intensive grazing. Moderate levels of limitation restrict the choice of crops or reduce productivity in relation to Class 1 or Class 2 land. Soil conservation practices and sound management are needed to overcome the moderate limitations to cropping use.

Land is moderately productive, requiring a higher level of inputs than Classes 1 and 2. Limitations either restrict the range of crops that can be grown or the risk of damage to the soil resource is such that cropping should be confined to three to five years out of ten in a rotation with pasture or equivalent during normal years.

CLASS 4

Land primarily suitable for grazing but which may be used for occasional cropping. Severe limitations restrict the length of cropping phase and/or severely restrict the range of crops that could be grown. Major conservation treatments and/or careful management is required to minimise degradation.

Cropping rotations should be restricted to one to two years out of ten in a rotation with pasture or equivalent, during ‘normal’ years to avoid damage to the soil resource. In

Photo 2. Class 1 (foreground) and Class 2 land (middle distance) on basalt rock at Table Cape in north west Tasmania.

Photo 3. Class 4 land on alluvial sediments with Class 5 land on basalt on hillslopes in background.

Photo 4. Class 4 land is also suitable for occasional cropping.

Photo 5. Class 5 land, suitable only for grazing and occasional fodder crops, with Class 6 land in the background**.**

some areas longer cropping phases may be possible but the versatility of the land is very limited. (NB some parts of Tasmania are currently able to crop more frequently on Class 4 land than suggested above. This is due to the climate being drier than ‘normal’. However, there is a high risk of crop or soil damage if ‘normal’ conditions return.)

CLASS 5

This land is unsuitable for cropping, although some areas on easier slopes may be cultivated for pasture establishment or renewal and occasional fodder crops may be possible. The land may have slight to moderate limitations for pastoral use. The effects of limitations on the grazing potential may be reduced by applying appropriate soil conservation measures and land management practices.

CLASS 6

Land marginally suitable for grazing because of severe limitations. This land has low productivity, high risk of erosion, low natural fertility or other limitations that severely restrict agricultural use. This land should be retained under its natural vegetation cover.

CLASS 7

Land with very severe to extreme limitations which make it unsuitable for agricultural use.

E - Exclusion Areas

Land that is not private freehold or leased crown land and has not therefore been considered during the evaluation. Also included in this classification are urban centres and other obviously non-agricultural areas.

<u>Note on Class Definitions</u>

The length of cropping phase given for Classes 1-4 is intended as a general guide only. Past experience has shown that there is some confusion and concern regarding the figures given. While some land will just not support production beyond the intensity recommended (due to the risk of erosion or soil structure decline, for example), other areas are limited by the risk of loss occasioned by such factors as adverse climatic conditions or flooding.

For example, some parts of a survey area may be subject to a significant flood risk. Due to rainfall patterns in recent years it might be possible to cultivate these areas more intensively than might 'normally' be achieved. By cultivating these areas farmers are accepting a high risk of failure or damage to crops from flooding and whether or not a crop is planted in any particular year is dependent, in part, on just how much risk an individual farmer is prepared to accept. In other areas the soils are such that significant periods of cultivation without a break can lead to severe structure decline, hindering germination, water infiltration, soil aeration and increasing the likelihood of erosion.

Also, the classification system takes into account the *variety* of crops that can be grown. Thus Class 4 land might incorporate areas where a relatively wide range of crops could be grown but the risk of damage to the resource is such that cropping should **only** be undertaken one or two years out of ten. Conversely, other areas may support a more limited range of crops but production may be sustainable over a longer period.

It should be noted that capability classes have not been defined on the basis of productivity. This is partly due to problems in comparing the relative value of different agricultural practices and partly due to the lack of data regarding just what is sustainable for each land class. As well, within any particular land class, there is likely to exist a range of land and, at a more detailed level of mapping, it may be possible to distinguish, for example, between good Class 4 land and poor Class 4 land.

3.3 Land Capability Subclasses

Subclass codes provide information relating to the nature of the limitation or hazard for a particular area. Twelve different limitations and hazards are identified and grouped under four main categories. Other limitations do exist but are not defined and are recorded by the main category subclass code under which they occur (ie poor nutrient status is a soils or ‘s’ limitation). Subclass codes are not normally presented on published 1:100 000 scale maps as the detailed fieldwork necessary to identify subclass map unit boundaries has not been done. However, subclass codes have been recorded for some more recent map sheets and are stored in the digital versions of the maps on the Department’s GIS. Subclass codes appear on all maps of 1:25 000 scale or larger.

The decision as to whether a subclass should be recorded at the general level (e, w, s, c) or at a more specific level is dependent on the ease with which specific limitations can be identified. Thus, only if it is clear that erosion has been caused by wind would the code *a* be used. If the cause of erosion is uncertain then the general code *e* should be used.

The assessment of the degree of risk or level of limitation imposed by many of the following criteria remains a subjective assessment on the part of the surveyor. The guidelines set out in Section 4 attempt to provide some objectivity to the classification system and further discussion and definition of these limitations is provided there.

- **e** (erosion). Unspecified erosion limitation (both current and potential).

    - **a** (aeolian). Erosion caused by the effects of strong wind. Usually affects sandy or poorly aggregated soils and can occur on slopes of very low gradient.

    - **h** (water). Erosion resulting from the affects of rainfall, either directly through raindrop impact or through secondary affects of overland flow and surface runoff (including stream bank erosion).

    - **m** (mass movement). Landslip, slumping, soil creep and other forms of mass movement.

- **w** (wetness). Unspecified wetness limitation.

  - **f** (flooding). Limitations created through the surface accumulation of water either from overbank flow from rivers and streams, run-on from upslope areas or because the area lies in a topographic depression.

  - **d** (drainage). Limitations resulting from the occurrence of a ground watertable, or restricted or impeded permeability within the soil profile, leading to the development of anaerobic conditions.

- **s** (soils). Unspecified soil limitations.

  - **g** (coarse fragments). Limitations caused by excess amounts of coarse fragments (particles of rock 2 - 600mm in size), including gravel, pebbles and stones, which impact on machinery, damage crops or limit growth. Coarse fragments may occur on the soil surface or throughout the profile.

  - **r** (rockiness). Limitations caused by boulders or outcrops of bedrock material greater than 600mm in size (cf coarse fragments, above).

  - **k** (conductivity). Land at risk from salinity (as indicated by high electrical conductivity readings of a 1:5 ratio soil:water paste).

  - **l** (limiting layer). Rooting depth or depth to some limiting layer.

- **c** (climate). Unspecified climatic limitations.

  - **p** (precipitation). Limitations resulting from insufficient or uneven distribution of rainfall.

  - **t** (temperature). Limitations caused by frost risk or by reduced length of growing season due to low temperatures.

- **x** (complex topogrpahy). Limitations caused by irregular, uneven or dissected topography which limit ease of management or divide land into parcels difficult to manage individually at the paddock scale.

In practice it may be possible to identify more than one limitation that restricts the use of an area of land. Every attempt should be made to record the dominant limitation although it may occasionally be necessary to record a maximum of two subclass codes. If more than two limitations are evident they should be grouped according to the broad limitation code under which they fall (e, w, s, or c).

At 1:100 000 scale mapping subclass codes are included on the digital map version only. These codes are intended to provide further information for potential users as to the nature of limitations that might occur within a particular map polygon. However, as individual subclass boundaries are not identified at this level of mapping several subclass codes may be needed to identify the nature of limitations in different parts of the polygon. The dominant limitation for a polygon should always be recorded. Other limitations are at the discretion of individual surveyors and are dependent on additional limitations being observed. For example, an area of land may be classified 5r on the basis of significant rock outcrop. However, one part of the polygon mapped was observed to have a drainage limitation. A subclass code of ‘d’ could then also be recorded for this polygon although the actual area limited by poor drainage would not be identified. This approach allows for the identification of several limitations without the necessity of trying to identify individual subclass boundaries.

3.4 Land Capability Units

Land capability units are the third level of capability evaluation appropriate to 1:25 000 scale mapping or larger.

Land capability units identify areas of land of similar land class and subclass and which require similar management and conservation measures, which have similar potential productivity and are able to support the same range of crops. Such areas are likely to have similar soils, geology, slope range, and climatic range. Where any individual factor changes sufficiently to alter the management requirements, use or productivity of the land, a new capability unit should be recorded.

For example, an area of sloping land on krasnozem soils on basalt on the North West Coast may be classified as Class 4, with a dominant limitation of erosion under cultivation, Class 4e. To distinguish this type of land from Class 4 land on grey podzolic soils on quartzite rock (also Class 4e), a *unit* code is used:

eg 4e1 may represent sloping land on basalt soils
4e2 may represent sloping land on quartzite soils

To extend the example, similar land on basalt soils is identified elsewhere which, while still dominated by high erosion hazard, also has an additional climatic limitation which significantly affects the range of crops that can be grown and the level of productivity compared to unit 4e1. This land would be classified as 4e3 at the land capability unit level. Similar subdivisions of all other subclasses can be made on the basis of some additional characteristic which affects management or productivity.

Land capability information presented at the unit level enables much more detailed planning to be carried out. At the same time it requires much more detailed information to be collected about the land, which is out of the scope of the Land Capability Survey at the 1:100 000 scale. The availability of detailed soil information (maps and reports) together with a range of other land resource data greatly facilitates the identification of land capability units.

It should be noted that unit level map codes are not consistent across the State but only across a survey. That is, Class 4e1 in one survey area is unlikely to be the same as 4e1 within another survey area. The unit numbers can vary depending on the number of different land capability units identified within the survey area. Unit numbers conventionally are ranked in order from best to worse within a particular capability class (i.e. land with higher productivity and fewer limitations would be given a higher land capability unit ranking than land with lower productivity and more severe limitations - thus 4e1 is better than 4e2 etc.).

3.5 Complexes

Complex map units are recorded when two land capability classes are identified in an area and occur in such a pattern that it is not possible to separate them at the scale of mapping being undertaken. For a complex map unit to be mapped each land class must occupy at least 40% of the map unit. In such cases the dominant land class is recorded first, followed by the subdominant land class - ie Class 3+2. Complex units are identified on the map with striped shading with the dominant land class having the broader stripe.

Some simple rules apply to the use and identification of complex map units. Firstly, complexes are not to be used in instances where it is difficult to decide whether an area of land falls in one class or another. A decision must be made. Secondly, there must be at least 40% of each land class within the mapped polygon. Thirdly, the size of individual units of a single class must be too small to map individually or the pattern must be too complex to separate at the scale of mapping. Fourthly, it must be feasible to manage each land class as a separate unit. For example, a complex mapped as Class 4+5 may be limited by rock outcrop. The pattern of rock outcrop should be such that it is feasible to manage the areas of Class 4 land as separate areas, even though they cannot be mapped individually. If the pattern of rock outcrop is distributed evenly across the area, making it unrealistic to crop any of the land, then the area should be classified as Class 5.

The use of complex map units should be kept to an absolute minimum wherever possible.

3.6 Permanent and Non-Permanent Limitations

Physical limitations can be classified as either permanent, or able to be removed or modified (non-permanent). Permanent limitations include slope and effects of climate. Removable or modifiable limitations include flooding, poor drainage, and the presence of stones. The feasibility of the removal of a limitation depends largely on the severity of the limitation, and also on economics.

While economics is not a factor in the assessment of land capability is it significant in considering whether or not an area of land can be improved through the removal of non permanent limitations. The improvement of land has to be considered as a) a reasonable option; b) technologically feasible and c) economically viable. Limitations that are assumed to be removable using existing technology on an individual farm basis include poor drainage, stoniness, and low fertility. Where the necessary technology for land improvement is not available, or is beyond the capability of an individual farmer and requires a catchment or community scheme, the land is classified according to the nature of its present limitations. If in time such schemes become operative, the land can be reclassified (if appropriate) into a higher land capability class.

3.7 Land Capability and Irrigation

While land capability evaluation does not consider the potential for irrigation it does recognise the importance that irrigation plays in modern farming systems in parts of the State. Where irrigation is considered normal farming practice, using on farm storage, land capability is assessed on the basis that irrigation is used. This position conflicts slightly with some reports which indicate that where land lies within a designated irrigation zone the potential for irrigation has been taken into account in the classification of that land. It is unlikely that, for the two map sheets completed taking this earlier approach, using the revised approach to irrigation potential would have resulted in a change in land capability. The rationale behind this approach is explained below.

Many areas of land have the potential to attain an improved land capability ranking through the application of irrigation. However the extent of the beneficial effects of irrigation on land capability will vary considerably, depending upon such factors as water availability and quality, soil suitability and irrigation management. These factors require individual assessment on a property basis. For the 1:100 000 scale land capability survey series such a detailed assessment of irrigation potential is obviously impossible. A number of regional irrigation schemes have been identified around the State (such as Cressy/Longford, Winnaleah and Coal River) but the irrigation scheme boundary is a somewhat arbitrary line. Consequently there are areas within the scheme that could not be economically irrigated and areas outside the boundary which could easily be provided with irrigation. To avoid this arbitrary assessment of irrigation potential land capability is assessed assuming no irrigation potential.

Thus, where crop production is limited by water availability rather than for any other reason, and the land is not within an irrigation scheme nor has ready access to irrigation water (assessed on the basis of whether or not irrigation is considered normal practice in the area) then the land capability is assessed on the basis that irrigation is unavailable. However, the potential for improvement would be identified by the use of a ‘c’ (climatic) or ‘p’ (precipitation) subclass code to indicate that the area is too dry under normal climatic conditions to support a higher capability classification.

For example, consider an area of well drained, well structured alluvial soil which lies in an area where rainfall is less than 750mm each year. Assuming that rainfall is the only limiting factor, this land would be classified Class 4p as the lack of rainfall severely limits the productivity and range of potential crops. Were irrigation water to become available, the area would be reclassified class 3, or 2 with a new limiting factor. Conversely, a similar soil which contained a high proportion of stones classified as 4g would remain class 4g even if irrigation was available, as the stoniness of the soil remains the dominant limiting factor.

