INGLIS
REPORT

Land Capability Survey of Tasmania

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Department of Primary Industries Water and Environment
Prospect Offices
1999

Inglis Report
and accompanying 1:100 000 scale map

DEPARTMENT *of* PRIMARY INDUSTRIES, WATER *and* ENVIRONMENT
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Contents

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SUMMARY

This report and map describes and classifies the privately owned and leased Crown land resources occurring within the limits of the 1:100 000 scale Inglis map (Sheet No. 8015) and the northern most part of the Sophia topographic map (No 8014), to a southern boundary delineated by the 5394000 northing. This region is referred to throughout this report as the Inglis area. It is located in north west Tasmania and includes the major population centres of Burnie, Somerset and Wynyard and many small inland centres such as Ridgley, Hampshire and Waratah. The area is well known for its industrial and agricultural input to the State's economy. The total survey area extends over 285 000ha of which approximately 97 000ha (34%) is considered exclusion and has not been mapped.

The land has been classified according to the land capability classification system for Tasmania as described by (Noble 1992a and Grose 1999). Land capability is based on the ability of the land to produce sustainable agricultural goods without impairing the long-term, sustainable productive potential of the land. The system categorises land into seven capability classes with increasing degree of limitation for agricultural production or decreasing agricultural versatility as the system progresses from Class 1 to Class 7. Classes 1 to 4 are considered suitable for cropping activities, Classes 5 to 6 suitable for pastoral activities only and Class 7 is considered unsuitable for agricultural use.

The survey area extends from the coast inland to highland plains and associated mountain ranges at the southern edge of the survey area. The topography is dominated by a series of sub-parallel ridges and associated steep sided river valleys, aligned roughly north east to south west, with highland plains, eroded hill slopes and mountain peaks further inland. The area is composed of a variety of rock types ranging from relatively recent deposits of alluvial material to rocks that exceed 225 million years old. Of particular interest to agriculture is the occurrence of Tertiary basalt lava plains that have been eroded and down cut to result in the rolling landscape of more northern parts of the area. This material has weathered to form red and brown Ferrosol soils that provide some of the best agricultural soils in the State.

Land use in the area is dominated by intensive cropping enterprises in northern regions and forestry activities further south. These land uses are interspersed by an assortment of other uses including dairy farms, beef studs, market gardens and hobby farms. Limited amounts of cereals are produced throughout the area due to the low economic return for these commodities compared with other crops, and also due to competition by the intensive vegetable cropping industry for the flat to gently sloping land.

The most intensive cropping areas occur where deep red soils known as Ferrosols have developed from basaltic rocks. In some areas up to three crops in any one year may be grown and a wide variety of crops are produced including potatoes, carrots, onions, peas, beans, buckwheat, an assortment of brassicas, poppies, pyrethrum, cut flowers and bulbs. Table Cape, Boat Harbour and areas south of Somerset and Burnie, represent some of the most intensively used agricultural land within the Inglis area.

Intensive cropping activities become scarcer at more inland locations. Here occasional cropping activities supplement incomes predominantly derived from grazing enterprises. Dairy farming occurs throughout the area up to approximately 500m asl.

where the climatic constraints become too severe for high grade pasture production. Other grazing activities on native pastures extend beyond this height to above 900m asl.

Despite moderate to high average annual rainfall (970-2200mm/annum) throughout the Inglis area, most falls occur in winter and necessitate regular irrigation of crops and pastures throughout the summer to achieve optimum yields. The majority of this irrigation water is supplied from on-farm storage or taken directly from rivers or creek systems. Where irrigation water is unavailable or dam creation impossible, such as on some plateau tops, agricultural uses are significantly constrained.

Land capability boundaries have been determined by a combination of field investigation, aerial photo interpretation and computer modelling. The major limitations to agriculture identified are:

- Erosion - rill, sheet, wind and landslip
- Poor soil conditions - poor drainage, stoniness, shallow effective soil depth
- Topography - irregular and fragmented microrelief
- Climate - impacts on the range of crops that can be grown but its significance is generally confined to the basalt soils as other limitations are usually of greater significance on other soil types.

COMPLEX units have been mapped where two land classes have been identified but cannot be usefully separated at the scale of mapping. Within each complex the first land class identified is dominant and occupies 50-60% of the unit, while the second class occupies only 40-50%. Table 1 shows the amount of each land capability class and each complex identified within the Inglis area together with its proportion of the total map area.

Table 1. Extent of Land Classes and Land Class Complexes on Inglis map.

Capability Class	Area (ha)	% of Inglis area
1	705	0.25
2	3 156	1.11
2+1	108	0.04
2+3	293	0.10
3	16 258	5.70
3+2	1 179	0.41
3+4	623	0.22
4	27 330	9.58
4+3	191	0.07
4+5	4 641	1.63
5	66 035	23.16
5+4	1 105	0.39
5+6	5 205	1.83
6	18 360	6.44
6+5	10 627	3.73
6+7	10 403	3.65
7	19 018	6.67
7+6	2 814	0.99
E	97 127	34.06
TOTAL	285 178	100.00

Figure 1 shows the percentage extent of each land class within the private and leased crown land on the Inglis Map (Exclusion areas are not included).

In an attempt to indicate the true percentage of each land class in Figure 1 a 60-40 split of the complex units is assumed thus, for example, the total area of Class 2 land equals "the total area of Class 2 + (60% of the area of Class 2+1 and Class 2+3) + (40% of the area of Class 3+2)".

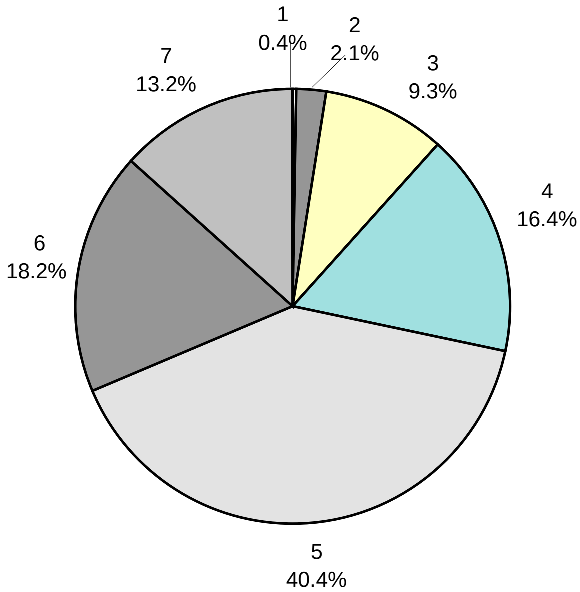


Figure 1. Land Capability Class Percentages Inglis Map

Class 5 land is the most abundant land class with just over 40% of the agricultural areas while Class 1 is the smallest making up less than 1 percent of the area

"Prime Agricultural Land" (Classes 1, 2 and 3 land) make up only 11.8% (or 22149ha) of the area surveyed. This small percentage reinforces the importance of protecting the existing resource from degradation. Good planning decisions by local governments and the use of sustainable practices by land managers can preserve this valuable agricultural land for use by future generations.

1. INTRODUCTION

1.1 Background

This report continues a series of land capability reports published by the Department of Primary Industries, Water and Environment as part of a 1:100 000 scale land capability survey of Tasmania's agricultural land first started in 1989. The report and accompanying map describes the land capability classes found within the agricultural land within the Inglis area. It evaluates the land capability of private freehold and leased Crown land only. Other areas are considered non agricultural and are mapped as exclusion areas.

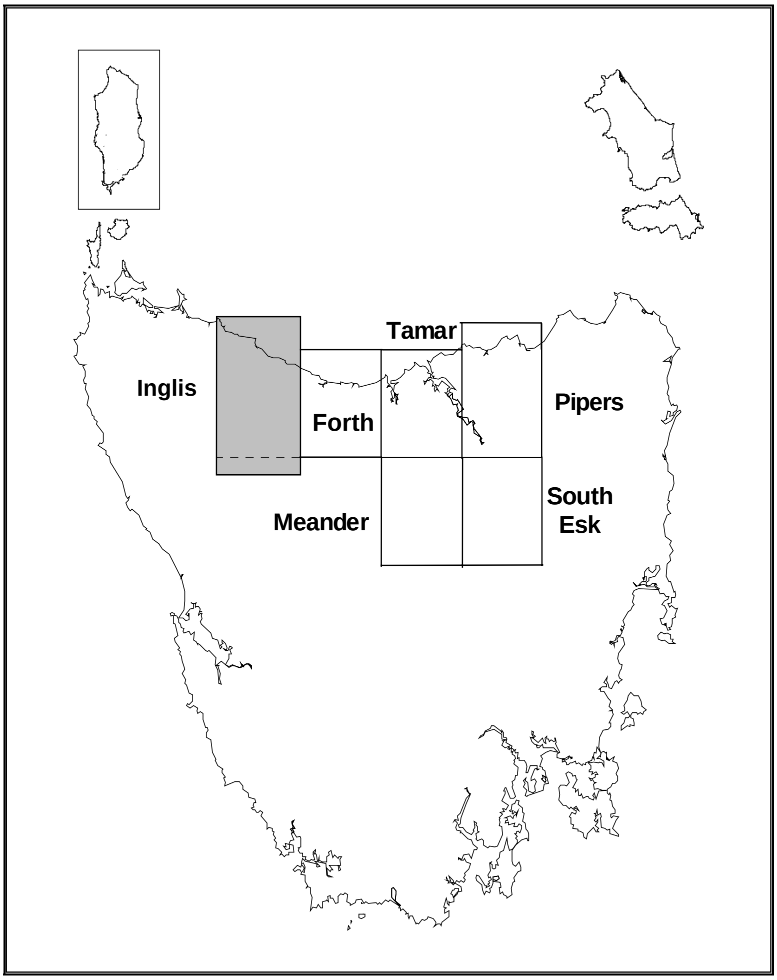


Figure 2. Inglis Survey Location and Previous Land Capability Surveys in Tasmania.