While irrigation potential is not considered at the 1:100 000 mapping scale it could be included at a more detailed level of mapping. If irrigation potential is included in the evaluation of land capability a number of other issues require consideration. For example, consideration should be given to the off-site impacts of irrigation and how this might affect land capability.

Consider an area of gently inclined basalt soils overlying Permian sediments. Without irrigation these soils might be considered to be Class 3c or 3p. With irrigation they might be reasonably expected to be Class 2 land. However, percolation of irrigation water through the basalt and subsequent surface seeps at the interface between the basalt and the Permian rocks is likely to lead to slumping and landslip at the juncture of the two rock types. Also, the surplus irrigation water draining through the ground may pick up salt from the Permian rocks, contaminate and/or recharge existing groundwater and give rise to the development of saline scalds on valley flats. While the degradation might be occurring on Permian soils and valley flats the source of the degradation is the irrigation on the basalt soils. Unless appropriate and reasonable management practices can be implemented to offset this degradation the basalt country should remain Class 3.

Where available irrigation water is of poor quality the capability of the land to support irrigated agricultural production may be reduced if such water is used compared to water of good quality. For the purposes of land capability classification the use of water of currently available quality is assumed, together with the adoption of appropriate drainage and irrigation management. Such an approach may lead to the classification of land at a class below that at which it is currently being used. However, this approach recognises the long term detrimental impact poor quality water usage has on sustainable land use management. Guidelines for irrigation water quality and land capability are presented at Section 4.2.6 in this report.

3.8 Land Capability and Drainage

Similar issues relate to the evaluation of land capability in areas requiring soil drainage. Where soil drainage is required and remains a feasible and realistic option open to individual farmers then the land will be evaluated on the assumption that improvements have been carried out. Elsewhere, where drainage requirements are at a catchment or regional level and are obviously beyond the scope of individuals then land is evaluated in its current state. The land capability of areas that fall within existing Drainage Trust Schemes (eg. Dairy Plains, King Island, Flinders Island, Mowbray Swamp and Circular Head) has been assessed according to the present condition of the land.

3.9 Summary

As with most land classification systems certain assumptions are necessary. For the Tasmanian system these include:

(a) The land capability classification is an interpretive classification based on the permanent biophysical characteristics of the land.

(b) A better than average level of management is being applied to the land.

(c) Appropriate soil conservation measures have been applied.

(d) Where it is reasonable and feasible for an individual farmer to remove or modify physical limitations (eg high water tables, stoniness, low fertility) the land is assessed assuming the improvements have been made.

(e) Land capability assessments of an area can be changed by major schemes that permanently change the nature and extent of the limitations (eg drainage or flood control schemes).

(f) The land capability classification is not a productivity rating for specific crops, although the ratio of inputs to outputs may help to determine the land capability class.

(g) Land capability does not take into account economic, social or political factors and is not influenced by such factors as location, distance from markets, land ownership, or skill of individual farmers.

(h) Present and past uses of the land (or similar land elsewhere) are guides to potential, in that they can indicate the limits of the capability of the land. Present land use and vegetation cover are not always good indicators of land capability class. The system of land capability is aimed at assessing the potential sustainable productivity of land rather than current productivity.

(i) Irrigation, or the feasibility of irrigation, is not considered when evaluating land capability except where it is considered to be part of general agricultural practice or the area forms part of a recognised irrigation scheme.

(j) Assessments are based on the capability of the land for sustained agricultural productivity, since use of the land beyond its capability can lead to land degradation and permanent damage.

Photo 6. Class 6 and 7 land, Middlesex Plains

Photo 7. Fragile organosols and Button Grass are classified as Class 7.

4. GUIDELINES FOR AGRICULTURAL LAND CAPABILITY CLASSIFICATION

4.1 Introduction

The guidelines set out in the following paragraphs are just that, *Guidelines*, not hard and fast rules to be used without exception. The guidelines attempt to give some objectivity to a system hitherto considered by many to be too subjective. It is hoped that these guidelines will bring a greater degree of consistency of mapping between those involved in fieldwork and provide a more reliable and understandable product for potential users of the information.

The following paragraphs present a summary of land characteristics and qualities for each land capability class. More detailed tables identifying class limits for many of the limitations described in Section 3 are presented in Section 4.2. Due to a lack of reliable data it has not been possible to identify class limits for all those limitations discussed in section 3. Where class limits are undefined the assessment of capability must remain subjective.

Class 1 land has most or all of the following features :

- land is level or very gently inclined with slopes less than 5%,
- soils are deep, stone free, well drained and have good water holding capacity,
- surface drainage is good, surface water ponding only occurs after heavy downpours,
- soils can be maintained in good tilth and productivity,
- productivity is high for a wide range of crops,
- erosion hazard is nil to slight, and virtually no special soil conservation techniques are required,
- soils are able to withstand frequent cultivation and irrigation without serious damage under sound, average management,
- soil physical and chemical deficiencies can be corrected economically,
- extremes of climate do not seriously affect productivity, and several crops per year are possible,
- soils do not have high sand or clay contents.

Class 2 land has most or all of the following features:

- slopes may range up to 12%,

- soils are deep, contain few stones, are well drained and have good water holding capacity,
- soils have a moderate to high capacity to withstand frequent cultivation without serious damage under sound, average management,
- minor conservation measures may be required,
- soils can be maintained in good tilth and productivity,
- productivity is high to moderately high for a range of crops, and two crops are possible each productive year,
- adverse soil characteristics can be improved economically,
- the risk of flooding is low.

Class 3 land has most or all of the following features:

- slopes may range up to 18%,
- high to moderately high levels of productivity under improved pasture species and crops,
- the range of crops is generally more restricted than on Class 1 or 2 land,
- soil depth and drainage can be variable,
- conservation measures are necessary under cropping,
- soil physical features and/or slope restrict the amount of cultivation the land will tolerate between pasture phases,
- adverse climatic conditions affect range of cropping options and/or productivity levels.

In addition they may have a range of limitations from among the following:

- erosion hazard,
- soil physical handicaps (e.g. stoniness, internal drainage, soil structure, nutrient deficiencies),
- salinity hazard,
- periodic flooding.

Class 4 land has a similar set of limitations to those described above for Class 3 but the limitations are more severe so that only occasional cropping is possible. Slopes may range up to 28%. Major soil conservation practices and careful management may be necessary under cropping.

Class 5 land has many of the following features:

- slopes can range up to around 56%,
- land may be broken by gullies and surface irregularities,
- the degree of stoniness, wetness or other physical limitations prevents the cultivation of the soil for cropping,
- erosion hazard may be moderate to severe,
- nutrient deficiency, acidity or salinity may depress but not prevent plant growth.

Class 6 land is often very steep, rocky or wetlands.

The land may have either a single very severe limitation or a combination of several severe limitations. These limitations make this class of land unsuitable to be cleared for grazing and steeper areas should be left under a vegetative cover, because of the potential erosion hazard and low productivity. Conservation measures including revegetation or retention of existing vegetation cover should be adopted. Class 6 land usually remains under native pasture or other natural vegetation cover and is generally impractical to traverse by a wheeled vehicle due to steep slopes, excessive topographic variability, stoniness or wetness

Class 7 land has a similar set of limitations to those described for Class 6 but the limitations are very severe to extreme, making this land unsuitable for any form of agricultural use.

Note:

1. Slope ranges given are the maximum slopes for the most stable soils in Tasmania (ie soils on basalt). Other less stable soils will have slope ranges lower than these for each capability class.

2. The cropping rotations indicated are a guide to ensure that soil structure is maintained or improved, thereby preventing degradation of the soil resource under cropping regimes. This applies particularly to sloping land that has the potential to be cultivated and where erosion of structurally degraded soils is a particular hazard.

4.2 Guidelines for Assessing Soil, Land and Climate Characteristics

The following sections set out to provide guidelines for assessing land capability against a number of soil, land and climate characteristics, limitations and hazards. Wherever possible, attempts have been made to provide quantified guidelines rather than entirely subjective notes. The class limits have been determined using information from alternative systems from around the country and modified following local experience and discussions with farmers and land managers in the north of the State.

It is not the intention of these guidelines to enable anyone to evaluate land capability. By its very nature the land capability classification system will always retain a certain amount of subjectivity which requires years of experience to be able to judge. It is not possible to show within this document how interactions between individual limitations might affect the overall capability classification. Salinity and waterlogging, for example, where they occur together, might result in a down grading of classification over areas where only one occurs. The significance of interacts between limitations is left to the expertise of individual surveyors to determine.

Further modification of these guidelines may, in time, become necessary as our understanding of the soils and climate, and the environmental processes that go on around us, grows and develops, and as we gain additional experience from other parts of the State. Meanwhile, this information is presented as an interim measure to ensure consistency between surveyors and information to potential users. Constructive criticism of class limits is encouraged and I welcome hearing the views of practitioners within the Department, agriculture and associated industries, and of private consultants.

4.2.1 Climatic Limitations (c)

Climate is one of the major permanent limitations that restrict the agricultural versatility of the land around Tasmania. While the climate generally is considered to be temperate maritime but the extensive mountain ranges, rising to over 1600m, that cover much of the State severely restrict those areas that can be considered suitable for agriculture to more coastal districts (particularly for cropping).

For land capability classification at the 1:100 000 scale, only generalised statements and boundaries relating to climate can be made. At more detailed scales of mapping, climatic boundaries (as they affect land capability) can be more clearly defined. However, other than rainfall information, some broadscale wind and temperature data and limited evapotranspiration information, there is limited information that is available which is appropriate to anything other than small scale land capability mapping. Even at 1:100 000 scale, assessment of climate is made on a map sheet by map sheet basis. Considerable emphasis is placed on the experience of farmers and surrogate measures, such as elevation for temperature, are often used. At more detailed levels of mapping it is possible to take into account the more localised effects of aspect, elevation, topography and seasonallity.

Some of the major climatic constraints to agricultural use of land in Tasmania are:

- Uneven rainfall distribution (associated with topography, altitude and time of year)
- Unreliable rainfall in certain areas
- Increasing frost hazard and shorter growing seasons in areas away from the coastal maritime influence
- Effect of wind in exposed areas.

Providing guidelines for the affect of climate on land capability class is not straight forward. Latitude, longitude, distance from sea and altitude, together with local topographic effects all exert some control on how climate can influence land capability.

In other States around Australia and overseas a range of factors have been used in attempts to determine climatic classes. In the UK three climatic groups have been identified and defined using average rainfall, average potential evapotranspiration and long term average of mean daily maximum temperature (Bibby and Mackney 1977). In

1988 revised agricultural land classification (ALC) guidelines defined capability classes according to average annual rainfall (AAR) and accumulated temperature (ATO) during the major part of the growing season (ATO is the excess of daily air temps. above a threshold of $O^{0}C$). Consideration is also given to the assessment of droughtiness. For the ALC system this is calculated using crop-adjusted available water capacity (AP) for the soil profile and moisture deficit (MD) data to estimate a moisture balance (MB) for the reference crops, winter wheat and maincrop potatoes A brief summary of this technique is presented in Appendix 1.

Temperature (t)

Temperature can impact on the ability of land to support a range of agricultural practices in a variety of ways. It can affect the moisture balance, discussed above, by controlling potential evapotranspiration rates and crop moisture demands. Low temperatures and frosts impact on the length of growing season which inturn restricts the range of crops that can be grown in an area. Lower temperatures and high risk of frost also limit the production of crops that require warmer temperatures or are frost sensitive.

As there is no growing season data available for Tasmania, and temperature information is limited to a few recording stations, it has been necessary to use surrogate information. After consultation with growers, land managers and consultants, generally in the north of the State elevation was identified as a suitable surrogate. The class intervals used have been identified following discussions with farmers, industry personnel and colleagues within DPIF. They are, however, untested and tentative and do not take into account local topographic affects caused by varying slopes, landforms or aspects. Also, no consideration is given to varying latitude or longitude or proximity to the coast, except where clear anecdotal evidence is supplied by farmers or industry.

Land Class	Altitude Range	Potential Activities
1	<180m	Full range of crops and livestock
2	180-260m	Full range but higher risk for frost sensitive crops
3	260-380m	Not sweet-corn or other frost sensitive crops
4	380-500m	Very restricted range of crop, eg cereals, seed potatoes, dairy
5	500-600m	Dairy, improved pasture, occasional fodder crops
6	600-900m*	Low intensity grazing, often on native pastures only
7	>900m	Nil

* Limits for Class 6 land are very tentative.

Rainfall (p)

Tasmania experiences a winter dominated rainfall pattern and in many areas the application of irrigation water during the drier summer season is essential to the economic productivity of the land. However, the Tasmanian Land Capability Classification System does not generally take into account the possibilities for irrigation except where land falls within a designated irrigation scheme, or irrigation of crops is standard practice amongst most farmers. The rainfall classes defined below are tentative and are for rain fed agricultural practices only. Interactions between rainfall and soil available water holding capacity (SAWHC) have not been considered, nor has the interaction between rainfall, soil texture and topographic gradient (erosion risk, see later section). Rainfall classes have been identified from experience and from discussions with farmers and land managers. As will be seen from the table below, some capability classes have an upper and lower rainfall range appropriate to that class. For example, average annual rainfall in range 700-850mm or 1500-1700mm is considered limiting at Class 3 level.

Land Class	Average Annual Rainfall (mm)*	
1	850-1300	
2	1300-1500	
3	700-850;	1500-1700
4	550 -700;	1700-1850
5	<550;	1850-2000
6	2000-2500	
7	>2500	

* Does not take account of rainfall seasonallity.

4.2.2 Soil Limitations (s)

A whole range of soil limitations exist which affect the ability of land to support agricultural enterprises on a sustainable basis. These guidelines discuss those major limitations which have been identified in Tasmania and which are commonly used in the classification of agricultural land.

Soil Depth (l)

For the purpose of these guidelines, soil depth is considered to be the depth of soil material, including both A and B horizons, overlying some limiting layer which severely impedes or restricts the development of plant roots. This limiting layer may be bed rock, ground water, iron pan or other cemented layer, heavy, massive subsoils (including some texture contrast B horizons) or some other similar type of barrier. Limiting layers restrict the volume of soil available from which plant roots can extract air, moisture and nutrients essential for the healthy development of the plant. While different plants clearly have different requirements in terms of soil depth, shallower soils invariably limit the range of crops that can be grown.