The land capability project aims to: a) identify and map the extent of different classes of agricultural land in order to provide an effective base for land use planning decisions; and b) ensure that the long-term productivity of the land is maintained at a sustainable level, through the promotion of compatible land uses and management practices. It undertakes to achieve these aims through a program of mapping activities and associated extension and awareness programs such as the Farmwi$e programme. It also supports the Policy on the Protection of Agricultural Land (1998) recently passed by parliament by identifying the areas of Prime Agricultural Land (Classes 1-3).

The land capability classification system for Tasmania comprises a seven class classification and is based on the capability of the land to support a range of agricultural uses on a long-term sustainable basis.

The evaluation system takes into account only the land's capability to support sustained agricultural production and does not consider suitability for individual crops, forestry, orchards, vineyards or other non agricultural uses. Being one of a series some parts of the earlier sections of this report have been reproduced from earlier reports.

Much of Tasmania's agricultural land has limitations which restrict its agricultural versatility. The land capability classification system recognises these limitations and uses the physical characteristics of the land and the local climatic characteristics, to evaluate the area and classify it accordingly.

The information printed here and in the accompanying map is intended for use at a regional planning level and has limited use at the farm scale. The system can however, be applied at any level (see Section 3).

Surveys undertaken to date indicate that the State of Tasmania has only a small percentage of high quality, 'Prime' agricultural land (Class 3 or better) in proportion to the total area of agricultural land. Table 2

Land Capability Map	**Class 1** (ha)	**Class 2** (ha)	**Class 3** (ha)	**Total Prime Land on map** (ha)	**Agricultural Land on map** (ha)	**Percentage of Prime Land mapped.**
Pipers	0	910	2 895	3 805	152 860	2.49
Tamar	42	604	10 061	10 707	131 345	8.15
Meander	0	127	13 090	13 344	106 656	12.51
South Esk	0	0	8 622	8 622	216 821	3.98
Forth	912	6 986	16 650	24 548	113 173	21.69
Inglis	748	3 868	17 533	22 149	188 051	11.78
Total (to date)	1 702	5 509	68 851	83 175	908 906	9.15

Table 2. Prime agricultural land statistics for land capability maps produced to date.

With ever increasing demands placed on our agricultural land to produce greater yields per unit area and the continuing uptake of good agricultural land for urban development and subdivision, the incidence of degradation and the loss of Tasmania's prime agricultural resource has been escalating. The acknowledgment of this has come in the form of legislation (State Policy on the Protection of Agricultural Land 1998) which sets out to protect Prime land and regionally significant agricultural areas, in order to prevent their loss to non agricultural uses.

By determining the location and extent of Tasmania's better quality agricultural land we are better able to protect it from loss to non-agricultural use or degradation through inappropriate land management practices.

2. HOW TO USE THIS MAP AND REPORT

This publication comprises a report and map. It is important that the land capability map be used in conjunction with the accompanying report. By referring to the map, and locating the area of interest, the land capability class assigned to that area can be determined. This is indicated on the map by a class number (1 to 7) and an associated colour shade.

Definitions of the land capability classes are given on the side legend of the map and in Section 3 of the report. Further detail about each of the land capability classes occurring within the Inglis area is given in Section 6.

2.1 Limitations of Scale

Special attention needs to be paid to the "limitations" imposed by the scale of mapping.

It is important that the map is used at the scale at which it is published (1:100 000). **The map should not be reproduced at a larger scale (eg. 1:25 000)**. The land capability boundaries found on this map are accurate only at the published scale of 1:100 000. Errors in interpretation will occur if the map is enlarged. If more detail is required, the area of interest should be remapped at a more suitable scale for the end use, rather than enlarging this 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 64 ha. 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 25ha have been mapped only 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 on this map will therefore often contain more than the one land capability class or subclass. 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%, and in more uniform areas up to 90%, pure.

COMPLEX map units (eg. 4+5) have been identified in a number of areas where, due to the complexity of the soil pattern and particularly variation in the topography, two land classes are identified, each occupying between 40% and 60% of the unit, but which cannot be adequately separated at the scale of mapping. 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 discussion of complexes and the method of labelling map units is found in Sections 3 and 4.

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.

The majority of the exclusion boundaries for this survey have been supplied in digital format by Forestry Tasmania and are deemed to be accurate to 1998. Some areas less than 25ha have been removed to improve legibility of the map and absorbed into the adjacent land capability units.

2.2 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. This map has been produced at 1:100 000 scale and is targeted for use at the district or regional planning level.

Larger scale maps such as those at 1:5 000 or 1:10 000 are more suitable for whole farm planning purposes, to plan farm layouts and identify 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 for 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.

Best use can be made of this map and report 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 its use, accessibility and interpretation.

While intended for use by regional and State planning authorities, the information supplied by this map and report can still be used at the farm level to give a general indication of the land quality at a particular location. For example, a new comer to an area wishing to purchase good quality land for cropping could look to the map to find where Class 1, 2 and 3 has been identified.

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.

Section 3 of this report provides more information about land capability classification and definitions for the individual land capability classes while Section 4 discusses the survey methodology used. A general description of the survey area, including climate, geology, topography, soils, vegetation and land use appears in Section 5, while a detailed account of land capability classes found is presented in Section 6. Section 7 discussed some of the issues identified during the survey concerning the long term sustainability of the agricultural land within the Inglis area.

2.3 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 Industries, 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.

2.4 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 location of maps published to date are indicated in Figure 2. and the prices of the Land Capability publications currently available are listed below.

Pipers Report and Map	$15
Tamar Report and Map	$15
Meander Report and Map	$20
South Esk Report and Map	$30
Forth Report and Map	$30
Land Capability Handbook (revised edition)	$10
Land Capability Classification in Tasmania, Information Leaflet	No Charge

All listed items may be viewed and ordered at DPIWE reception desks or telephone 1300 368 550 State wide or Service Tasmania on 1300 366 173

3. LAND CAPABILITY CLASSIFICATION

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

For the Tasmanian classification system, agricultural land uses only are considered, and are defined as broad scale 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.

Land capability may be defined as a rating of the ability of land to sustain a range of land uses without degradation of the land resource. It is 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 (Figure 3).

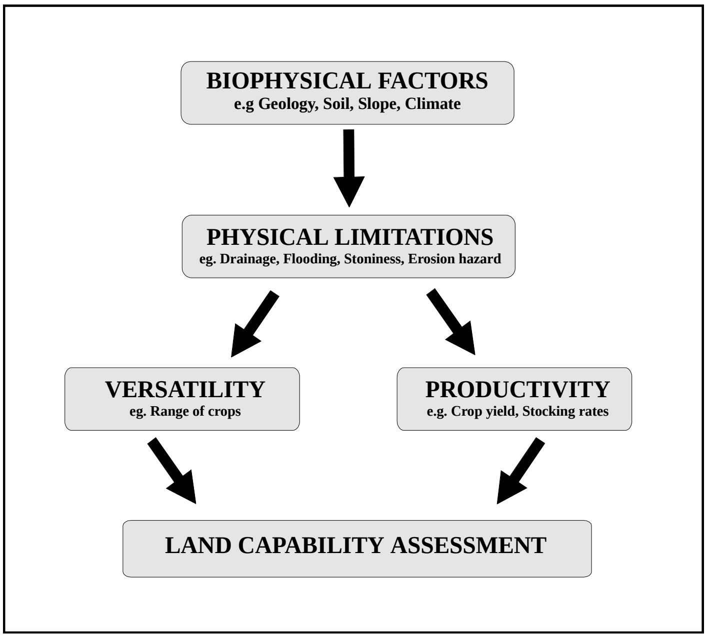


Figure 3. Factors in land capability assessment.

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, or social or political factors.

Land capability assessment should not be confused with land suitability assessment which, in addition to the biophysical features, may take into account economic, social and/or political factors in evaluating the 'best' use of a particular type of land.

Land capability classification gives a grading of land for broad scale agricultural uses, whereas land suitability is applied to more specific, clearly defined land uses, such as land 'suitable' for growing carrots, and usually defines specific management systems. The basic principle of land capability brings together both land conservation and land protection of land as well as its potential for broadscale agricultural production. In other words, the balance between use of the land and the risk of degradation of the land resource.

3.1 Features of the Tasmanian Land Capability Classification System

The Tasmanian system of land capability classifies land into seven classes according to the land's capability to produce agricultural goods. The system is modelled on the USDA (United States Department of Agriculture) approach to land capability (Klingbiel and Montgomery, 1961) and is described in full by Grose (1999). A summary of the system is presented here to assist with the interpretation of the report and accompanying map. The classification 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 Tasmanian land capability classification system is based on agricultural production (cropping and pastoral 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, silviculture).

The classification relates primarily to the three permanent biophysical features of the landscape - soil, slope and climate. These three factors have a major influence in determining the capability of the land to produce agricultural goods. Other factors which must be taken into account include rock type, erosion hazard, range of crops that can be grown, management practices, soil conservation treatment, risk of flooding and past land use history.

A valid criticism of the land capability classification process is that it is a very subjective system. In order to improve this aspect of the system a reviewed set of guidelines have been produced by Grose (1999). This handbook supersedes that of Noble and sets out more quantitative guidelines for assessing some land attributes. While the guidelines will improve the consistency between different surveyors a certain amount of subjectivity still remains in the determination of cut-offs for each land class.

Considerations of the system

The system assesses 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. For example, small scale intensive activities like soft fruit orchards and floriculture are not considered when evaluating the versatility of an area. Opportunities for silviculture are another activity that the system does not consider. The main agricultural land uses that are considered when evaluating land include cereals, poppies, broad acre vegetable production (potatoes, peas, beans, onions etc), pyrethrum and essential oils, dairy, beef, lamb and wool production.

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. except where it might impact on the quality of the agricultural resource.

The classification, in particular at the unit level, takes into account the management strategies and soil conservation requirements the land may need in order to maintain a level of production without long-term degradation.