Land Class	Soil Depth (cm)
1	>90
2	65-90
3	50-65
4	35-50
5	20-35
6	10-20
7	<10

Salinity (k)

Salinity as a limitation to sustainable agriculture, is not widespread in Tasmania, and where it has been identified it is often of limited extent. Issues relating to the occurrence of salinity have been identified in the north Midlands and, more recently, in the Coal River Valley where it is beginning to impact on horticultural productivity where the land is being irrigated.

In Tasmania, salinity is usually associated with saline seeps and scalds and, in some areas, with the use of poor quality irrigation water. Soil salinity affects plant growth and productivity and the impact of salinity is heightened if the land is also subject to impeded soil drainage. Different crops have different levels of sensitivity to salt and increasing levels of salt in the ground will consequently limit the range of crops that can be grown to those that are increasingly tolerant.

For the purposes of land capability classification, the severity of the salinity hazard is assessed partly from the electrical conductivity (EC) of a 1:5 soil:water mixture and partly from the level of risk of salinity development as indicated by position in the landscape, ground water and irrigation water quality etc. While the measurement of current salinity levels is quantitative, the risk of future salinisation remains a somewhat subjective assessment. The units of measurement for salinity are decisiemens per metre (dS/m) although various other units have been used (conversion table for more commonly used units is presented in the Appendix 2). Care needs to be taken with the interpretation of salinity results to ensure that the units are clearly understood. Also, soil conductivity can be determined on a saturation extract. This is more difficult to achieve but is considered to give better results as it considers the relationship between plant, soil texture and salinity. There is no precise conversion from EC to ECe although the following conversions are in general usage in Tasmania.

Sands	ECe=ECx14
Sandy loams to clay loams	ECe=ECx9.5
Clays	ECe=ECx6.5

Class limits for salinity are presented using saturated extract conductivities and all EC measurements will therefore require converting.

Land Class	ECe (dS/m)	Crop indicators
1 and 2	0-2	Only sensitive crops affected.
3	2-4	Wide range of horticultural crops affected and productivity reduced.
4	4-8	Most crops affected; halophytic species evident. Occasional patches of bare ground.
5	8-16	Common halophytic species evident; pasture productivity reduced. Patches of bare ground common
6	16-32	Land dominated by halophytic plants but will support productive species such as tall wheat grass and puccinellia.
7	>32	Bare salt and salt pans.

For the purposes of land capability classification in Tasmania, consideration is given to the maximum ECe in the top 50cm of soil. Consideration is also given to the *risk* of salinity development in this zone. For example, current ECe levels might be only 3dS/m (Class 3 land). However, due to the position in the landscape of the area of interest, there is considerable risk of a rising saline groundwater table if the land is cropped on a regular basis. It is therefore considered that there is a high risk of ECe levels rising above 4dS/m in the top 50cm of soil and the land is evaluated as Class 4.

Coarse Fragments (g) and Rock Outcrop (r)

The assessment of the degree of limitation caused by the presence of coarse rock fragments and rock outcrop is a topic that has created much discussion. Land capability is limited not only by the abundance of rocks and stones but also by their size and distribution throughout the soil profile. Fewer large rocks can be more limiting than more smaller rocks. Also, the distribution of rocks and stones is also important, both two dimensionally across the land surface and three dimensionally within the soil profile. Stones scattered evenly across an area are likely to be more limiting than the same percentage of stones occurring in isolated pockets and surrounded by relatively stone free land. It is difficult to provide reliable and useable guidelines relating to the distribution of coarse fragments and the impact on land capability remains the subjective judgement of individual surveyors.

The terms rock, stones, and boulders have very specific meanings for soil surveyors, based on the definitions that occur in the *Australian Soil and Land Survey Handbook* (McDonald *et al*, 1990). These terms have been generally misused in everyday discussion and even within this report the term *stones* has often been used to mean all coarse fragment size groups. For land capability purposes the *g* limitation is intended for use where coarse fragments are of a size from 2mm to 600mm. This range includes gravel, cobbles and stones. The use of the *r* limitation is intended for coarse fragments greater than 600mm in size (boulders) and bedrock outcrop.

Some general comments may be of value. There has been considerable discussion as to whether the figures in the table below represent surface stone or profile stone content as each can affect land capability in different ways and to different degrees. Surface stone can impact on cultivation, seedling emergence, harvesting and trafficability while profile stone content tends to affect cultivation, root development, nutrient and water availability. Broadly speaking, a given percentage coarse fragments is likely to have a greater impact on the surface than the same content distributed throughout a soil profile. As a general rule, the figures presented below should be considered to be profile stone content. If similar amounts of stone are found on the surface then land capability may be reduced by a half to a full capability class.

In considering the amount of surface coarse fragments attention should be given to the way such fragments are distributed. Is it fairly even over the area of the unit concerned or are stones, cobbles and rock outcrops concentrated in reefs allowing cultivation around them? What is the proportion and size of these reefs in relation to the overall area concerned? The impact of these issues on land capability has to be determined by individual surveyors using experience and common sense.

The use of the g or r limitation in land capability is intended to reflect the physical limitation on crop production imposed by coarse fragments and rock outcrop. Impacts on erosion and plant available water should be addressed under the appropriate alternative limitation.

Abundance (%)	**Coarse Fragment size**			
	2-60mm (gravel)	60-200mm (cobbles)	200-600mm (stones)	>600mm (boulders and rock outcrop)
<2	1	1	2	2
2-10	2	2	2	3
10-20	2	3	3	4
20-35	3	4	4	5
35-50	4	5	5	5
50-70	5	5	6	6
70-90	6	6	6	6
>90	7	7	7	7

Land capability classes for various coarse fragments sizes and abundance.

An alternative, and more subjective, evaluation of coarse fragments is presented in the following table:

Capability Class	Definition
1	Nil or very few coarse fragments on the surface or within the profile.
2	Sufficient coarse fragments to interfere with tillage operations but for most land uses stone picking is not necessary.
3	Sufficient coarse fragments to necessitate picking, and limits range of potential crops.
4	Coarse fragments severely impact on cultivation and harvesting and severely limit the range of potential crops.
5	Too many coarse fragments to consider picking but pasture improvement possible using conventional machinery.
6	Too many coarse fragments for improvement with conventional machinery; pasture improvement only possible through aerial application.
7	Rock pavements, scree slopes and cliff faces.

4.2.3 Wetness limitations (w)

Two types of wetness limitation are defined although it is acknowledged that the identification of the nature of soil wetness is not always clear. Wetness resulting from restricted internal soil drainage and from flooding are defined below, but issues relating to run-on from off-site areas, inundation resulting from heavy rain or run-on, or low surface infiltration are not discussed and remain subjective.

Soil Drainage (d)

Soil drainage defines the internal drainage status of the soil which has a significant impact on workability, trafficability and poaching risk as well as crop physiological effects. Soil drainage is a complex soil property defined according to a range of soil and climatic characteristics including rainfall (amount and distribution), soil permeability (itself dependent on texture and structure) and depth to ground water. Each of these factors can influence the degree to which a soil becomes waterlogged. Waterlogging causes a deficiency of oxygen within the crop rooting zone which retards root development and consequently affects crop health and productivity.

Land Class	Drainage Status	Mottle Depth (cm)	Mottle Severity	Approx. Permeability	Comment
1	Well	>90	Few/feint	250-500mm/day	
2	Well	>90	Few/feint	250-500mm/day	
	Rapidly	Nil	Nil	>500mm/day	Sandy soils
3	Moderately well	50-90	Few/distinct	50-250mm/day	
4	Imperfectly	20-50	Common/ feint	25-50mm/day	May have few rusty root mottles to surface; possible seasonal water table below 50cm
5	Poorly	10-20	Common/ distinct	5-25mm/day	May be rusty root mottles from surface; may have shallow seasonal groundwater table
6	Very Poorly	Surface	Many/ prominent	5mm/day	May be saturated for long periods or have shallow groundwater table
7	Swamp		Many/ gleyed		Permanently Saturated

In Tasmania, the assessment of soil drainage remains a somewhat subjective procedure and some experience is necessary for consistent and reliable results. Drainage status is defined according to the depth and degree of mottling and care needs to be taken to ensure that the mottles are truly redox mottles (not a weathering product of rocks and stones within the profile, or mixing of material from adjacent horizons) and that they are a contemporary feature, not relict. In some soils, particularly ferrosols and vertosols (krasnozems and Canola soils) identification of mottles may be difficult.

The following guidelines for soil drainage may also be useful and are adapted from McDonald *et al*.

Drainage Status	**Definition**	**Capability Class**
Rapidly drained	Soils are usually coarse-textured; no horizon is normally wet for more than several hours after water addition.	1 or 2
Well drained	Soils often of medium texture; some horizons may remain wet for several days after water addition.	1 or 2
Moderately well drained	Soils are usually medium to fine textured: some horizons may remain wet for as long as a week after water addition.	3
Imperfectly drained	Soil have a wide range of texture: some horizons may remain wet for periods of several months.	4
Poorly drained	Soil have a wide range of texture: all horizons may remain wet for periods of several weeks.	5
Very poorly drained	Soil have a wide range of texture: strong gleying and surface accumulation of organic matter are typical.	6

Flood Risk (f)

The assessment of flood risk is very subjective and is often based on local knowledge although flood risk maps and detailed information do exist for some major rivers. The significance of flooding for land capability assessment depends on a range of factors including flood depth and duration. Shallow floods are frequently less damaging than deep floods; similarly floods lasting more than a day or so are more significant than those that occur only for a few hours. Timing of a flood event is also important as different crops are more or less sensitive to inundation depending on their stage of development. The following generalisations are made for the Tasmanian system:

Land Class	**Flood Risk**
1 and 2	Negligible
3	Winter floods of 1-2 days; rare summer floods of <1 day
4	Severe flooding 1 year in 5 for periods of >2 days; Occasional summer flooding.
5	Severe flooding 1 year in 3; common summer flooding.
6	Damaging floods in most years; significant risk of stock losses.

4.2.4 Erosion Hazard (e)

Erosion of the land surface is a natural geomorphic process which operates under varying soil, geomorphic and climatic conditions. In the agricultural context we are concerned mainly with accelerated erosion, or that aspect of erosion resulting directly from the activities of man through various land use and management activities. Three elements of erosion are considered for land capability purposes; erosion by wind, erosion by water and mass movement. The first two of these, erosion by wind and water, are widespread throughout the agricultural areas of Tasmania, while mass movement, mainly in the form of landslip, is locally important.

Erosion is considered to be a limitation when it leads to losses in productivity, interferes with cropping flexibility or requires additional costs or management to prevent deterioration. Susceptibility to erosion is dependant on a variety of factors including rainfall amount and intensity, soil texture and structure stability and slope steepness. The tables below provide only a rough guide and consideration should be given to any local effects or knowledge. The system uses soil texture, structure grade, topsoil depth and dispersibility related to gradient to determine a susceptibility rating for erosion by water.

Water Erosion (h)

Erosion by water can take many forms from simple rain drop impact to sheet, rill and gully erosion. Even landslips may be triggered by a build-up of hydraulic pressure within the soil mantle.

For land capability, it is the risk of sheet, rill and gully erosion with which we are most concerned. The following tables assess the erosion hazard on the basis of soil texture, structure and dispersion characteristics as influenced by topographic gradient. It is acknowledged that rainfall amount and intensity also contribute to erosion risk but these climatic effects are not specifically considered in this evaluation.

To assess erosion risk by using the following tables it is necessary to know soil texture, structure and dispersion characteristics. Erosion risk can then be assessed against a range of slope classes. The first table is used to assess the erodibility of the soil and the second table takes this result and uses it to determine the level of erosion risk with respect to topographic gradient. The level of erosion risk determines capability class.

To use the tables first identify the appropriate texture, structure and dispersion categories for the soil of interest. This provides an indicator of the *erodibility* of that soil. Thus structured sandy clay loams with no dispersion have a low erodibility.

From the second table, identify the appropriate slope category and erodibility class to determine the erosion risk for that soil. Continuing with the above example, a soil with low erodibility on a 12-18% slope has a moderate erosion risk. From the third table, land with a moderate erosion risk comes out as Class 4 land.

Key to estimation of soil erodibility

Texture	Structure	Dispersion		
		None	Slight	Dispersive
Sands	Loose	V high	V high	Extreme
Loamy sands		High	High	V High
Sandy loams	Apedal	High	High	V high
	Weak	High	High	V High
	Moderate	Moderate	Moderate	High
Loams,	Apedal	Moderate	High	V High
Silt Loams,	Structured	low	Moderate	High
Sandy clay loams				
Clay Loams,	Apedal	low	Moderate	High
Light Clays	Structured	V low	low	Moderate
Medium to heavy clays	Apedal	Low	Moderate	Moderate
	Structured	Low	Low	Moderate

Key to estimation of soil erosion risk

Slope	Erodibility					
(%)	V Low	Low	Moderate	High	V High	Extreme
0-5	Nil	V low	Low	Moderate	Moderate	Moderate
5-12	V low	V low	Low	Moderate	Moderate	High
12-18	Low	Moderate	Moderate	High	Very High	Very High
18-28	Moderate	High	High	Very High	Very High	Very High
28-56	High	High	Very High	Very High	Very High	Extreme
>56	High	High	V High	V High	Extreme	Extreme

Erosion Risk	Land Class
Nil	1
Very Low	2
Low	3
Moderate	4
High	5
V High	6
Extreme	7

Wind Erosion (a)

The susceptibility of soil to wind erosion is partly dependent on the size and degree of aggregation of individual soil particles. The risks of wind erosion can be reduced by maintaining a good vegetative ground cover to protect the soil surface and by minimising tillage operations which reduce soil structural aggregates to individual soil particles.

Only general guidelines are available for the assessment of wind erosion risk in Tasmania:

Class 1 and 2: Well structured or massive loams, clay loams and clays generally have low erodibility and low erosion risk;

Class 3: Structured sandy loams and sandy clay loams with good organic matter content.

Class 4: Loose sandy loams, and loamy sands with some structure and reasonable organic matter content;

Class 5: Loose loamy sands

Class 6 and 7: Loose sands with little or no organic matter (beach dunes).

Mass Movement (m)

Mass movement, particularly landslip, is of local significance in Tasmania. Landslips frequently occur where soil developed on reasonably permeable materials overlie less permeable materials. Rainwater percolating through the more permeable upper layers of soil and rock is held up at the interface of the two rock types and lubricates the intervening surface. If the overlying material is well fractured, or becomes saturated, slippage can easily occur along this surface. The risk of landslip for land capability is assessed from evidence of previous landslips within the area and on similar rock types. Care needs to be given in assessing whether existing landslip evidence is contemporary or relict, and what the affect of further vegetation clearance or irrigation (if relevant) may have on sub-surface hydraulic characteristics.

Generally speaking, capability classes 1-3 are not at risk from land slip. Class 4 land has some risk but this is negligible if the land remains under pasture or is cropped only occasionally. Class 5 land shows occasional active slips and grazing needs to be controlled to maintain a good vegetative ground cover. Class 6 land has common active landslips and has very limited potential for agricultural activities. If this land occurs under a natural vegetation cover that cover should be maintained and no land clearing should be undertaken.

4.2.5 Complex Topography (x)

Experience over the last few years has suggested that occasionally there is a need for a topographic limitation which reflects the general unevenness or irregularity of the terrain, and where it is this unevenness which is the major limiting factor to the agricultural use of the land rather than some alternative factor (eg drainage, erosion risk). Such uneven ground may be the result of strong gilgai microrelief or hummocky landscape resulting from numerous land slips.

The use of this limitation appears to be confined predominantly to the separation of land classes 3, 4 and 5. The limiting criteria in each case is the ease of access and trafficability of an area. Irregular and uneven ground not only makes vehicular access uncomfortable but affects the efficiency of cultivation, seeding and harvesting machinery. Classification depends on the degree of unevenness:

Class 3 land: minor impediment caused by irregular terrain

Class 4 land: significant impediment such that machinery is constantly digging over-deep or lifting too high above the ground.

Class 5: Generally impractical to cultivate except for occasional pasture improvement.

Summary Table

The following table presents an easy to use summary of the tables that have been presented above. It is not intended as an exhaustive list of soil and land characteristics used to assess land capability but simply a guide to the assessment of some of the more common properties used in Tasmania.

Land Class	Gravel % (22-60mm)	Cobble % (60-200mm)	Stone % (200-600mm)	Boulders and rock outcrop %	Rooting Depth (cm)	Soil Drainage Status	Flood/ Innundation Risk	Erosion Risk	Elevation* (m.a.s.l.)	Rainfall (mm p.a.)	Salinity (ECe dS/m)
1	<2	<2	N/A	N/A	>90	Well	Negligible	Nil	<180	850-1300	0-2
2	2-20	2-10	<10	<2	65-90	Well/ rapidly	Negligible	Very low	180-260	1300-1500	0-2
3	20-35	10-20	10-20	2-10	50-65	Mod Well	Occasional, short winter, rare summer	Low	260-380	700-850; 1500-1700	2-4
4	35-50	20-35	20-35	10-20	35-50	Imperfectly	Occasional severe winter, occasional summer	Moderate	380-500	550 -700; 1700-1850	4-8
5	50-70	35-70	35-50	20-50	20-35	Poorly	Severe winter, common summer	High	500-600	<550; 1850-2000	8-16
6	70-90	70-90	50-90	50-90	10-20	Very Poorly	Damaging floods in most years	Very high	600-900*	2000-2500	16-32
7	>90	>90	>90	>90	<10	Swamp	Swamp	Extreme	>900	>2500	>32

* Limits for Class 6 land are very tentative.

4.2.6 Irrigation Water Quality and Land Capability

The fact that some land can have an improved land capability under irrigation rather than rainfed agriculture has been discussed earlier in this report (page 19). However, the issue of irrigation water quality has not been adequately addressed. In areas where this issue has previously been identified, such as the Cressy/Longford irrigation scheme, the assumption was made that all irrigation water would be of good quality. At the time this was a reasonably accurate, if simplistic, assumption.

However, since commencing fieldwork within the Derwent map sheet it has become necessary to review the validity of this assumption. Within the Coal River irrigation scheme water of category 2 and 3 quality is currently being used for irrigation of some horticultural crops. In some situations crop losses have been experienced, while in others, little affect has been noticed and improved crop yields have been achieved. It would not be unreasonable to continue to classify this land on the assumption that only good quality irrigation water is used; this evaluation indicating the absolute potential of the land to support agricultural activities. This would not be a true reflection of reality, however, and imposes a further assumption that good quality water can be made available.

Within the Coal River Valley, the use of good quality irrigation water by farmers is currently not uniformly achievable and the improvement of existing water quality standards is considered by many to be beyond the control of individual farmers. It is proposed therefore that, where land capability is limited solely by lack of rainfall and where the land lies within a designated irrigation scheme or irrigation is considered common agricultural practice, land capability is assessed on the basis of currently available irrigation water quality following the guidelines outlined below.

The extent of degradation imposed by poor quality irrigation water depends to some extent on the nature of the irrigated soils, the internal drainage of those soils and irrigation management. The following guidelines assume that suitable management practices are applied.

In using the following guidelines it is important to distinguish between *water quality categories* and *land capability classes*. Firstly, we determine the quality of the irrigation water.

Water Quality Category	EC (μS/cm)	Total dissolved solids (mg/l)	Comment
Class 1	0 - 280	0 - 175	Low salinity water which may be applied to most soils using any method. Some leaching required but salt buildup is unlikely.
Class 2	280 - 800	175 - 500	Medium salinity water which may be applied to well or moderately well drained soils on all but the most salt sensitive crops. Moderate leaching is required
Class 3	800 - 2300	500 - 1500	High salinity water which may be applied only to well drained soils and requires salinity control. May retard growth of salt sensitive crops
Class 4	> 2300	> 1500	Very high salinity water which may only applied to well drained soils if absolutely necessary. Considerable leaching and salt sensitive crops are required.

General guidelines for irrigation water salinity (after ANZECC, 1992).

Secondly, we consider the drainage status of the soils to be irrigated. In the absence of any other limitation, the affect of irrigation on the land capability classification of soils with differing drainage characteristics are given below.

Soil Drainage Status	Water Quality Category 1	2	3	4
Well drained	Capability Class 1	Capability Class 3	Capability Class 3	Class 4
Moderately well drained	Capability Class 3	Capability Class 3	Class 4	unsuitable
Imperfectly drained	Class 4	Class 4	unsuitable	unsuitable
Poorly drained	Class 5	unsuitable	unsuitable	unsuitable

General guidelines for land capability assessment of drainage limitations and irrigation.

4.3 Stylised Land Capability/Landform Relationships for Different Rock Types

The following pages represent stylised relationships between land capability, landform and various rock types. They are not intended to cover all eventualities across the State but are simply a guide as to how information on preceding pages can be applied.

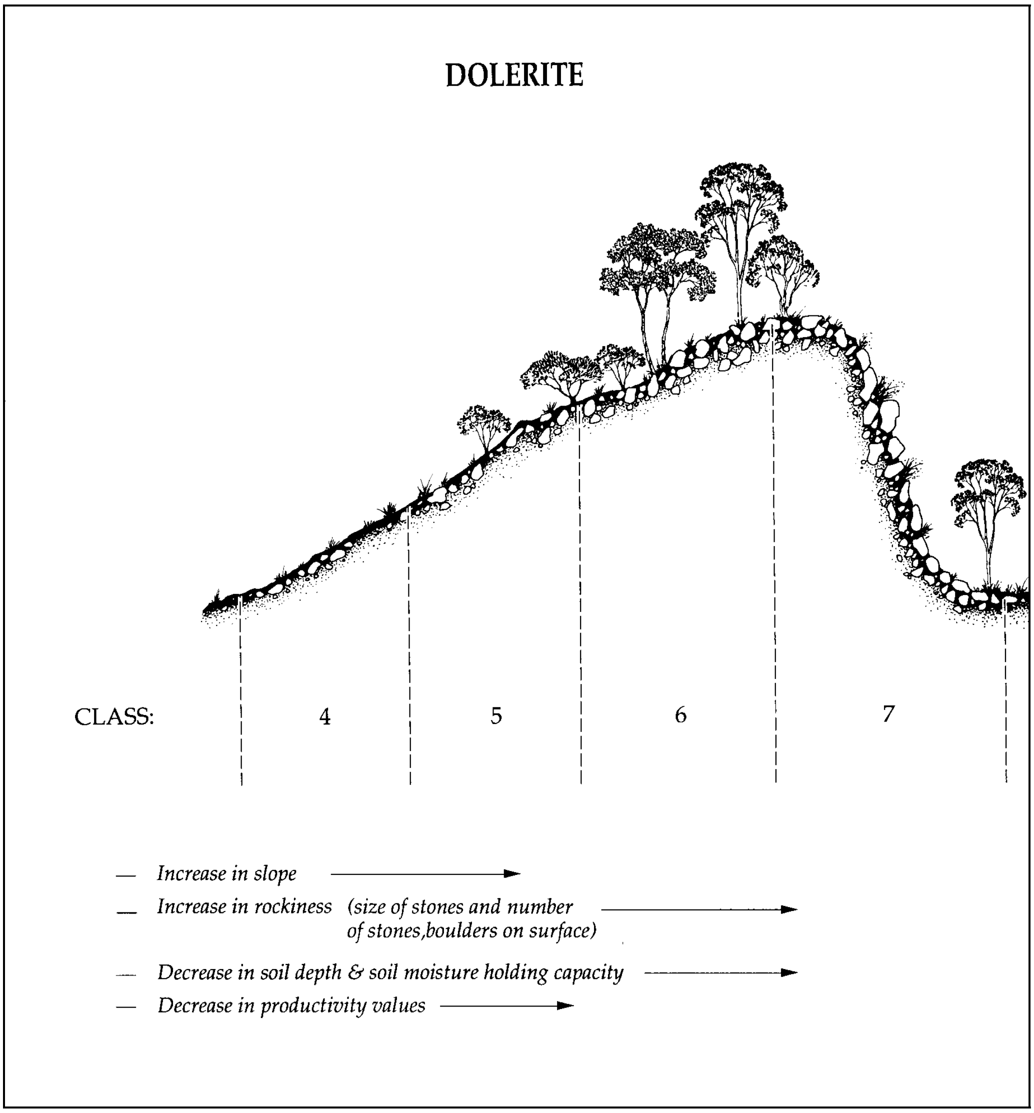


Figure 6. Diagrammatic representation of land capability classes mapped on dolerite