For 1:100 000 scale surveys the issue of irrigation and its impact on land capability classification has created much discussion. While it is recognised that some areas of the State have the potential to attain an improved land capability ranking through the application of irrigation water, the extent of the beneficial effects of irrigation on land capability will vary considerably, depending upon such factors as water quality, economics and the skill of the property manager. These factors all require assessment on an individual property basis, a procedure inappropriate at this level of mapping. As well, it is beyond the scope of this survey to identify areas where irrigation water might be available. Land capability is therefore assessed on the ability of the land to support rain fed agriculture except where irrigated agriculture is considered normal practice and water is readily available from on farm water storage.

Assumptions

As with most land classification systems certain assumptions are necessary. These include:

(a) A moderately high level of management is being applied to the land.

(b) Appropriate soil and land conservation measures have been applied.

(c) Where it is reasonable and feasible for an individual farmer to remove or modify physical limitations (eg. surface and sub-surface drainage, stoniness, low fertility) the land is assessed assuming the improvements have been made.

(d) 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.

Other features of the system

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

- 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.
- Irrigation, or the feasibility of irrigation, is considered when evaluating land capability only where it is currently standard agricultural practice.
- The system is consistent across the State.

It is important to remember that the land capability of an area can change as a result of improved farming practices, changes in crop variety, technical innovations or just a better understanding of the relationships between soils, farming and the natural environment. The information in this report has a limited lifespan and care should be given to its interpretation in future years. Farming practices that today are only available for the advanced or innovative farmer may become common practice in the future.

3.2 The Classification Hierarchy

Three levels are defined within the Tasmanian land capability classification:

- The land capability ***Class*** - which gives an indication of the general degree of limitation to use
- ***Subclass*** - which identifies the dominant kind of limitation
- and the ***Unit*** - which differentiates between land with similar management and conservation requirements, productivity characteristics, etc.

The levels are also shown in Figure 4.

The land capability system can be used and applied at various scales by mapping to the class, subclass and unit levels. The level at which the mapping is undertaken and presented depends on the purpose and scale of the survey.

Class

The classification system comprises seven classes ranked in order of increasing degree of limitation, and in decreasing order of versatility, for agricultural use. The system is hierarchical. Class 1 land is identified as the best land and 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.

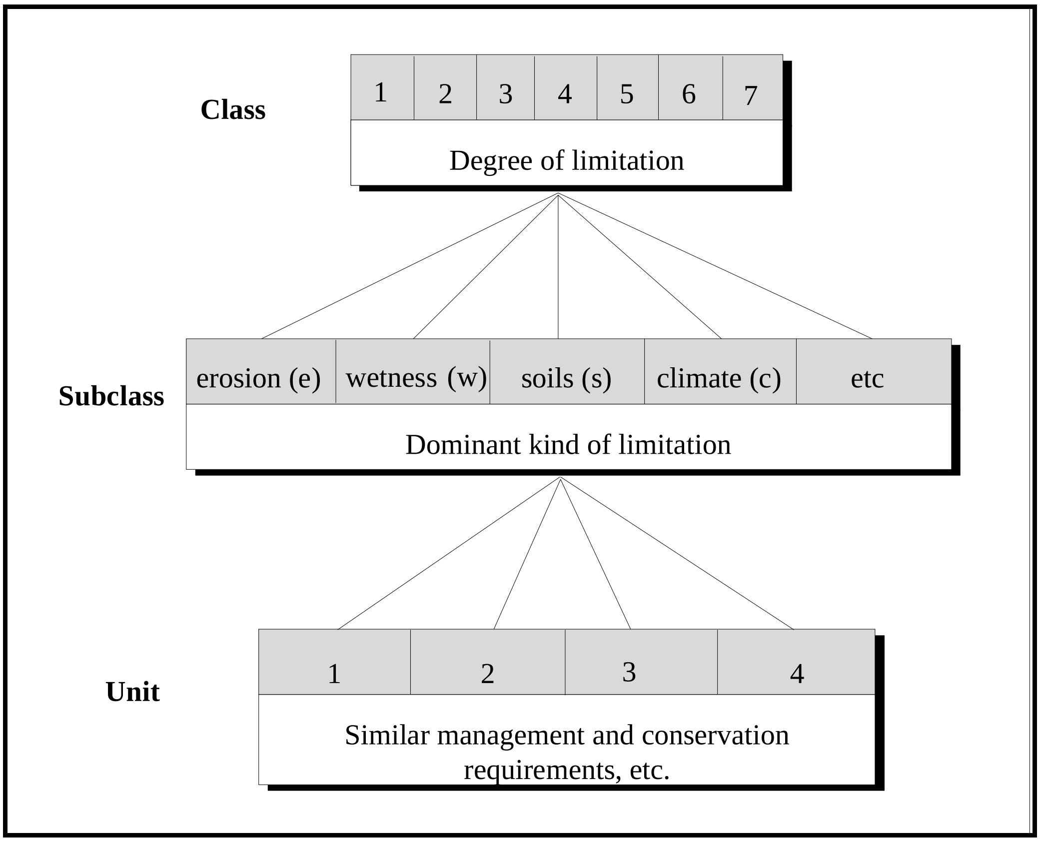


Figure 4. Levels of the land capability classification system.
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land Resources. (NWASCO), Wellington, New Zealand.)

A range of land may occur in any one capability class. Thus it is often possible, for example, to identify good and poor quality Class 4 land. While the intensity of mapping required to achieve this is not feasible when mapping land classes at 1:100 000 scale it would be possible to map such differences at the unit level.

Classes 1-4 only are considered capable of supporting cropping activities on a sustainable basis; Classes 5 and 6 are more suited to grazing activities only although occasional fodder cropping and pasture improvement may be possible on Class 5 land, while grazing of native pastures only is appropriate for Class 6 land. Class 7 land is unable to support any form of sustainable agricultural activity.

Definitions

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.

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.

CLASS 4

Land well suited to grazing but which is limited to occasional cropping or to a very restricted range of crops. The length of cropping phase and/or range of crops are constrained by severe limitations of erosion, wetness, soils or climate. 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 to avoid damage to the soil resource. In some areas longer cropping phases may be possible but the versatility of the land is very limited.

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.

Notes on the Class Definitions

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), other areas are limited by the risk of loss occasioned by such factors as adverse climatic conditions or flooding.

For example, some parts of the survey area are subject to a significant flood risk. Due to rainfall patterns in recent years it has been possible to cultivate these areas more frequently 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.

Figure 5 summarises the main features of the land capability classes.

Subclass

Within each class it may be possible to identify a number of limitations that restrict agricultural use. Limitations may be defined as physical factors or constraints which affect the versatility of the land and determine its capability for long-term sustainable agricultural production.

<table>
<tr><th colspan="2">CLASS</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

Where limitations are found a class may be allocated a subclass code, depending on the nature of the dominant limitation or hazard that exists. Subclass codes are a single letter which is added directly after the Class. For example an area identified as Class 4 that is limited by erosion risk is coded 4e. A range of subclass codes exist. The four basic subclass codes are (c)-Climate, (s)-Soil, (e)- Erosion and (w)-Wetness. More discussion of subclasses exists in Section 4.

Unit

Unit codes may be added to the *Class* and *Subclass* classification when conducting a detailed land capability study at the farm scale. Unit codes help to distinguish between similar areas that require different management or conservation requirements. They may also be used to separate areas which have slightly different productivity characteristics which may not be significant in a broader scale study. For example an area identified as 4e may be further divided into land requiring conservation practices appropriate to wind erosion 4e1 and land requiring conservation practices appropriate to water erosion 4e2. Unit codes are therefore not a consideration in a 1:100 000 scale study.

3.3 The Use of Land Capability Information

Land capability information remains a valuable interpretative tool for long term regional and State planning and the system can be applied relatively easily at a more detailed level for local and farm planning. There continues to be a demand for this type of information from local government for strategic plans and also by Landcare, whole farm planning and catchment management groups who can use the system at a more detailed level.

Demand for land capability information is also set to increase due to implementation of the State Policy on the Protection of Agricultural Land (1998) by local governments. DPIWE, in order to provide information in the higher priority agricultural areas, has increased its resources to cover the Inglis, Circular Head, Forester, Derwent, D'Entrecasteaux and Nugent areas by June 2000.

Seminars and training sessions for local government planners are also being organised to help local governments understand what land capability information is, how it can be used and its short falls in terms of strategic planning.

Funding of the Land Capability programme by DPIWE and the Natural Heritage Trust will see much of the States' agricultural area mapped by June 2000.

Potential users of the information should be aware of the problems of trying to use the information at a scale larger than the published one. Land capability information within this report has been collected at an intensity appropriate to the scale of the final map (1:100 000). The level of impurity of each map unit and the accuracy of boundaries are therefore acceptable at this level of mapping but would be inappropriate for use at a more detailed scale.

DPIWE staff welcome constructive comment and criticism of the report and accompanying map and, in the unlikely event that significant errors in classification are identified (at a scale appropriate to the level of mapping), they can be reported to DPIWE staff and documented appropriately.

4. SURVEY METHODOLOGY

The land capability map is produced through a combination of field work and aerial photo interpretation (API). Fieldwork commenced in November 1997 and concluded in August 1998. A review of relevant land resource information was also undertaken to provide a background for field investigation.

Resource Information used

The Soil Association Map of the Burnie-Table Cape Area, 2 miles to 1 inch scale by J Loveday (1954) has been used as the primary soil reference. Other soils information has provided valuable background information throughout the study and are referred to within Section 5.5.1. Detailed soil descriptions generated by each of these studies have been utilised as reference sites for this study.

Geological information for the area is covered by 4 maps produced by the Tasmanian Department of Mines at a scale of 1:63 360 and 1:50 000. These are, from north to south, Table Cape, Burnie, St Valentines and Mackintosh. These maps have helped determine the relationships between landform, geology, soil and the associated land capability.