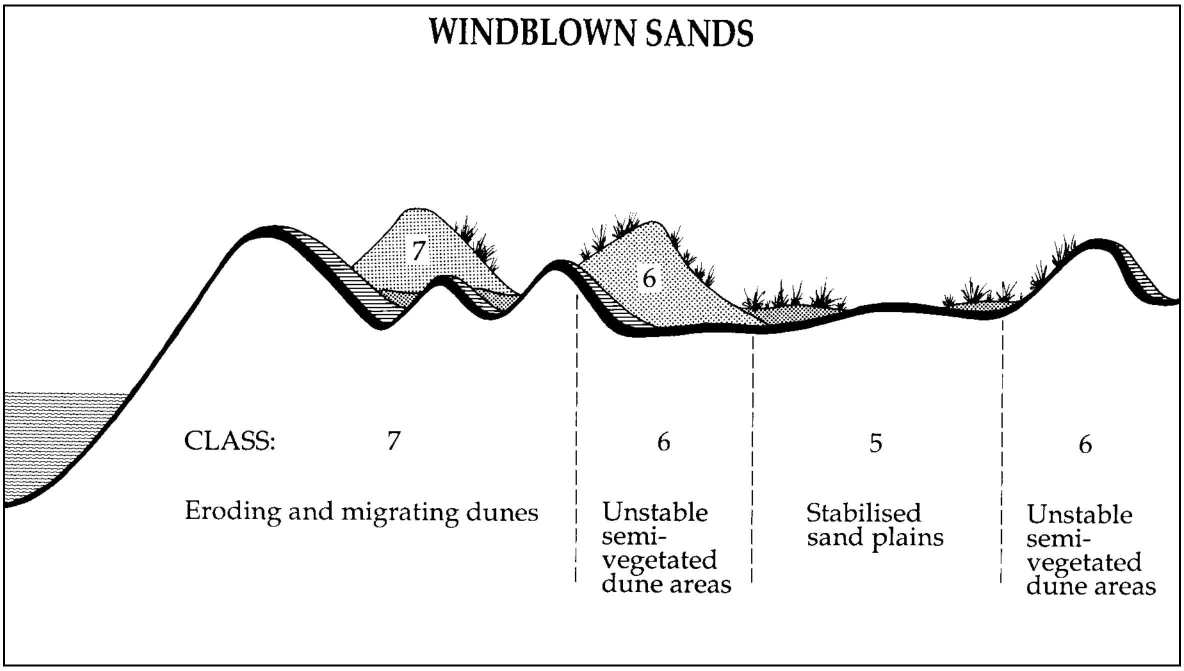


Figure 7. Relationships between land capability classes mapped on windblown sand

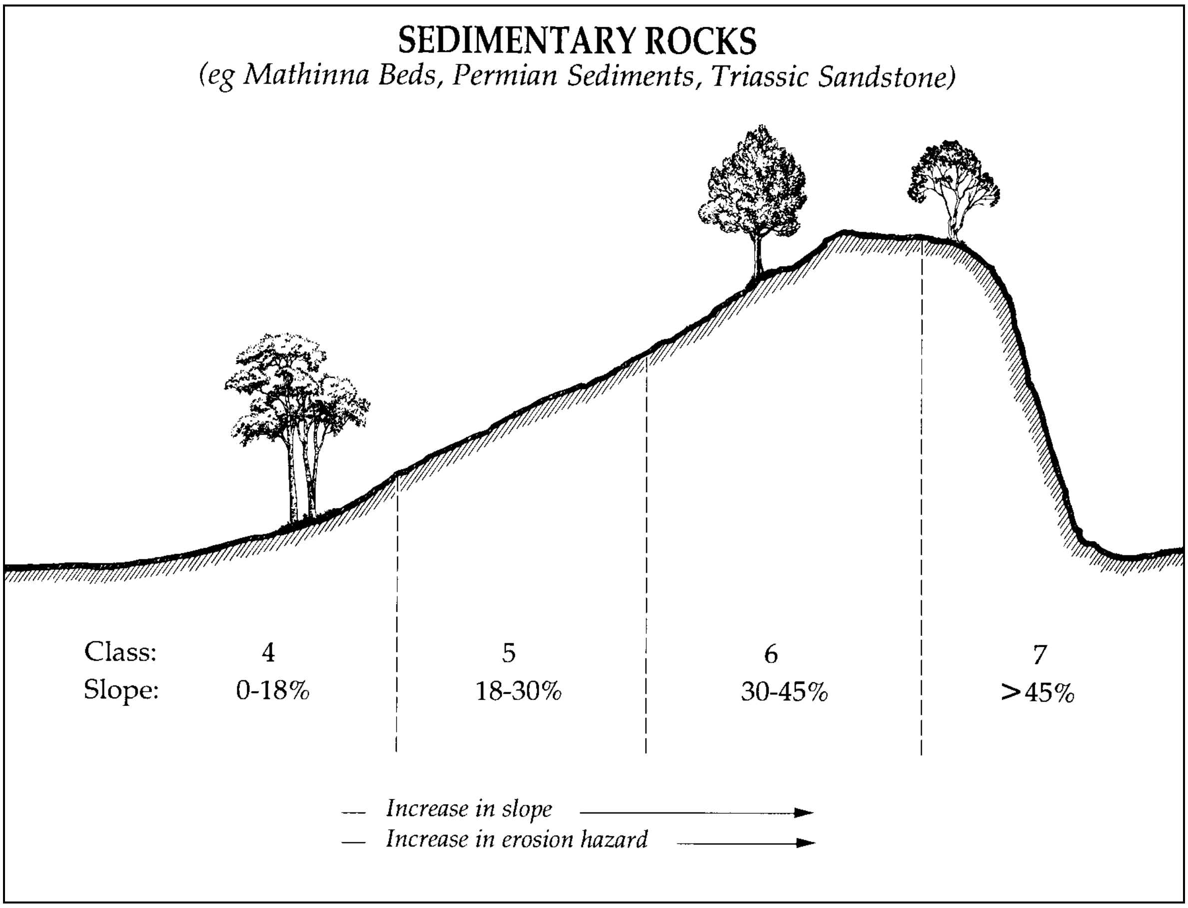
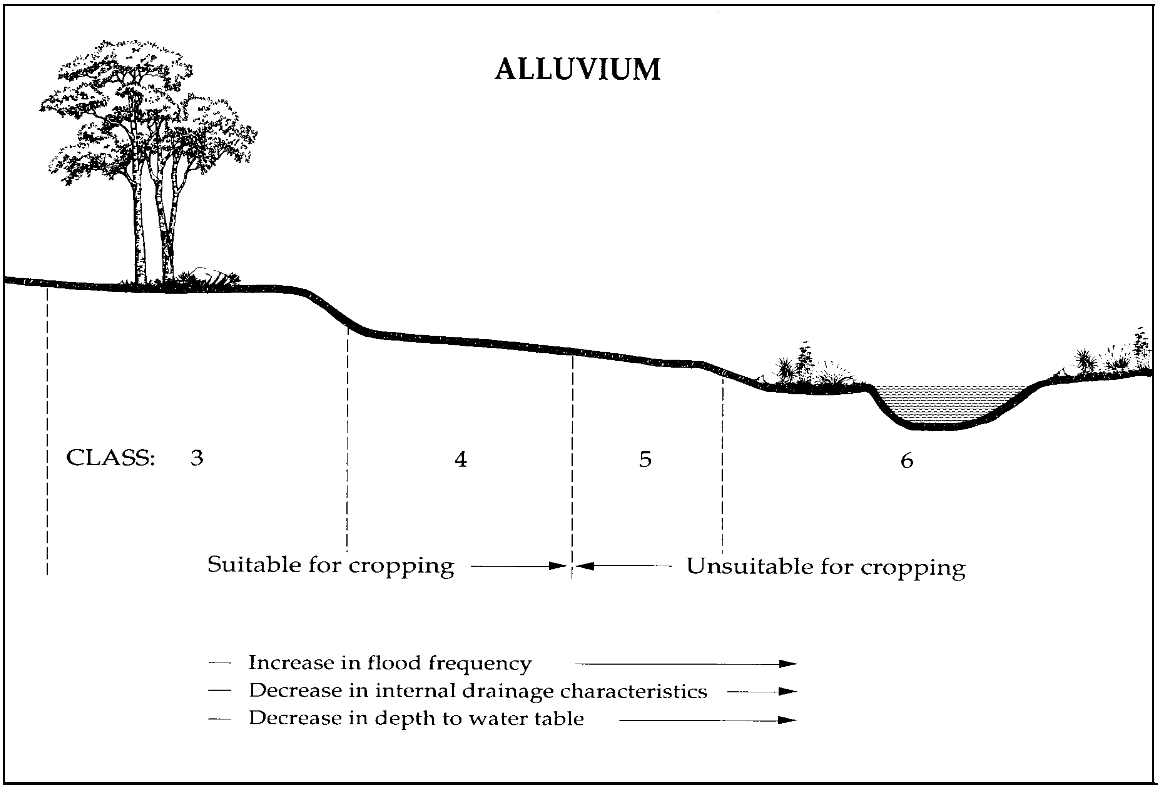
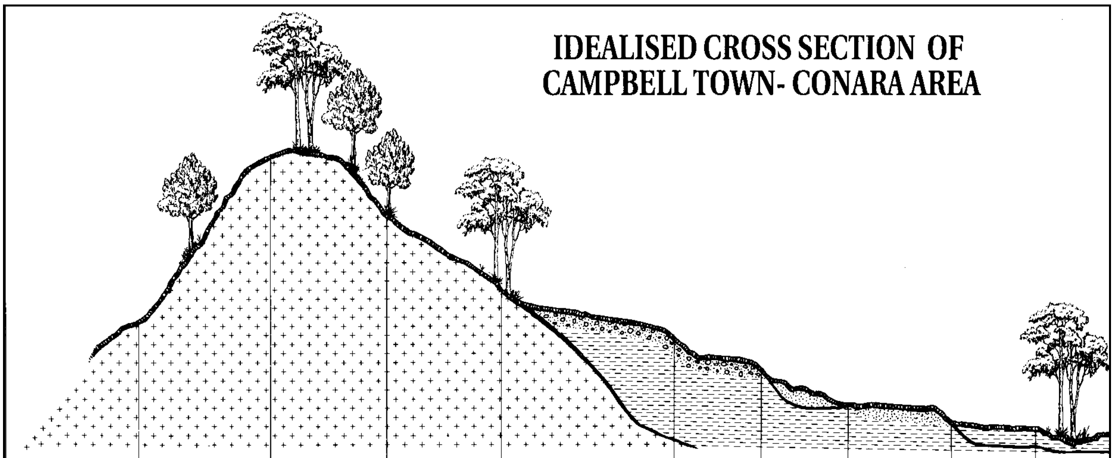


Figure 8. Relationship between land capability classes on sedimentary rock types



Class	3	4	5	6
Flooding Frequency	Not flooded	Occasionally flooded	Often flooded	Frequently flooded
Water Table	Fluctuating	Fluctuating; near surface in winter	Surface water in winter	Surface water much of year
Internal Drainage	Well to moderately drained	Moderately well to poorly drained	Poorly to very poorly drained	Very poorly drained

Figure 9. Diagrammatic representation of land capability classes on recent alluvium



Land capability classes	**6**	**5**	**4**	**4,5**	**4**	**4**	**4**	**4**	**6,5**
Geology	dolerite	dolerite	dolerite gravels	sands on clay and ironstone gravels	sandy gravel on clay	windblown sand	sands on clay	silts, clays	river bed gravels
Soil association	Deddington	Eastfield	Eastfield	Woodstock	Brickendon	Panshanger	Brumby	Canola	
Topography	steep hills > 40%	rolling to moderately steep hills < 40%	rolling slopes	flat to undulating terraces	flat to undulating terraces	rolling sand dunes	flat to undulating terraces	flat terraces	flat areas near river beds
Limitations	numerous rock outcrops, shallow soils	rock outcrops	stony soils	low fertility, acid soils susceptible to drought, some areas with much ironstone gravel.	gravelly, more freely drained than Brumby soils.	loose, freely drained soils, subject to wind erosion.	dry in summer, wet in winter	heavy clay soils prone to flooding. fertile soils	frequent flooding, some areas very stony

Figure 10. Stylised cross-section showing geology, soil, landform and land capability relationships from the North Midlands

5. HOW TO USE LAND CAPABILITY MAPS AND REPORTS

As discussed previously, the land capability classification system is applicable to mapping at almost any scale. Within Tasmania the focus is on 1:100 000 scale mapping with some limited 1:25 000 information. It is important that the land capability map be used in conjunction with the accompanying report. The potential uses for land capability information are dependent on the level of classification provided and the scale of mapping. Only capability class information is presented on 1:100 000 scale maps, class and subclass information would be available on 1:50 000 scale publications and class, subclass and unit information would normally be available on maps of 1:25 000 scale or larger.

5.1 Limitations of Scale

Special attention needs to be paid to the "limitations" imposed by the scale of mapping and the following comments relate to the 1:100 000 scale mapping currently being undertaken by the Department.

It is important that maps are used at the scale at which they are published (1:100 000). **The map should not be reproduced at a larger scale (eg. 1:25 000)**. The land capability boundaries found on the maps are reliable only at the published scale of 1:100 000. Errors in interpretation will occur if maps are enlarged or if the information is used at the farm or detailed planning level. If more detail is required, the area of interest should be remapped at a scale more suitable for the end use, rather than enlarging the map.

5.1.1 Minimum map unit size and purity

The accuracy of the land capability class boundaries depends on a number of factors including the complexity of the terrain, soils and geology. Where topography, or other visible features, change abruptly the class boundaries may be well defined. Alternatively, changes may be gradual and more difficult to assess such as with a change in soil depth, some soil types, slope, or extent of rockiness. In these cases the boundary is transitional and therefore can be less precisely plotted on the map.

Gunn *et al* (1988) indicate that, at a scale of 1:100 000, the standard minimum area for a map unit which can be adequately depicted on the map is approximately 64ha. There appears to be little consistency however, as Landon (1991) suggests a wide range of "minimum areas" are currently in use. For the purposes of this work, unit areas of less than 64ha have been mapped where they are identifiable on the basis of clearly visible boundaries (usually topographic). Impurities in map units will occur where land class changes are a result of less obvious changes in land characteristics or qualities.

In any mapping exercise there are always areas which are physically too small to delineate accurately at a given map scale and in such cases these areas are absorbed into surrounding units. The map units shown will therefore often contain more than the one land capability class or sub-class. The map units are assigned the dominant land capability class within them but it should be recognised that some map units may contain up to 40% of another class. In the majority of cases however, a land capability map unit may be deemed to be about 80% pure and, in more uniform areas, up to 90%.

COMPLEX map units (eg 4+5) are identified in some areas where, due to the complexity of soils and landscape, two land classes are identified within a single map unit, each class occupying between 40% and 60% of the unit. However, at the scale of mapping, the individual pockets of each land class are either too small to map independently or the pattern is very complex and separate capability classes cannot easily be identified. Such units are shown as striped units on the map. The first digit of the map unit label represents the dominant land capability class as does the slightly wider of the two coloured stripes on the map. Further information on the use and identification of complexes is presented earlier in this handbook.

5.2 Interpretation of the Land Capability Information

The scope and range of applications of the land capability information depends on the scale at which the surveys are carried out. Large scale maps such as those at 1:5 000 or 1:10 000 contain detailed information and are suitable for whole farm planning purposes, planning farm layouts and identifying appropriate land uses, soil conservation and land management practices. A scale of 1:25 000 is more appropriate for catchment planning, although this is a guide only as the scale used will often be determined by the size of the catchment to be surveyed and the amount of time that is allocated for mapping it. Medium scale surveys, about 1:50 000, contain class and subclass information and are suitable for district planning for route alignment, urban and rural development planning including residential and industrial development planning.

Best use of the 1:100 000scale maps and reports can be made by local government, regional and State land use planning authorities. The information at this scale is **not** intended to be used to make planning decisions at farm level, although the information collected does provide a useful base for more detailed studies. The methodology does however apply to all scales of mapping and can be utilised equally well by local landowners, local, regional or State planning authorities.

Examples of other potential uses of land capability information at 1:100 000 scale are:

- Identifying areas of prime agricultural land (Classes 1 to 3) for retention for agricultural use
- Rational planning of urban and rural subdivisions
- Identifying areas for new crops, enterprises or major developments
- Identifying areas for expansion of particular land uses
- Planning of new routes for highways, railways, transmission lines, etc.
- Identifying areas of land degradation, flooding or areas that may require special conservation treatment
- Identifying areas of potential erosion hazard

– Resolving major land use conflicts

Integrated catchment management (depending on catchment size)

Land capability information combined with other resource data can, with the aid of a GIS (Geographic Information System), greatly enhance the accessibility, interpretation and use of this information.

Describing land capability information through reports and accompanying maps is insufficient to ensure the adoption of sustainable land use practices. Change away from unsustainable practices can only occur through increased social awareness and education (a recognition that change is needed) together with the development of an appropriate implementation framework, including legislative and administrative support, responsible for putting land use policies into practice. The protection of high quality agricultural land from non-agricultural use is an issue of particular concern in many areas and the information included in the various maps and reports will help to achieve this and support the proposed State Policy on the Protection of Agricultural Land currently under preparation by DPIWE.