During field work considerable use has been made of computer generated slope maps using 1:25 000 scale contour information (10m contour intervals). These maps interpret slope from a digital elevation model created from the contour information and spot heights recorded on the 1:25 000 maps and provide a 50 m resolution. This information has proved invaluable in locating class boundaries where access has been difficult or in areas that are extensively covered by forest. Use has also been made of a rainfall isohyet map created by the HEC (1986).

Black and white aerial photos at a scale of 1:42 000 taken during March 1992 have been utilised to determine boundaries where access has been difficult or where topography and landform has been the major determinant of the boundary (eg ridge or steep valley top).

The Mapping Process

Field work progressed along public access roads and on private property as needed, to assess land capability on-site and to check soil type, geological boundaries etc. Soil investigations have been made by hand auger and spade, as well as examination of soil exposures in ditches or road cuttings to determine depth of soil horizons and other important soil properties (Photo 1).

A combination of aerial photo interpretation and field assessment was used to determine land capability boundaries. These boundaries were then recorded onto 1:50 000 scale field maps before being transferred to base maps for digitising.

In line with standard mapping practices not all map units have been visited, rather informed assumptions have been made about some map units based on a knowledge of the area and information extrapolated from similar sites. Interpretations of existing land information and aerial photographs have been used to predict land capability. This approach is necessary to reduce the time required to produce an end product. It is applicable for areas where a good understanding of the relationships between soil, geology, landform etc and land capability exists and is consistent with 1:100 000 scale mapping methodology.

In assessing land capability consideration has been given to a wide range of land factors, together with information supplied by local farmers, land managers and agricultural advisers within DPIF.

Photo 1. The description and characterisation of soil types forms an important part of land capability fieldwork. Here soil depth and stone/outcrop abundance severely limits agricultural capability. (GR E 391200, N 5426650)

Storage of the data

All map information has been captured and stored in the Arc Info Geographic Information System (GIS) at Prospect offices in Launceston. This information was digitised from 1:50 000 scale base maps and includes subclass label information.

Site information was recorded in the field and entered to the Departments Soil and Land Capability Database for reference and quality control purposes. This database includes a range of site information relevant to evaluating land capability and holds both land capability class and subclass information. An example of a completed site card appears in Appendix A.

Other site observations relating to previous surveys have also been used during the survey as reference sites giving a total of 357 reference sites within the survey area.

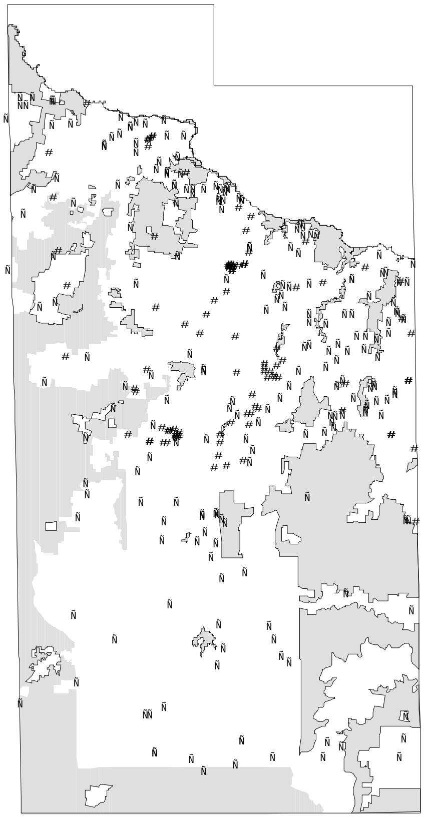
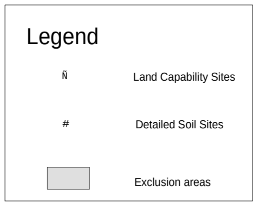


Figure 5. Distribution of Land Capability Observation and Soil Reference sites for the Inglis study area.



Reliability of the Data

Figure 5 provides an indication of the distribution of these sites and those used for reference purposes. Each site observation recorded during the survey is only accurate for the locality specified by its corresponding grid reference.

Figure 6 presents a reliability diagram which reflects the availability of resource information, the level of field work intensity and the expected boundary accuracy. This diagram is also located on the side legend of the Inglis map.

The region with greatest reliability is Zone 1. This area corresponds to the detailed mapping that was undertaken for the Pet and Guide Survey (Grose and Cotching, 1995). The 1:25 000 map boundaries have been used but simplified for publication at 1:100 000 scale use. No further field investigations were undertaken within this zone for this study.

Because the northern portion of the Inglis area is more intensively used for agricultural and urban use and the south mainly used for plantation forestry use, a decision was made at the start of the survey to focus most of the field work time in the northern area. The area covered by the soil association map of Burnie-Table Cape by Loveday (1954) provided a convenient southern boundary for this area and determines the limit of Zone 2. The information from this soil map and its associated report has resulted in greater a certainty of land capability boundary identification.

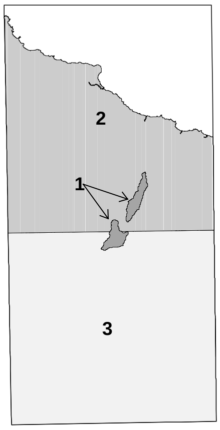


Figure 6. Reliability diagram based on intensity of field observations and existing land resource information**.**

The remainder of the land area below the southern boundaries of Zone 2 and Zone 1 has been assigned to Zone 3. This represents an area of lower priority and lower intensity of field observations, therefore having the lowest of the reliability ratings. This area also has the least amount of land resource information available, requiring greater use of aerial photo interpretation and geological information to determine land capability boundaries. Boundary reliability and map unit purity are therefore likely to be lower in this zone.

Complex Map Units

In some parts of the survey area the complexity of topography or soils make it impossible to separate pure land capability classes at the scale of mapping. In such instances 'complex' map units have been identified.

Considerable effort is made to map areas of a single land class but inevitably some complex units are unavoidable. Due to the reduced intensity of the survey procedure in the south of the map area together with the shortage of soil information and greater problems of access more use of complex units has been made in this area.

It is likely that more detailed investigations, at a more appropriate scale, could resolve many of the complex areas identified on within the Inglis area into units of a single land class.

Use of Subclass codes

Although the published map does not display any subclasses codes, an attempt has been made to identify the dominant limitations (subclass) to agriculture within each polygon during the course of this survey. No attempt has been made to determine the boundaries between each of the subclasses however. As mentioned above the sub-class information is stored by DPIWE. This information can be requested by contacting the resource assessment staff at Prospect Offices in Launceston.

In the Inglis area it is common for large map units to occur that contain several limitations which change frequently over a very short distance. In such cases multiple subclass codes are recorded in order of dominance within that area (eg 4es).

During the course of the fieldwork it became evident that the traditional four subclass codes as specified in Section 3 of this report were insufficient to identify the precise nature of the limitation, or that the limitation identified did not fit any of the existing categories. For example previously, where stoniness of the soil was identified as the most limiting factor to agriculture, it had been simply defined as a soil (s) limitation. In this survey, site records denote it as an (r) rockiness limitation.

Similarly, in some parts of the survey area it is the irregular nature of the surface topography which limits land capability. This did not fit well within any of the existing limitation codes and thus a new limitation, topographic fragmentation (t), was created.

The increase in the number of subclass codes used makes little difference to the map product at 1:100 000 scale, but it has enabled more useful information to be recorded on the site record cards. The latest improvements to the system have been finalised since the completion of this work and are detailed within the NEW Land Capability Handbook by Grose (1999) which supersedes that by Noble. The final list of subclass codes within the new handbook may differ slightly from those recorded during this survey.

General Principles

When using the land capability information for the Inglis survey area consideration should be given to the following points:

- The Land Capability Classification system is designed to evaluate the general *agricultural* capability of the land and thus no consideration is given to other potential land uses. For the purpose of this work "*agriculture*" does not include forestry operations.
- Only private freehold and leased Crown land has been mapped with all other areas of State Forests, State Reserves, Conservation Areas, National Parks, Crown Land, Urban areas etc being excluded from the study. These non agricultural areas are determined by land tenure boundaries supplied by Forestry Tasmania and are indicated on the map by the letter E and appear without a colour shade.
- As provided by the Land Capability System (Section 3) seasonal irrigation of crops is considered standard practice throughout the Inglis survey area. Irrigation of crops is generally considered essential to produce economic yields and protect crops from failure. As a result, land capability in this survey area has been assessed assuming irrigation water is freely available and that appropriate conservation and drainage measures are undertaken to minimise degradation.

5. THE INGLIS SURVEY AREA

5.1 Introduction

The study area lies on the north west coast of Tasmania (see Figure 2). It includes the local coastal centres of Burnie, Somerset and Wynyard and numerous other smaller inland townships such as Ridgley, Waratah and Yolla. The total area is some 285 000ha of which just over 97 000ha (34%) are exclusion areas, most of which comprise State Forest, Forest Reserve and National Park.

The area as a whole has a diverse range of landscapes, climate and associated land uses which are discussed in the sections below.

5.2 Climate

The climate of the Inglis survey area is considered temperate maritime with cooler, drier summers and milder (in the northern parts), but wetter winters compared to some other parts of the state.

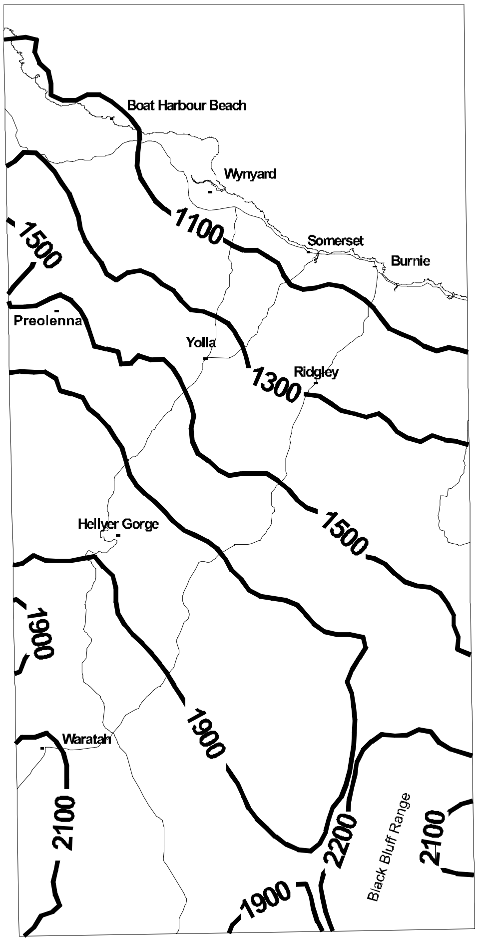
A range of climatic conditions is experienced within the Inglis area which can be directly related to distance from the coast, proximity to the mountain ranges, elevation, topography and aspect. The climate becomes increasingly more severe with distance away from the coast.

The climate has affected land use within the area to the extent that the main intensive vegetable production areas occur near the coast where more conducive growing conditions exist. As elevation and distance from the coast increases, conditions become less favourable for temperature and frost sensitive crops. Cropping enterprises then give way to dairy farming and other grazing activities. Further inland the establishment and growth of improved pastures becomes increasingly more difficult due to poorer climatic and soil conditions, eventually giving way to intensive plantation forestry and seasonal grazing of native pasture on the highland plain country.

Within the intensive agricultural areas, and even within some of the intensive grazing areas (especially dairy), irrigation is essential to achieve economic and reliable productivity. This is a reflection of the seasonal distribution of precipitation throughout the region, rather than the lack of it.

5.2.1 Precipitation

The amount of rainfall received in the Inglis area increases from north to south. The north east coastal areas are the driest regions within the survey area recording close to 1000mm at Burnie. The south western and south eastern regions are the wettest with over 2100mm per annum recorded at Waratah and over 2200mm in the Black Bluff region. Figure 7 shows a simplified rainfall isohyet diagram for the survey area. This information has been created using ESOCLIM climatic modelling software, and the results closely reflect previous work by HEC (1986).



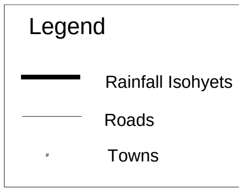


Figure 7. Simplified rainfall isohyet diagram for the Inglis survey area (mm/annum).

A selection of rainfall stations have been chosen throughout the survey area to show average monthly rainfall and the variation between coastal and inland locations (Figure 8). Precipitation is winter dominant at all stations with over two thirds falling between the start of April and end of October. The driest period of the year is January through to March.

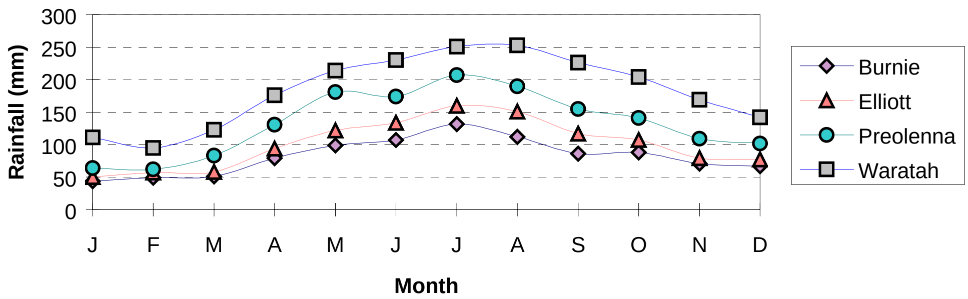


Figure 8. Average monthly rainfall for selected stations

Snowfalls and hail storms occur mainly between April and October, but are largely confined to upland areas. Snow may settle and remain for days and sometimes weeks on the mountain summits and highland plains in the southern areas of the survey area. When south to south westerly weather systems prevail occasional isolated snow falls occur within 12km of the coast, but rarely settle for any length of time.

5.2.2 Evaporation

Three stations record evaporation data within the survey area, Burnie, Elliott and Preolenna. While these stations are all located in the northern half of the survey area, their average monthly evaporation figures (Table 3), plus climatic modelling using ESOCLIM (Figure 9), provide a good indication of the areas and the months of the year that are likely to have a moisture deficit.

		Jan	Feb	Mar	Apr	Mar	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Burnie	Evaporation	151.9	130.0	102.3	63.0	37.2	27.0	27.9	40.3	60.0	99.2	126.0	145.7	1010.5
	Rainfall	44.0	49.0	51.0	79.0	99.0	107.0	132.0	112.0	86.0	88.0	71.0	67.0	985.0
Elliott	Evaporation	170.5	141.3	114.7	72.0	46.5	36.0	37.2	52.7	69.0	105.4	129.0	158.1	1132.4
	Rainfall	50.0	57.0	58.0	94.0	122.0	134.0	160.0	151.0	117.0	107.0	79.0	77.0	1206.0
Preolenna	Evaporation	142.6	118.7	93.0	57.0	40.3	36.0	37.2	46.5	60.0	89.9	111.0	130.2	962.4
	Rainfall	64.0	62.0	83.0	131.0	181.0	174.0	207.0	190.0	155.0	141.0	109.0	102.0	1599.0

Table 3. Average monthly evaporation and rainfall figures for stations which record evaporation data Shaded area indicates months where a moisture deficit occurs ie where evaporation exceeds rainfall.

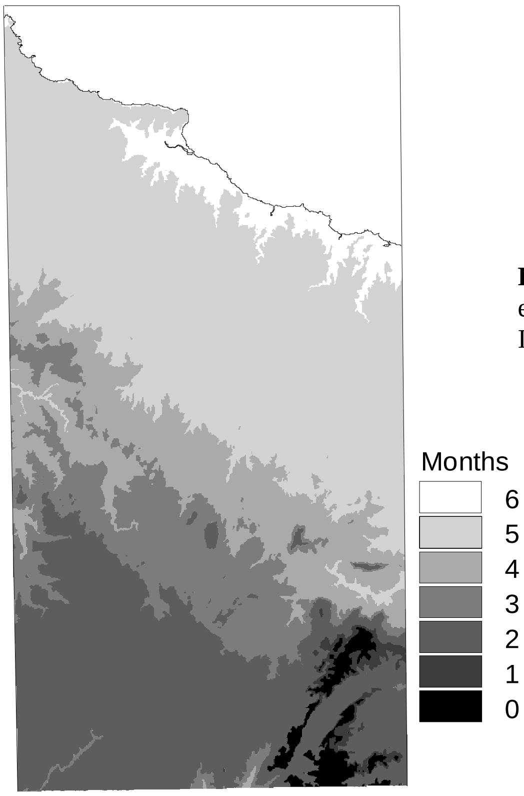


Figure 9. Number of months that evaporation exceeds rainfall across the Inglis survey area (ESOCLIM).

Both data sets indicate that evaporation plays a larger role close to the coast where rainfall is lower. Each year farmers here may expect a 5-6 month period (Oct through to end of March) where rainfall is less than evaporation. This means that cropping farmers nearer the coast need to use more irrigation water than those further inland. More importantly however, this moisture deficit period does also allow them to plant earlier and harvest later, due to more conducive soil moisture conditions, thereby extending the potential growing season. In some locations this can allow an extra crop to be grown.

Calculations of effective rainfall using the evaporation figures for each evaporation station and Prescott's Effective Rainfall formula (Prescott and Thomas, 1949) also confirms that some locations within the Inglis area will experience acute shortages of moisture during the growing season. Average monthly rainfall falls short of the amount of rainfall required to result in germination and maintain plant growth (referred to by Prescott as Effective Rainfall) during the months November through to March. This period is lengthened to mid September through to April in the drier areas of the north and north east.

Without supplementary irrigation through these months, the risk of crop failure or yield loss is considered very high. Consequently irrigation is a common practice in the intensive cropping areas and considered essential to maintain the high levels of production currently demanded by growers to ensure their economic viability.

Some locations within the survey area experience very wet soil conditions due to high rainfall and low evaporation. This results in a shortened window of operation for farmers in these regions. Soil moisture conditions prevent timely access to perform planting and harvesting activities and increase the risk of soil degradation when the ground is cultivated. Localised waterlogging and surface ponding can occur for extended periods at these locations. Cold temperatures also combine to further limit agricultural activities at these locations.

5.2.3 Temperature

Average temperatures for selected stations in the Inglis show a distinct seasonality (Figure 10). Maximum temperatures occur during January and February and minimums during July.

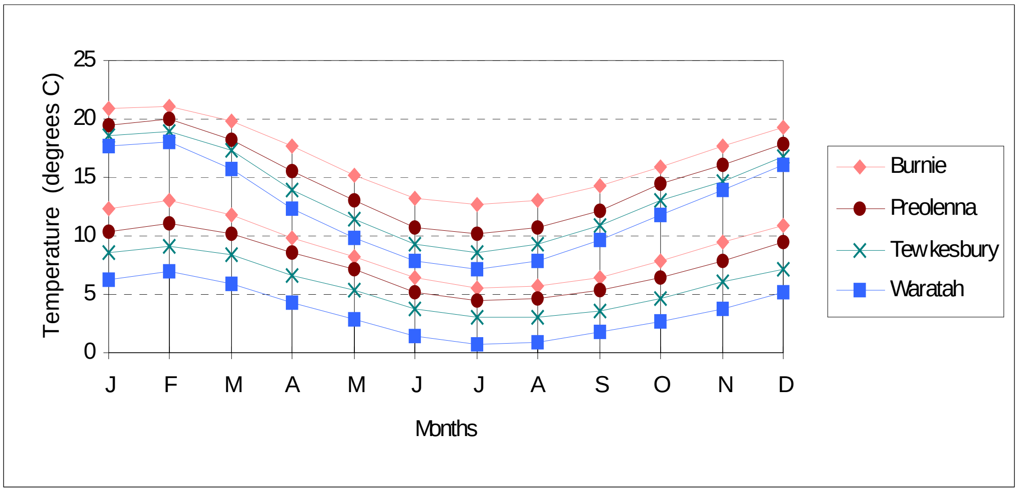


Figure 10. Mean monthly maximum and minimum temperatures for selected stations (Source: Bureau of Meteorology, unpublished data, 1998)

Elevation and proximity to the coast have a significant affect on mean daily maximum and minimum temperatures. Burnie for example, at an elevation of just 10m and adjacent to the coast, has average maximum and minimum daily temperatures of 21^{o}C and 5.6^{o}C respectively. Waratah, at 612m and 55km from the coast, has corresponding temperatures of 17.6^{o}C and 0.8^{o}C.