The land capability maps and reports do not purport to have legal standing as documents in their own right, nor should they attempt to stand alone in planning decisions without being supported by other relevant land resource, economic, social or conservation considerations. The information is intended as a guide to planning development and, where more detailed planning is required, for farm planning or route alignment for example, further fieldwork at a more appropriate scale needs to be undertaken.

5.3 Copyright

The maps, reports and digital information stored on the DPIWE databases are copyright, and the data is solely owned by the Department of Primary Industry, Water and Environment, Tasmania. Every encouragement is given to individuals and organisations who wish to use the information contained in this report and accompanying map to assist property management or regional planning activities. However, commercial organisations or individuals wishing to reproduce any of this information, by any means, for purposes other than private use, should first seek the permission of the Secretary, Department of Primary Industries, Water and Environment, Hobart.

5.4 Availability of Other Reports and Maps in this Series

An Index of the land capability maps (based on the TASMAP 1:100 000 Series) is shown on the rear cover of this report. The maps which have been published to date are indicated in Figure 1.

Land capability publications currently available :

Pipers Report and Accompanying Map ($15)

Tamar Report and Accompanying Map ($15)

Meander Report and Accompanying Map ($20)

South Esk Report and Accompanying Map ($30)

Forth Report and Accompanying Map ($30)

Inglis Report and Accompanying Map ($30)

Land Capability Handbook ($10)

Land Capability Classification in Tasmania, Information Leaflet (free**)**

Maps, reports and the handbook are available for purchase by contacting your nearest Department of Primary Industries, Water and Environment Office or direct from:

Department of Primary Industries, Water and Environment
Resource Management and Conservation Division
Land and Water Assessment Branch
GPO Box 46
Kings Meadows, TAS. 7249.

6. LAND CAPABILITY FOR LAND USE PLANNING: REGIONAL AND DISTRICT SCALES

Correct land use planning decisions, at the property, local, regional or State level, can only be made when based on a full and accurate picture of the total land resource and there is no doubt that land resource information (in particular, land capability information) is an essential ingredient in planning to allow informed and reliable decision making.

In carrying out the Land Capability Survey of Tasmania, the Department of Primary Industries, Water and Environment (formerly Department of Primary Industries and Fisheries) recognises that there has been a lack of this type of information available to planners in the past, and that many land use decisions in the State have not been based on land capability principles. Other States that have had land capability information available for some time, have also recognised that the information may not have been adequately incorporated into land use planning decisions. As a result, land capability information is now used extensively as a basis for land use planning decisions in all other States.

However, it is insufficient to provide land capability and other resource information in order to protect our valuable agricultural resources if administrative, legislative and political frameworks are not in place to ensure that this type of information is used in the planning process. Further, land capability information is insufficient to protect the land if there is no legislative framework to ensure that not only is land used within its capability but is also managed according to its capability classification. In recognition of this, the State government proposed the development of a policy on the Protection of Agricultural Land which required the incorporation of land capability principles in the development of regional development strategy plans. This policy was passed in April 1999. Further political developments will be required, however, if the State’s valuable agricultural resources are to have a sustainable future.

The value and use of land capability information is largely dependent on the purpose and scale for which the information was gathered. Obviously, the more detailed the information the greater it’s value for detailed planning and development. However, with limited resources available for land capability classification and land resource surveys in general, the approach of DPIWE has been to undertake 1:100 000 scale mapping which will provide an overview and relatively quick coverage of the State with the type of information that is useful to planners at district and regional scales.

It is proposed that once the 1:100 000 State survey is completed, areas where more detailed information is required (eg around urban fringes, areas of highly intensive agricultural use) will be remapped at 1:25 000 scale, providing planners and land managers with more detailed information.

Land capability on its own cannot and does not purport to dictate land use planning decisions or policies and should not be regarded as standing alone in any planning decision, without being supported by other relevant land resource, economic, social or conservation considerations that may be pertinent to the decision making process. Only with recognition of all these factors can responsible decisions on land use be made. The land capability information provides a scientific and objective base on which to overlay all other information in order to make wise and rational land use decisions. A broadening of the issues to be considered in this way is more of a suitability evaluation, undertaken in many other states as part of a strategic development plan. In Tasmania it is up to the planners and developers to investigate social and economic factors as the land capability information provides only an assessment of the physical resources of the land.

The decisions that planners make in interpreting the land capability data must take into account:-

a) The physical potentials and limitations of the land, as indicated in the land capability assessment.

b) The land capability information - an understanding of the land capability system, the limitations of the data, and the limitations imposed by the scale of the information presented.

c) Other social, economic, political, infrastructure, and conservation considerations.

d) Regional and State planning strategies and policies, eg protection of prime agricultural land for agricultural use (Classes 1-3).

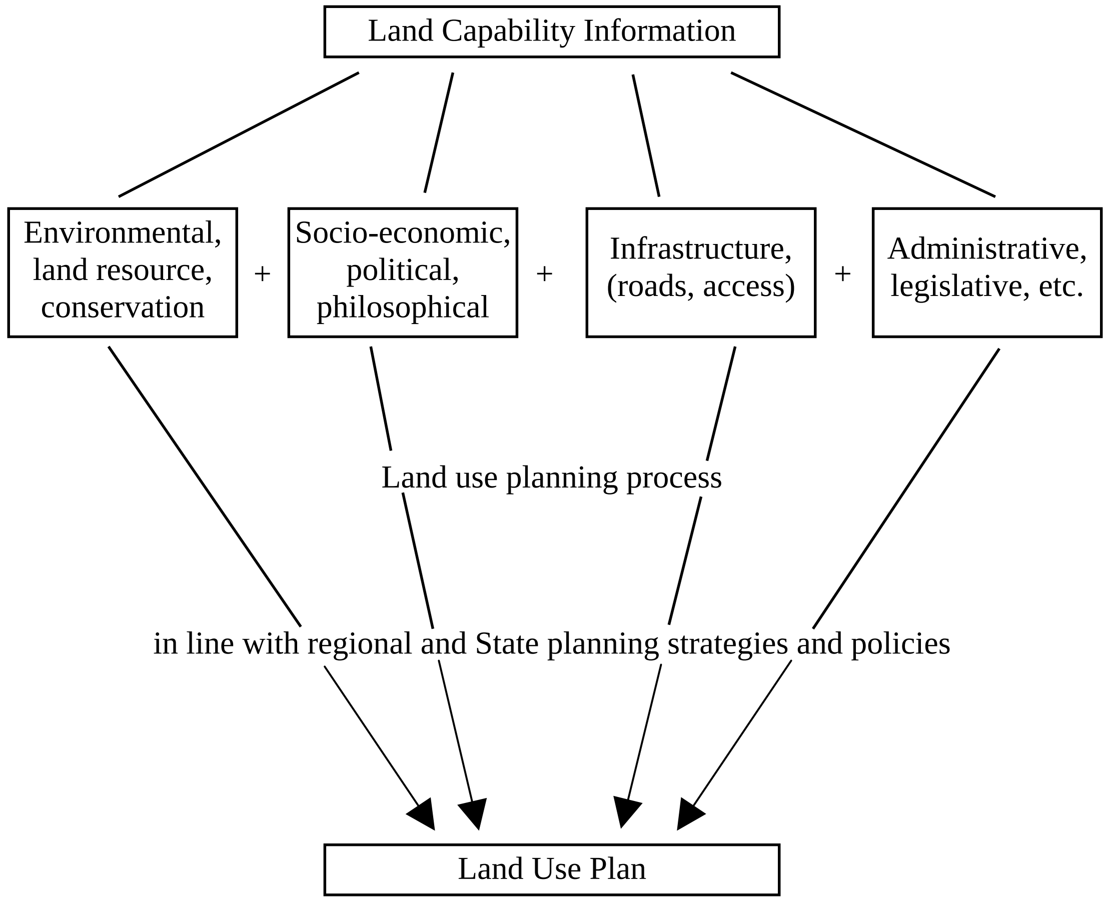


Figure 11. Framework for Land Use Planning

Potential uses of the land capability information at the regional or district scales include identifying areas of prime agricultural land, areas for expansion of particular land uses, new crops or major developments, planning for urban and rural subdivisions, and planning for new routes, highways or transmission lines.

Land capability information can be used to provide a basis for deriving zoning or policy areas for regional and district planning schemes. This has been successfully undertaken for West Tamar and Kentish Councils.

Local authorities can identify areas where development may be safely promoted or should be restricted. Areas can be defined which should be protected from urban intrusion, preserved for agriculture, or used for semi-rural living.

This objective information can be used to allay concerns that decisions about residential developments are made on a piecemeal basis, and fail to recognise the regional or State importance of agriculture.

Outlined below are some examples of applications of land capability at various scales.

1) Regional and State Planning: 1:100 000 (small scale)

At this scale, the land capability information can only be presented at the class level. This information can be used to:

a) Provide an overview of land capability of the region.

b) Identify the nature and extent of the land resource.

c) Identify areas with potential for intensive agricultural use eg prime agricultural land.

d) Assist with regional strategic planning.

e) Identify extent of areas at risk from land degradation.

f) Identify areas for new developments, or urban expansion.

g) Provide a standardised framework on which to base more detailed assessments.

h) Resolving state level land use conflicts.

2) District Planning and Large Catchment: 1:50 000 (medium scale)

Mapping at this scale can be carried out to the class or subclass levels. At this scale information on the time of limitation is necessary for consultants and planners involved in urban and rural development planning.

Provides information for all of those mentioned above in more detail, including more detail about the land resource, for: -

a) Urban and rural development planning, including residential and industrial subdivision

b) Transport, telecommunication and transmission line route alignment

c) Soil conservation planning

d) Location of industries

e) Location of irrigation schemes

f) Locating landfill and effluent disposal sites

Medium scale mapping provides more reliable information on the nature of limitations. It is also able to supply some information relating to soil type and soil characteristics. Land capability classification is not a substitute for soil survey, however, and for reliable soil information soil surveys should be undertaken at a scale appropriate to the proposed development.

3) Catchment Planning; Urban Fringe Areas 1:25 000 (large scale)

a) Specialised agriculture (eg viticulture)

b) Defining management options

c) Hobby farm expansion

d) Urban growth options

e) Providing information for detailed planning and policy development

More detailed plans for urban development may be recommended to ensure that inappropriate developments do not occur on land at risk from flooding, areas with landslip hazard, land with reactive or unstable soils, or on areas that are too steep or too rocky for development. Some other States and New Zealand have developed an Urban Land Capability Classification System which takes into account in detail these types of constraints that affect development of land for urban use.

Figure 12 outlines a possible framework for the application of land capability assessment.

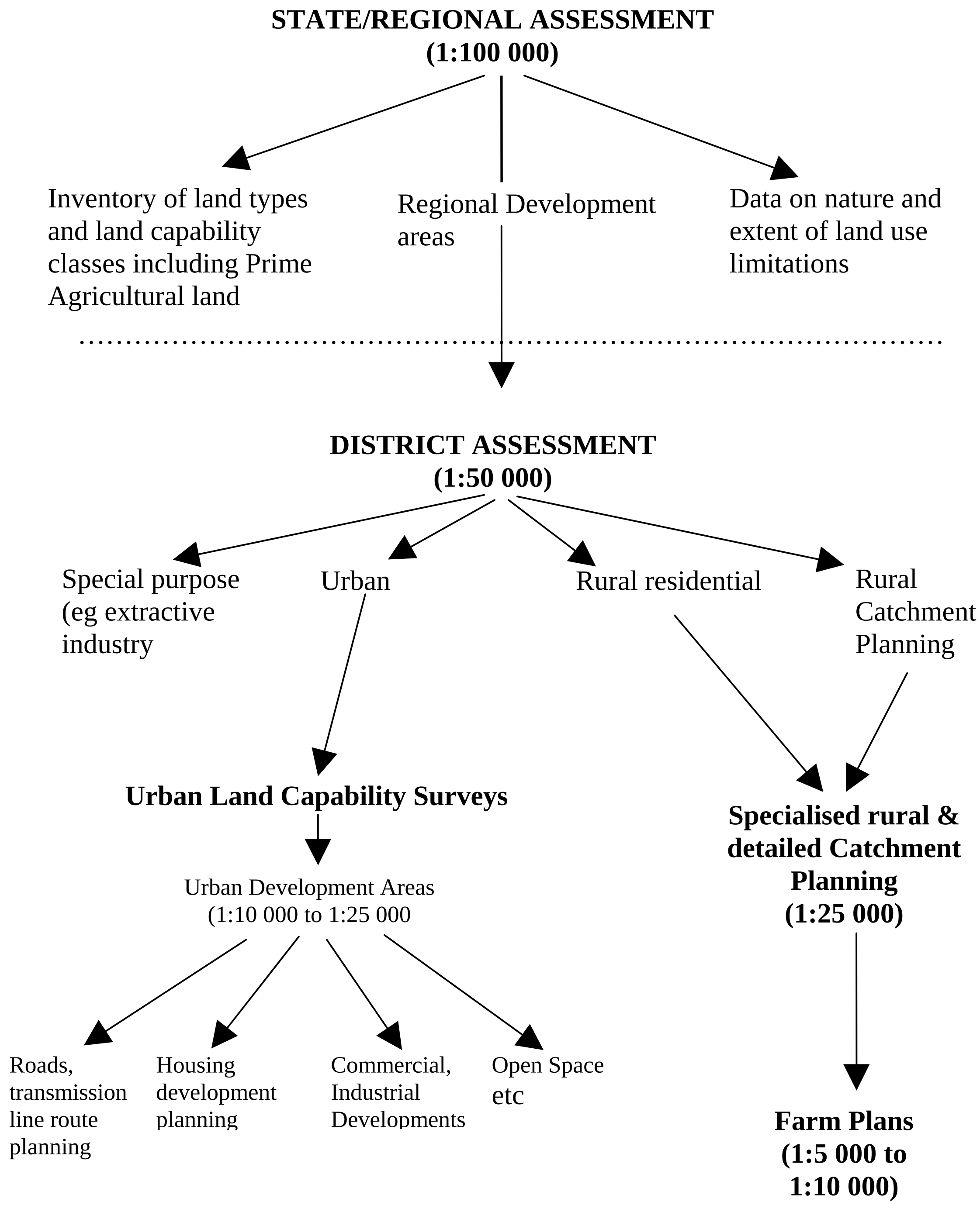


Figure 12. A possible framework for the application of land capability assessments. (Adapted from Dept. of Agriculture, South Australia)

7. LAND CAPABILITY FOR FARM PLANNING

Using land within its capability naturally starts at the farm level. Decisions such as land use, length of cropping phase, stocking rates and management methods develop from an assessment of the land's capability to sustain the proposed level of use.