Frosts can occur anywhere within the survey area at almost anytime of year (Figure 11). Greatest risk is generally between April and November for inland and higher altitude areas and May through to October for more coastal locations.

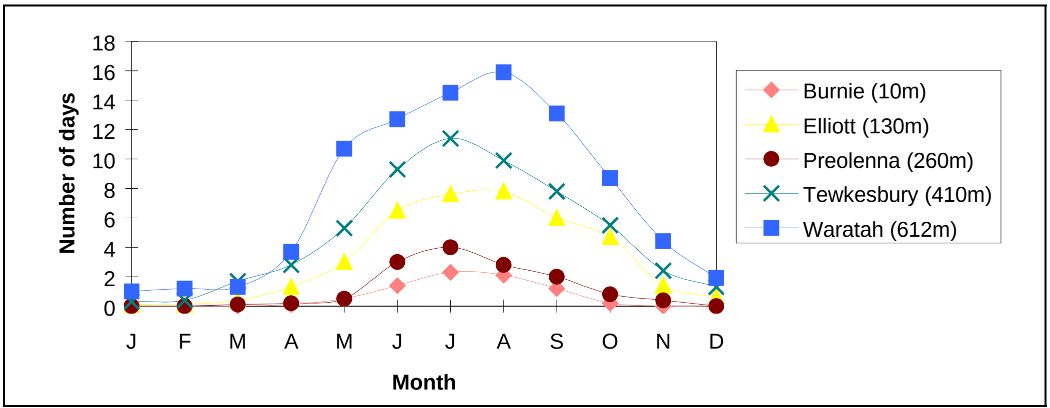


Figure 11. Mean number of days per month with frost
(Source: Bureau of Meteorology, unpublished data, 1998)

Frost risk is a significant consideration when assessing the versatility of the land and altitude has been used as a surrogate to identify separate land classes on the basis of frost risk. The altitude limits for each land capability class have been determined through observation and discussion with land managers and crop experts. These limits have been used as a general guide although it is recognised that cold air drainage, aspect and topography can also affect the frequency and severity of frost at the local level.

Local experience indicates that on the plateaux and ridges at about 280-300m cold air drainage occurs and therefore these areas are less prone to frosts than some lower elevations. These local air movements can mean a slightly longer growing season than might normally be expected for an equivalent altitude but the areas are rarely identified with sufficient reliability to map them individually.

5.2.4 Growing Season

The length of growing season in the Inglis survey area is determined by moisture availability and temperature. As discussed earlier, the natural growing season can be significantly extended with the application of irrigation and this has become standard practice in many parts of the survey area where better soil conditions make greater levels of inputs more financially viable. A lack of reliable information on growing season allows only general comments to be made.

The effect of rainfall distribution on growing season is difficult to determine as little cropping is undertaken in the area without supplementary irrigation. It seems generally accepted that some crops could be grown without extra water but yields would be significantly reduced or perhaps not viable. Irrigation certainly extends the length of the growing season well into the summer months and allows the growing of more than one crop a season in some areas. At inland locations water logging from frequent high intensity rainfall events has been seen to retard the growth and development of plantation trees indicating that too much rainfall can also affect growing conditions in some areas.

Altitude has been used as a surrogate for temperature in assessing the risk of frost and the period during the year when daily temperatures are suitable for germination and crop growth. Altitude classes used have been determined through discussion with farmers and industry representatives with experience of a wide range of crops and crop climatic requirements. As a general rule the upper elevation limits for climate to be a limiting factor within the Inglis survey area are as follows:

Class 1 land	180m (long season, low frost risk)
Class 2 land	260m
Class 3 land	380m
Class 4 land	500m (short season, high frost risk)
Class 5 land	700m
Class 6 land	No upper limit set.

Over the area as a whole the growing season is likely to be longest at lower elevations and where there is ample precipitation or irrigation potential. Coastal regions in the north of the survey will have the longest season while higher elevations towards the south and south-west will have the shortest. Local topographic effects, aspect, frost hollows and local airflow patterns are likely to have a significant impact on this general pattern but fall outside the scope and level of detail of this work.

5.3 Geology

The geology of the survey area is covered by four geological maps which are, from north to south, ‘Table Cape’ 1:63 360 (Sheet 22, 1966), ‘Burnie’ 1:63 360 (Sheet 28, 1967), St. Valentines 1:50 000 (Sheet 36, 1986) and Macintosh 1:63 360 (Sheet 44, 1966). Each map has an accompanying explanatory report that has detailed descriptions of all the rock types present.

Data from the above maps have been simplified and overlaid onto a digital terrain model in order to show the areal extent and the variety of rock types throughout the Inglis area (Figure 12).

This figure also shows the complex geological make-up which covers a substantial time-span from the Precambrian period which includes rocks older than 570 million years, through to very recent features of the Quaternary period that are younger than 2 million years.

Only a summary of the major rock types and their main form is found in the next few pages and readers are directed to the explanatory reports accompanying the above maps for more detailed information. Rock types are described in order of their age beginning with the oldest rocks within the survey area.

Precambrian Rocks (570-2500 Million Years Ago (MYA))

Precambrian materials, including quartzite, siltstone, shale, dolerite and schist, occur in the coastal locations of Rocky Cape and Sisters Hills in the north west and at Round Hill in the north east. Rocky Cape is formed by a geanticline that was folded and faulted during a previous period of mountain building (Penguin Orogeny). Near the coast the hills stand above surrounding Tertiary basalt lavas, while elsewhere they have been buried by younger materials. Some sediments have been exposed by erosion and dissection in the major river valleys. Small pockets of quartzite and phyllite also occur north of Cradle Valley and near Waratah.

Cambrian Rocks (505-570 MYA)

Cambrian mudstone, chert, siltstone and greywacke occur mainly in conjunction with the Precambrian and Ordovician sediments, which overly them at Waratah, and accompany them in the Native Track area, the foothills of the Black Bluff range and St. Valentines Peak where faulting has occurred. Cambrian igneous rocks take the form of pillow lavas and sedimentary rocks that have formed from accumulations of ash and pyroclastic materials. These occur at The Hummocks and Winter Brook area in the south of the survey area.

Ordovician Rocks (438-505 MYA)

In the south of the map Ordovician conglomerate and sandstone combine with minor areas of Cambrian mudstone and greywacke to form the Black Bluff range and other peaks and mountains such as Mt Pearse, Mt Catley and St. Valentines Peak. Talus materials occur at the foot slopes of these mountain areas, forming a very rocky, broken landform. Many faults occur in this area and often determine the boundaries separating lithology. Ordovician hornfels occurs east of St. Valentines peak and fossiliferous limestone of variable texture occurs at the Vale of Belvoir, Gunns Plains and Loongana where sinkholes and caverns have formed.

Devonian Rocks (360-408 MYA)

To the north of Black Bluff an expanse of Devonian granite occurs and occupies the upper valley of the Emu River and surrounding areas of Natone, Loyetea and South Riana. Outcrops are common at the breaks in slope and summit of the hills. Some smaller granite hills have been surrounded by the Tertiary basalt lavas and have granitic peaks and a shallow covering of basalt on lower slopes. Erosion continues to reveal the underlying granite material. It is suggested by Seymour (1989) that the shape and extent of the granite intrusions have been determined by pre existing structures in the country rock.

Permian Rocks (245-286 MYA)

Permian sediments occur in many of the river valleys of the central and coastal north west. These sediments include mudstone, siltstone, sandstone and glacial tillite, and are often fossiliferous. Removal of younger material through erosion and incision of the relatively soft Permian sediments has resulted in steep hills and cliffs along the Cam,