While most farmers make an assessment of the land's ability to produce and the appropriate methods for management, economic circumstances may lead farmers to look only to the short-term and neglect long-term considerations. Where the land's ability to sustain a particular land use without permanent damage is ignored, the unfortunate, but inevitable result is land degradation: soil compaction, erosion in its various forms, tree decline or soil salting.

Property management decisions should therefore be more consciously based on land capability. Planning farm layout and operation on the basis of the inherent bio-physical characteristics of the land - soil type, slope, drainage and erosion hazard - is a basic principle of Property Planning. Matching the land's capability for production with the required farming practices leads to subdivision of the farm into land capability units (or natural land management units).

For example, fence location and paddock shape and size should be dictated by factors such as topography and soil type.

Of particular importance in cropping areas is the situation where individual paddocks may have more than one soil type present. Usually this results in one soil type being used beyond its capability and therefore suffering permanent damage. Where practical, different soil types should be identified and treated separately.

A similar situation applies with paddocks which may contain only one soil type, but may contain some small steep areas or drainage lines. If the entire paddock including the steep areas or drainage lines are cultivated, these areas may be subject to erosion. The preferred practice is to suit the land use to capability by leaving drainage lines as pasture, and planting steeper areas for wood production. Both options result in less soil disturbance and prevention of long-term damage.

Land capability assessment at the property level involves the same principles as those used for broader scale assessment. However, more detailed information needs to be collected as the result is direct guidelines for land use and soil management practices.

By using the principles of land capability assessment at the property level, the farmer can better plan his farm layout and operations to identify the most appropriate land use for different areas of his property, and thereby ensure the long-term sustainable productivity of the land is not threatened (see Figure 13).

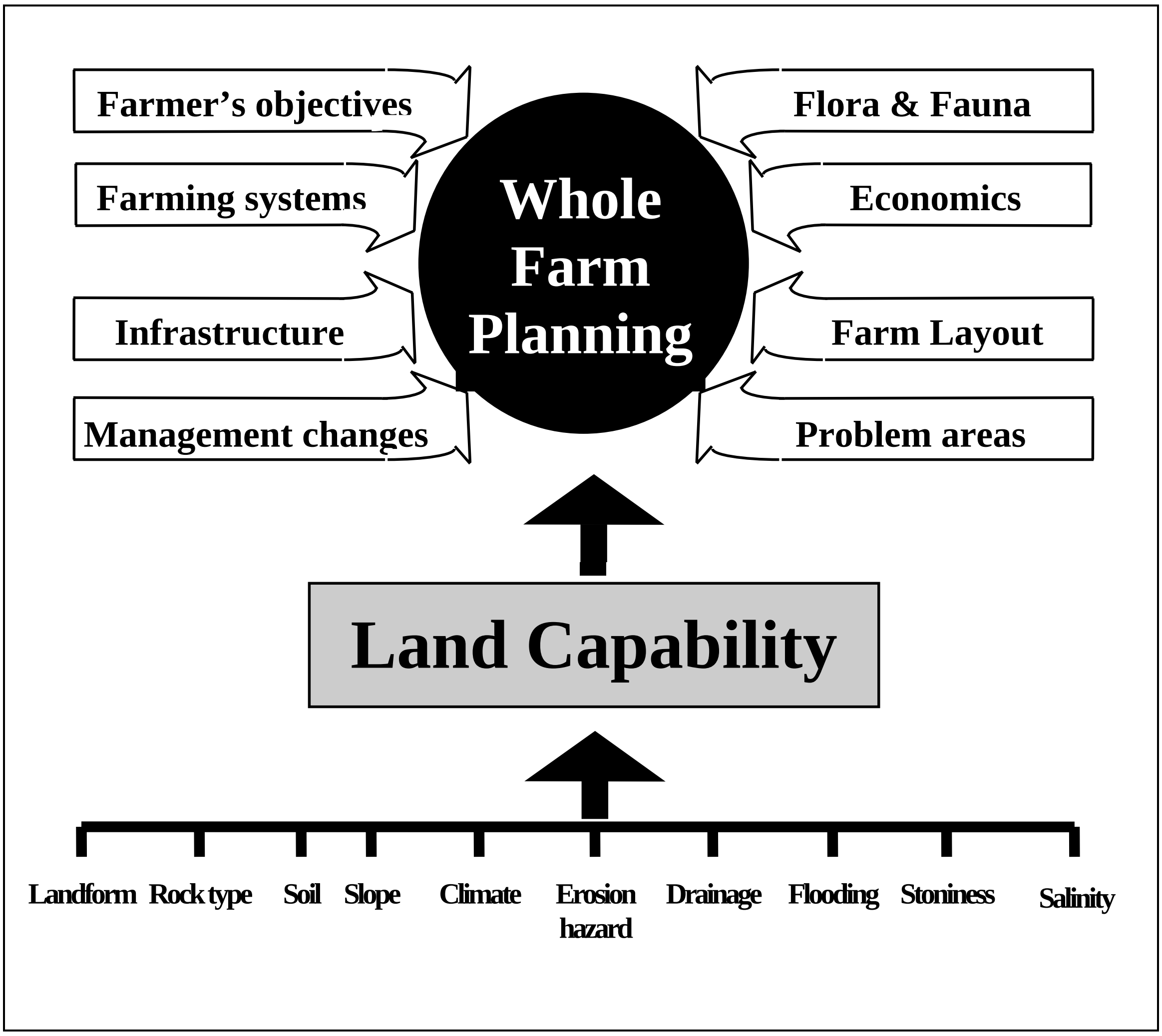


Figure 13. Land capability as a basis for farm planning

7.1 Procedure for Land Capability Mapping at Farm Level

Land capability at the property level is carried out by mapping to the class, subclass and unit level, as described in Section 3.

Before a land capability map can be drawn, it is essential to have an understanding of the physical resources of the property, and their relationships.

A detailed physical resource inventory is required for each area of the farm as this is used as the basis for the land capability assessment. The type of information needed would be rock type, soil type and properties, slope, aspect, altitude, exposure, erosion, hydrology and rainfall, etc. The land capability units based on this physical information are then drawn onto an aerial photograph of the farm and this information then forms the basis for the whole farm plan (Figure 13, above).

As part of a farm plan a series of overlays will be drawn over an aerial photograph of the property. Suitable scales for aerial photographs will depend on the size of the property and on the complexity of the landscape, but should be between 1:1 000 and 1:10 000.

At these scales it is possible to subdivide the landscape into land management units which reflect farm management and soil conservation needs.

In preparation for land capability assessment, overlays will be needed showing:

(a) major landforms

(b) geology

(c) soil types

To derive these overlays, the farmer's detailed knowledge will need to be supplemented by extensive field work over the entire property to determine boundaries and to make records or notes about certain features eg. descriptions of major soil types, slope, erosion features, rockiness, flooding hazard, drainage problems, salinity areas, etc.

The land capability units at the property level will be a subdivision of the landscape into management areas that have similar soil types, geology, slope, erosion hazard, aspect etc. These areas will require similar management and conservation treatments, and will be capable of growing the same kinds of crops, with similar potential yields.

Many of the land capability boundaries will be obvious, but others will require field checking. If the first three overlays are completed in detail, then this will make the land capability overlay much easier to compile. Land capability is an assessment of the potential of the land, so the boundaries should not be influenced by present fence lines, infrastructure, vegetation or land use. The practicality of managing these areas will be dealt with when developing the whole farm plan.

The land capability units identified should then be ranked in order, and described in an accompanying legend. An example is presented in the table below.

LAND CAPABILITY LEGEND - CRESSY RESEARCH STATION

LAND CAPABILITY CLASS	AREA (ha)	DESCRIPTION	ROCK TYPE	SOILS	SLOPE	LAND DEGRADATION HAZARD	LIMITATIONS TO CROPPING USE	SOIL CONSERVATION AND WATER MANAGEMENT MEASURES	COMMENTS
4e1	21	Gently undulating slopes (between Brickendon and Brumby surfaces)	Colluvium on clay.	**Newnham Series (N)** 0-15cm brown fine sandy loam, 15-20cm bleached clayey sand, some gravels, 20cm+ brown friable clay with red and yellow mottles.	0-3%	Rill, sheet erosion. Structural decline.	Suitable for cropping most of the year.	Minor soil conservation works.	Subsoil clays drain more freely than the Brumby series soils.
4e2	62	Flat to gently undulating surfaces of a thin veneer of Panshanger windblown sand, overlying Brumby terrace,	Windblown sand (35-50cm deep) overlying clays and gravels.	**Panshanger over Brumby Series (P/Br)** 0-20cm brown fine sandy loam, 20-40cm bleached yellowish, sand (wet during winter), 40cm+ yellowish, sometimes mottled sandy clay to heavy clay	0-5%	Rill, sheet erosion. Structural decline.	Suitable for spring and autumn cropping.	Windbreaks. Minimum Tillage techniques	Where depth of Panshanger sand is less than 35cm profiles were considered to be more typical of Brumby soil series.
4e3	5	Undulating to rolling slopes and scarps.	Alluvial sands on clay.	**Brumby Series (Br)** 0-20cm grey or brownish grey fine sandy loam, 20-30cm bleached white or pale yellow sandy clay loam or clay, with small quartz and ironstone gravel, 30cm+ yellowish grey (mottled & gleyed) clay.	5-15%	Wind erosion. Structural decline. Waterlogging.	Easier to get machinery on than 4w1 because of better drainage.	Drainage. Minor soil conservation works	Soils are better drained than 4w1.
4e4	73	Flat to rolling surfaces, lunettes and dunes of deep, windblown sands. Includes flat to gently undulating low lying areas within sand dune formations.	Windblown sands (>60cm deep)	**Panshanger Series (P)** 0-20cm dark reddish brown fine sandy loam 20-25cm + loose reddish brown sand **Panshanger Series (Pw)** 0-20cm brownish grey sandy loam 20-35 bleached loose grey/yellowish grey or creamy yellow sand, with manganese concretions, 35cm+ loose grey sand or yellow sandy clay.	0-15%	Wind, rill, sheet erosion. Structural decline.	Good winter cropping (free draining). Soils dry out too rapidly for spring and summer cropping. Cultivation timing critical because of wind erosion hazard.	Windbreaks. Minimum Tillage techniques	Deep uniformly textured and weakly structured sand, with low organic matter content. P soils are very free draining with frequent periods of severe soil moisture deficiencies. Highly susceptible to wind erosion. Includes areas of Wilmore (W) soils which have a higher clay content than P soils. Low lying areas on Pw soils retain moisture for longer periods than Ps soils because of slower drainage. Some Pw profiles are paler with cream/yellowish colours in B, C horizons.
4w1	214	Flat to gently undulating terraces with poorly drained soils.	Alluvial sands on clay.	**Brumby Series (Br)** Similar profiles to 4e3, sometimes with more gravel present.	0-5%	Wind, rill, sheet erosion. Structural decline. Waterlogging.	Suited to spring cropping. Must be careful with irrigation timing and amounts, to give soils time to dry out before winter.	Drainage. Minor soil conservation works	Poorly drained soils with impeded vertical and lateral drainage. The surface soil is normally acid. In summer these soils set hard and with excessive cultivation rapidly lose their surface structure. The fine grained nature of the A2 horizon may result in excessive siltation of mole drains. Topsoil depths and textures may vary due to varying amounts of admixed Panshanger sand.
4w2	45	Flat terraces adjacent to streams. Recent alluvial soils with high clay content and restricted internal drainage.	Alluvial clays.	**Canola Series (Ca)** 0-25cm very dark grey or black organic clay loam or clay with grey or rust mottles, 25cm+ dark grey clay, yellowish grey clay or sandy clay, sometimes gravelly with orange mottles.	0-3%	Streambank erosion, waterlogging, flooding.	Suitable for spring cropping (good barley country). Difficult to get soil in suitable condition for cultivation - sets into hard clods, or is too boggy to work.	Drainage	Profiles are variable due to differences in alluvial parent material, flood frequency and degree of soil development. High water tables, poor internal drainage and surface flooding make these clay soils difficult to manage.
4s1	1	Gently sloping lower level surfaces of the Brickendon Terrace.	Alluvial gravel and sands on clay.	**Brickendon Series (B)** 0-15cm brown/grey silt loam or fine sandy loam, 15-25cm yellow/grey bleached fine sandy loam with quartz and ironstone gravel 25-30cm + heavy orange and red mottled clay.	0-5%	Wind erosion. Structural decline. Waterlogging.	Suitable for cropping most of the year.	Drainage. Minor soil conservation works	Subsoil clays drain more freely than Brumby Series soils. Slightly more erodible than 4e1 because of increased slope. Profiles are not as gravelly as typical Brickendon Series soils.
5e1	0.8	Moderately steep scarps of deep windblown sand.	Windblown sands (>60cm deep)	**Panshanger Series (P)** 0-20cm dark reddish brown fine sandy loam 20-25cm + loose reddish brown sand	30%	Wind, sheet, rill erosion.	Unsuitable for cropping because of slope and erosion hazard.	Windbreaks. Block planting of conservation trees. Maintenace of complete pasture cover.	
5w1	21	Poorly drained, low lying areas in drainage channels subject to frequent surface flooding and waterlogging and salinity concentrations.	Alluvial sands on clay.	**Brumby Series (Br)** Profiles generally shallower than those in 4e3, with clay B horizon at 20-25cm.	0-3%	Flooding, waterlogging. Salinity, gully erosion.	Unsuitable for cropping unless drainage is successful. Avoided for cropping because of wetness problems and associated poor yields.	Drainage Maintenace of waterways and drainage channels.	
6w1	7	Low lying poorly drained areas adjacent to streams and broken by meanders and oxbows.. Soils are subject to flooding and are very difficult to drain successfully.	Alluvial clays	**Canola Series (Ca)** Similar profiles to 4w2	0-3%	Streambank erosion, flooding waterlogging.	Unsuitable for cropping because of difficulty of drainage and flooding hazard.	Flood levees where practical	

Example of Land Capability Legend at Farm Scale

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APPPENDICES

APPENDIX 1

SOIL MOISTURE AND ITS APPLICATION TO LAND CAPABILITY CLASSIFICATION

The following pages provide an introduction to Soil Available Water Capacity and Soil Moisture Deficits and explores how they might be applied in the context of land capability. The information presented is based on an approach adopted by the Ministry of Agriculture Fisheries and Food in England (MAFF, 1988). The methodology is untested here in Tasmania and so has not been included in the main body of this text. Some more uptodate information on moisture retention by different soil textures is also included.