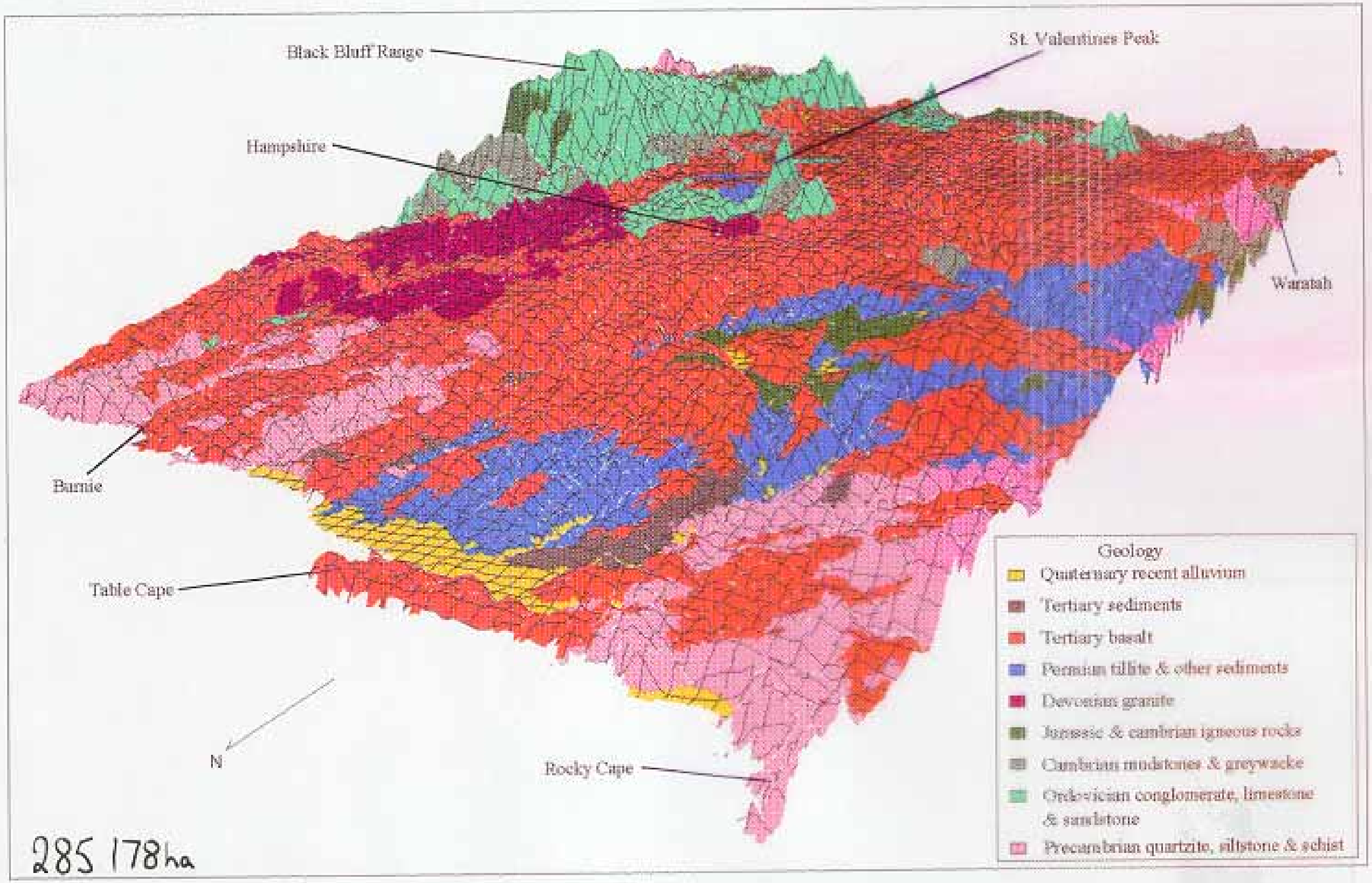


Figure . Digital elevation model & simplified geology of the Inglis survey area

Jessie, Hellyer, Calder and Inglis rivers. These sediments are visible in the banks of Seabrook, Camp, Baulds and Blackfish Creeks. Tillites have been described by Banks *et al*., (1955) and have been measured to 250m in depth. These glacial deposits are usually made up of a matrix of poorly sorted stones and pebbles of a variety of rock types that have been loosely cemented together by finer material.

Jurassic Rocks** **(144-208 MYA)

Jurassic dolerite appears as a small remnant sill (Gee 1977) at Diabase Hill, south of Preolenna, overlying Permian sediments, and at Takone and Henrietta. This rock is medium to coarse grained but becomes finer toward the margins of the intrusion.

Tertiary Volcanic Rocks and Sediments** **(2-66 MYA)

Tertiary basalt is by far the most dominant rock type within the survey area. It is characterised by many different lava flows which in combination reach depths of up to 300m (Seymour 1989). The volcanic neck at Table Cape and probable eruptive sites at Mt Hicks, Mt Catley, Hampshire and South Riana, represent the only sources of this lava that have been discovered to date.

It is thought that these lava flows engulfed many of the valleys existing at that time. Evidence of this is found at the western edge of Emu Bay and at Doctors Rocks where columnar basalts occur. Inland however lava has covered nearly all of the older landscape to produce a vast highland plain where only the higher mountain peaks and hills have escaped being enveloped. To the south of the Inglis area outliers of basalt indicate a once much wider extent of this rock type.

The rocks are a mixture of tholeiitic and alkali olivine basalts that display a wide variety of grain sizes and textures. Columnar jointing is displayed at a number of quarry sites where the material has been utilised for road and construction material. Basalt hills are often the site for springs and water seepage. Water flows through the fractures in the rock or along the contact zone with underlying less permeable rock types.

Overlying the Permian sediments in a number of locations south of Wynyard, are sands and gravels of terrestrial origin. These materials have often been utilised for construction purposes and many quarries and gravel pits are evident in these areas.

Other Tertiary deposits include an assortment of terrestrial and marine sediments that are found between the lava flows throughout the Burnie and Somerset districts. These areas have been found to contribute to landslides (Hughes 1959).

Quaternary Sediments** **(<2 MYA)

Quaternary alluvium occurs mainly on the relict coastal platform, river valleys, flood plains, swamps and marshes. The materials range from beach cobbles through to fine sands and clays.

The main deposits are found around Wynyard, south of Sisters Beach, the Flowerdale River valley, and in a variety of marshes and swamps at both upland and coastal locations (such as Micklethwaite Marsh and Champion Heath). The accumulated material represent a mixture of weathered rock fragments and finer sediments eroded from surrounding country rocks.

Other Quaternary material includes the talus fields adjacent to the hills and mountains in southern upland areas. These accumulations of material include large boulders and stone fragments originating from the rocks types found upslope and are a result of freeze thaw processes operating on exposed rock and cliffs.

5.4 Topography and Geomorphology

The Inglis area has a large range of topographic features from coastal plains and escarpments to rolling hills and plateau country, steep river valleys, highland plains and inland mountain peaks and ranges. One of the more notable aspects of this area is the complexity of the topography within relatively small physical areas. At times this complexity of topography has made the identification of pure land capability units exceedingly difficult, particularly at the scale of mapping used.

Coastal Plains and Escarpments

Along the coast a number of coastal plains exist, notably at Blythe Heads, Wivenhoe, Somerset, Wynyard and Sisters Beach. These areas can vary from a few hundred metres in width to a few kilometres and reflect emergence of the sea floor caused by past changes in sea level. They also represent zones of accumulation of the varied sediments carried to the coast by the major river systems. Along much of the coastline, rocky shore platforms and escarpments occur including features such as cliffs, sea caves and headlands. These are displayed at locations such as Doctors Rocks and Fossil Bluff.

Behind the coastal plain areas, a relict, cliffed coastline exists indicating that sea levels were once higher. Many of these cliff lines represent the terminal ends of the Tertiary lava flows that have been eroded by wave action when they were once sea cliffs. The volcanic neck of Table Cape is also a prominent coastal feature and is bounded at its north east perimeter by precipitous 90-100m basaltic cliffs which descend directly to the sea.

Plateau and Rolling Hill Country

Behind the escarpments and coastal plains, the terrain is characterised by a heavily dissected and undulating landform. These hills and valleys represents one of the more complex topographic units. This area has been formed due to the erosion of basalt lava flows by the many small streams in the area. In some areas this erosion has cut through the basalt and exposed the underlying bedrock within steep sided river valleys and creek lines.

The plateaux that remain form a linear pattern adjacent to the river valleys, and are themselves dissected but to a lesser degree. Vegetation clearance and subsequent mass movement have resulted in a hummocky or “slumped“ pattern on the steeper slopes of this landform (Jennings 1963). Examples of slumping land are evident at Elliott Research Station and 2km east of Lower Mount Hicks along the Seabrook road.

Steeper River Valleys and Hill slopes

Steep river valleys and hill slopes are to be found in association with all the major river valleys. These features have resulted from the powerful down cutting action of river waters. These areas can be differentiated on the basis of steeper slope gradients, cliffed landforms and high erosion risk. Most notable are those areas surrounding the Blythe, Emu, Cam, Inglis and Flowerdale, Hellyer and Leven Rivers. Each river has cut deep gorges into the underlying bedrock and in places exposes a range of strata from Tertiary age higher in the landscape through to Precambrian on the lower slopes.

Highland Plains

Extensive plains are found throughout the southern section of the survey area, generally above the 500m contour, surrounding St. Valentines Peak, Talbots Lagoon and around the historic settlement of Guilford. These areas have formed from Tertiary basalt lava flows and feature low hillocks and knolls that are characteristically rocky in nature. Some of the areas are very flat and foster wetland vegetation forming small isolated marshes and swamps.

Marshes, Swamps and Button Grass Plains

Areas of Tea Tree swamp occur along the coastal areas skirting Sisters Hills and around parts of the Wynyard district. All occur low in the landscape and receive significant run-off from nearby hills and escarpments.

Within the mountain areas and those to the south of the survey area, boggy areas such as Micklethwaites and Romney Marshes occupy depressions in the landscapes or gently sloping land. Many of these marshes are characterised by button grass and sedge vegetation formed on acidic organic soils.

Mountain Peaks and Ranges

There are several prominent peaks and ranges within the survey area. These include the lower altitude formations of Sisters Hills (100-290m) and the Dip Range (~300m) in the coastal north west as well as St. Valentines Peak (1106m) located centrally in the survey area. Further inland alpine areas include Mt. Bischoff (784m), Mt. Pearse (1001m) and Mt. Cripps in the south west. The Black Bluff Range includes the peak of Black Bluff (1339m), Mt. Tor and Mayday Mt. (1140m) and skirts the south eastern region of the Inglis area.

Major Rivers and Hydrology

The major rivers include the Blythe, Emu, Cam, Inglis and Flowerdale Rivers and the upper catchments of the Hellyer and Leven Rivers. While the predominant drainage direction for the northern river systems is north east, the inland rivers have a slightly different direction of flow. The Hellyer River, a tributary of the Arthur River, flows north west and the Leven, blocked by the Loongana Range, flows eastward at first before heading northward to the coast.

All these rivers have headwaters that originate well into the high rainfall zone. This provides high flow volumes during winter periods and tremendous erosive power. Some rivers are utilised for town water supply and some sections are reserved to protect water quality.

Stylised cross sections have been created for parts of the survey area and presented in Figures 13, 14 and 15 These transects represent the dominant landforms present within the Inglis survey area and aim to display the interrelationships between landform, geology, soil and land capability.