Crop adjusted available water capacity (AP)

AP is a measure of the amount of water retained in the soil profile which can be easily used by a crop. It is widely accepted that there is a direct relationship between water retention and soil texture but the figures seem to vary depending on the author of the data. For the ALC system, available water is calculated for the rooting depth of the crop (wheat or potatoes) and also giving allowance to the differing demands of the crops through different seasons and the degree of development of the root system.

Thus:
AP(wheat) cm = TA_{vt} x LT_t+$\sum(TA_{vs}$ x $LT_{50})$+$\sum(EA_{vs}$ x $LT_{50\text{-}120})$

and:
AP(potatoes) cm = Ta_{vt} x LT_t+$\sum(TA_{vs}$ x $LT_{70})$

where
Ta_{vt} = Total available water (TA_V) for topsoil texture
Ta_{vs} = Total available water for each subsoil layer
Ea_{vs} = Easily available water for each subsoil layer
Lt_t = Thickness (cm) of topsoil layer
LT_{50} = Thickness (cm) of each subsoil layer to 50 cm (depth of well developed wheat root system)
$LT_{50\text{-}120}$ = Thickness (cm) of each subsoil layer between 50 and 120 cm (depth of less well developed wheat root system)
LT_{70} = Thickness (cm) of each subsoil layer to 70 cm (depth of potato root system)

Moisture Deficit

The moisture deficit term used by ALC droughtiness assessment represents the balance between rainfall and potential evapotranspiration calculated over the critical part of the growing season.

Thus:
MD (wheat)= mid-July PSMD-1/3April PSMD

and

MD (potatoes)= August PSMD-1/3June PSMD -1/3 mid-may PSMD

Where
PSMD is Potential soil moisture deficit at various stages of crop growth reflecting differing demands for moisture (ie potatoes have little leaf cover until mid May and full cover not achieved until end of June).

and PSMD = $\sum$(R-PE)

where (R-PE) is calculated daily and summed over a defined period.
R = rainfall
PE = potential evapotranspiration - the amount of moisture transpired by a short green crop, completely covering the ground and with unrestricted water supply (Penman 1948).

Moisture Balance

Then moisture balance for ALC is therefore

MB(Wheat)= AP(wheat)-MD(wheat)

MB(potatoes)= AP(potatoes)-MD(potatoes)

The reliability and usefulness of these moisture balances are dependent on good rainfall and evaporation data at a substantial number of recording stations. Within Tasmania there is reasonable rainfall information data available but very limited evaporation and temperature data. Calculation of water balance information is thus severely constrained and inappropriate even to 1:100 000 scale mapping.

Available Water Holding Capacity

Soil available water holding Capacity (AWHC) is a measure of the soils ability to retain water under freely drianing conditions. Close correlation has been identified between AWHC and soil texture although actual AWHC may influenced by such factors as soil structure, organic matter content and stone content. In assessing AWHC storage within the rooting zone of potential crops needs to be considered. For most annual field crops this depth is usually about 120 cm, while for potatoes it is only 70 cm. Also, cereals have a less well developed root system below about 50 cm and can only extract readily available moisture (this concept is discussed further under Climate).

In some soils plant roots may not extend to their optimum depth due to some restricting layer within the profile. In Tasmania such layers are often rock or the underlying clayey B horizons within duplex or texture contrast soils. In such instances the rooting zone is the depth to the restricting layer. The following tables indicate total and readily available water in different texture groups and provide a guideline to the assessment of land capability class and soil available water holding capacity.

Texture Group	Water Holding Capacity (mm water/metre soil)	
	Readily available	**Total available**
Medium to coarser sand	30-50	40-80
Fine sand	40-60	60-100
Loamy sand	50-70	80-120
Sandy loam	40-70	100-140
Light sandy clay loam	60-90	110-170
Loam	80-100	140-200
Sandy clay loam	70-90	150-180
Clay loam	60-90	150-220
Clay	50-70	140-220

After Maschmedt and adapted from Wetherby 1992

The water holding capacity of a soil may be calculated by totalling the capacity for each texture layer within the rooting zone.

Land Class	Rootzone AWHC
1	>100 mm
2	80-100 mm
3	50-80 mm
4	30-50 mm
5	<30 mm

Soils with available storage of less than 30 mm are considered unsuitable for cropping activities and pasture becomes increasingly fragile as AWHC decreases further. Agricultural systems are considered to be rainfed with no application of irrigation water.

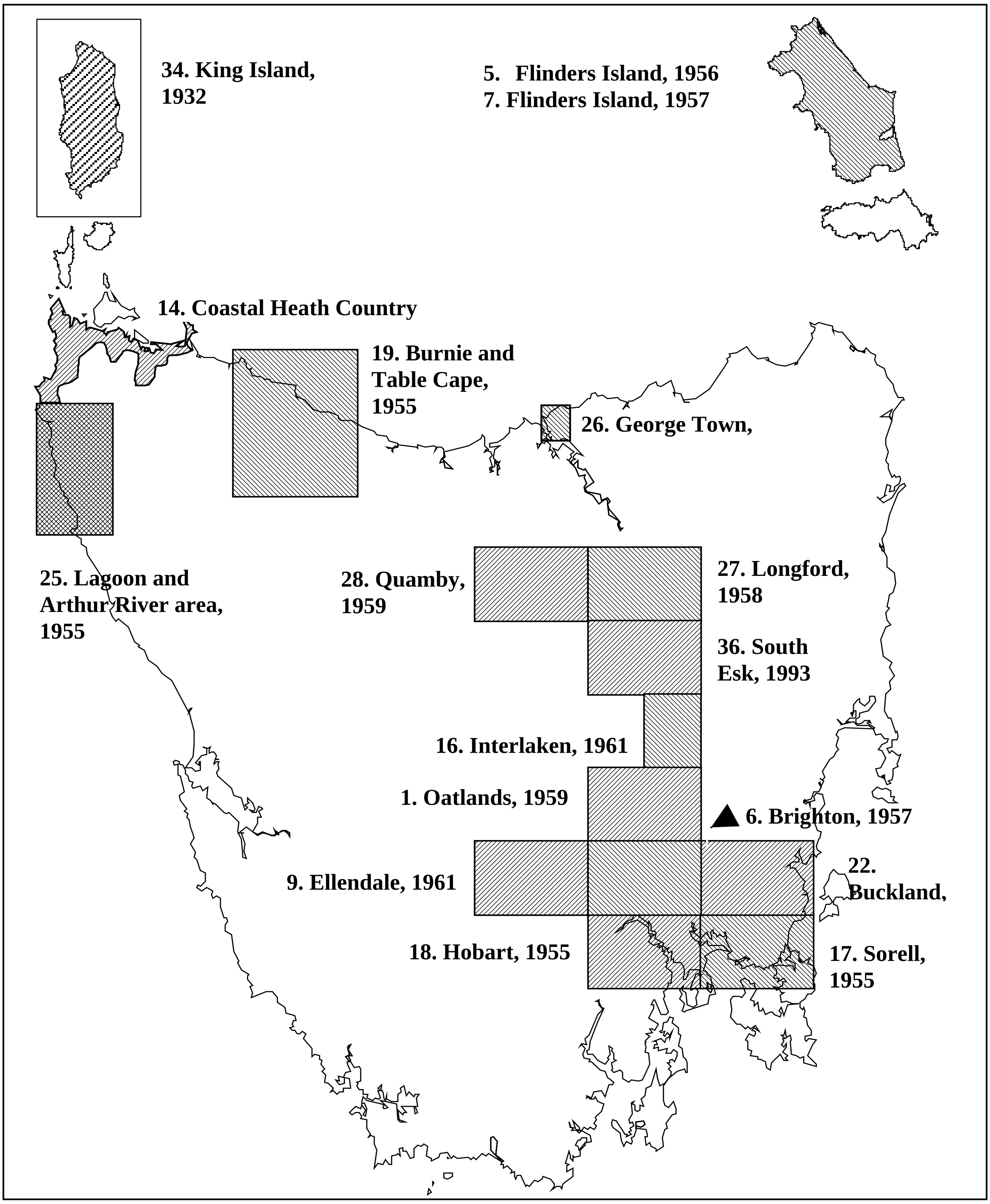
APPENDIX 2

CONVERSIONS FOR COMMON EC AND SALINITY MEASUREMENTS

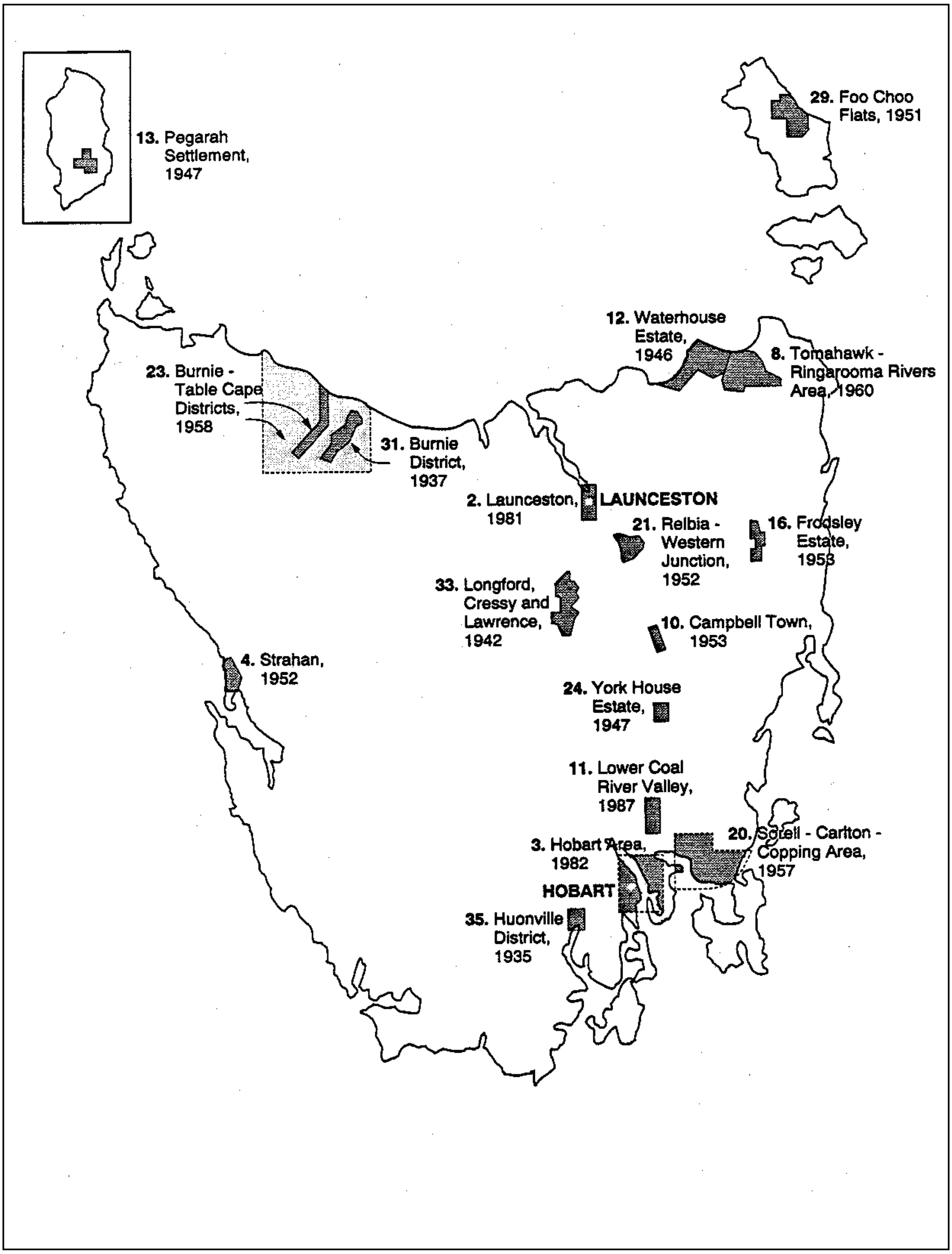
dS/m	μS/cm	mS/cm	mS/m	ppm
0	0	0	0	0
0.5	500	0.5	50	320
1.0	1000	1.0	100	640
1.5	1500	1.5	150	960
2	2000	2	200	1280
2.5	2500	2.5	250	1600
3	3000	3	300	1920
3.5	3500	3.5	350	2240
4	4000	4	400	2560
4.5	4500	4.5	450	2880
5	5000	5	500	3200
6.0	6000	6.0	600	3840
7.0	7000	7.0	700	4480
8.0	8000	8.0	800	5120
9.0	9000	9.0	900	5760
10.0	10000	10.0	1000	6400

APPENDIX 3

SOIL MAPS AND REPORTS AVAILABLE FOR TASMANIA



Published Reconnaissance Soil Maps of Tasmania (as at June 1999)



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