5.5 Soils

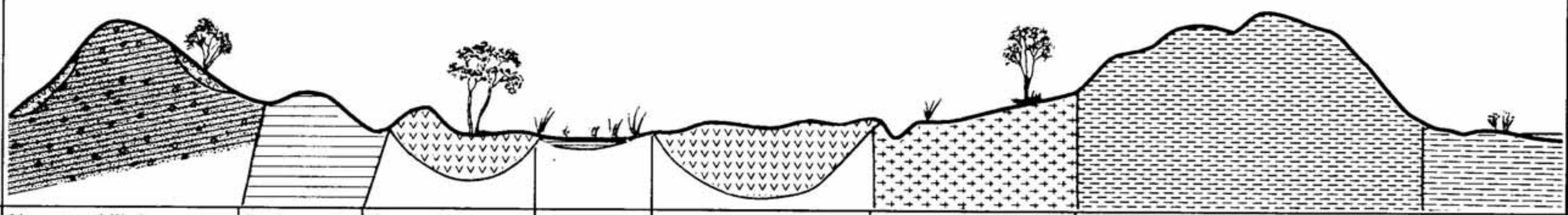
5.5.1 Background and Previous Studies

The north west coast of Tasmania has attracted the attention of primary producers since the early days of settlement and has been the focus of a number of land and soil studies that have aimed to understand the soil formation, soil nutrient status and the potential of the region for a number of different enterprises, including timber harvesting, pasture production, vegetable cropping and water catchments.

One of the earliest studies in the area was the report by Stephens (1937) on the basaltic soils of northern Tasmania. This work contained a semi-detailed soil survey and attempted to answer a number of questions pertaining to the response of pasture to lime and superphosphate applications. Later, in 1944, Hubble undertook a reconnaissance survey of the Wynyard district with a view to establishing post-war forest plantations. While this report used the same classification as Stephens no map was produced.

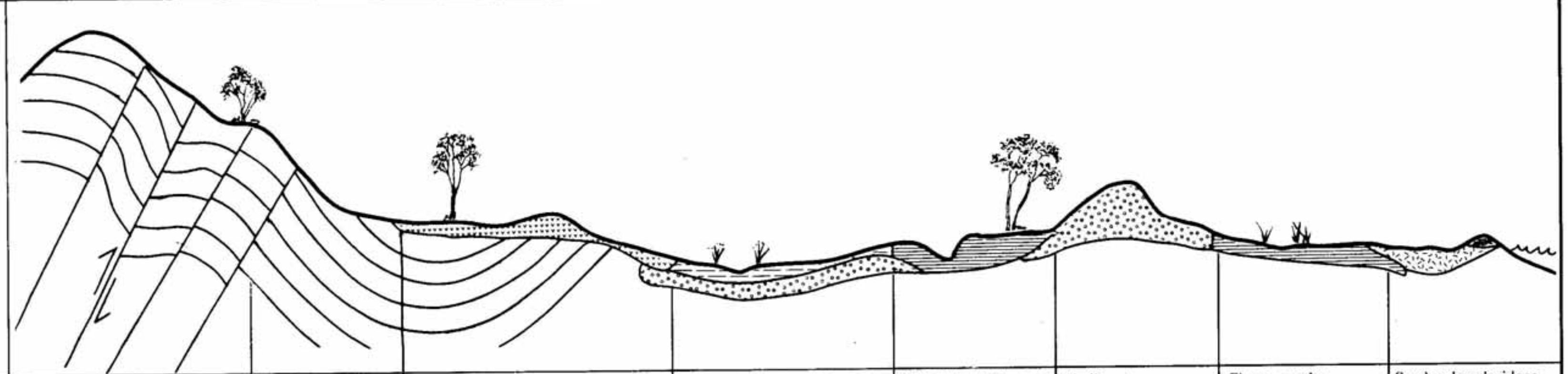
These early studies and the pressure of expanding agricultural use of the region laid the foundations for a full reconnaissance study of the Burnie and Table Cape areas at a scale of 1 mile to 1 inch (1:63 360) by Loveday (1955). All the maps for the region were subsequently revised and amalgamated at a scale of 2 miles to 1 inch (1:126 720). This was accompanied by an explanatory report by Loveday and Farquhar (1958), which contains detailed descriptions of the soils found within the Inglis area. This study has been a major source of soil information used by this land capability study. A more recent study of the Pet and Guide River catchments by Grose and Cotching (1995), has assisted in gaining an understanding of the soil relationships and the variable nature of the soil properties which affect land capability classification throughout the area.

The soil map and report by Hill *et al* (1995) detailing the soils that occur in the forests of the Forth area has been a valuable reference for identifying similar soils within the Inglis area, especially in the southern region. The Forest Soils of Tasmania Handbook by Grant *et al* (1995) has also helped to identify soils with potential erosion and soil nutrient limitations.



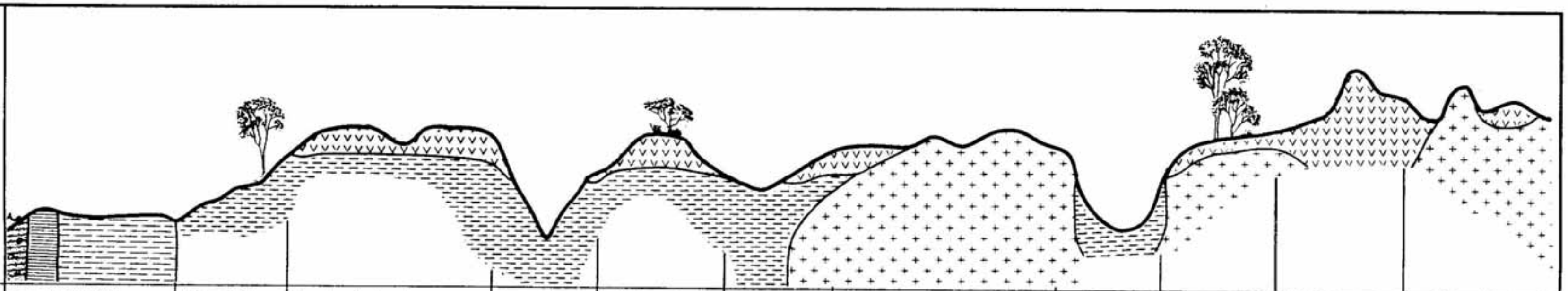
Typical Landform	Very steep hill slopes to precipitous cliffs.	Moderate to steep hill slopes.	Gently undulating highland plain and hills.	Level to gently inclined Alluvial plains.	Moderately steep hill slopes and knolls.	Moderately inclined to steep hills with some wet depressions.	Steep to very steep and precipitous hill slopes.	Flat to gently sloping hills, swamps and plains.
Geology	Ordovician conglomerate with Quaternary talus	Ordovician limestone with areas of sandstone mudstone.	Tertiary basalt.	Quaternary alluvium.	Tertiary basalt.	Cambrian sedimentary and volcanic rock.	Ordovician siliceous, sandstone and conglomerate.	Ordovician limestone and Quaternary alluvium.
Soil Type	Semi aquic Podosols, Brown Dermosols. (Barren Gaunt and Bramich Soil Profile Classes).	Semi-aquic Podosol, Dermosols (Un-named, poorly drained, shallow soil).	Red and Brown Ferrosols, (Oonah Association).	Organosols	Red Ferrosol (Oonah Association).	Brown and Red Dermosols, Grey Kurosols and Red Ferrosols. (Gaunt, Castra, Gregory and Minnow Soils).	Aquic and Semiaquic Podosols, Organosols	Organosols, Aquic and Semiaquic Podosols
Slope Range	>32%	<18%	0-12%	0-5%	>18%	>32%	>56%	0-12%
Drainage Status	Imperfect.	Imperfect.	Moderately well drained.	Poor.	Well drained to moderately drained.	Poor to well drained depending upon landform.	Poor.	Poor to very poor.
Permeability	Slow to moderate.	Slow.	Moderate to slow.	Slow.	Moderate to slowly.	Slow to Moderate.	Slow.	Slow to very slow.
Erosion Risk	Very high to extreme.	Very high.	Low.	Low.	Moderate.	Very high .	High to very high.	Low.
Main Limitations	Shallow, stony soil, erosion, climate.	Poor drainage shallow soil.	Stone content of the soil, climate and drainage in low landscape positions.	Poor drainage, high water-tables and acid soils.	Harsh climate - low temperatures, soil stoniness.	Shallow stony soil, erosion risk, climate.	Erosion, shallow stony soil, rock outcrop, climate.	Drainage, high watertable, acid soil.
Land Capability Classes	6, 7, 6	6	5	7	6	6, 7	7	6, 7

Figure 13. Stylised cross-section south east from St. Valentines Peak to Lake Lea.



Typical Landform	Steep to moderately steep hill slopes.	Moderate to rolling hills.	Flat to gently undulating rises and rolling hills.	Low lying alluvial plains.	Undulating hills and gullies.	Medium to very steep hill slopes and ridges.	Flat to gently undulating.	Swales, beach ridges and dunes.
Geology	Precambrian quartzite, siltstones and sandstones.	Precambrian quartzite siltstones and sandstones.	Tertiary basalt lavas overlying ancient Precambrian sediments.	Recent Quaternary alluvium over lying older Tertiary sediments.	Permian tillite often overlying Tertiary sand and gravel.	Tertiary sand and gravel.	Quaternary sediments.	Quaternary alluvium and beach deposits.
Soil Type	Sisters Hills Association. Podosols and Organosols.	Sisters Hills Association. Podosols and Organosols.	Mainly Red Ferrosols with deeper, slightly darker soils in lower landscape positions.	Flowerdale Association, Brown Dermosols in better drained areas and Grey Dermosols where poorly drained.	Hellyer Soil Association, Brown and Red Dermosols.	Inglis Soil Association, Podosols and Tenosols.	Wynyard Association Aquic Podosols.	Rudosols, Podosols, Grey Dermosols and Organosols in small depressions.
Slope Range	32-56%	0-32%	0-18%	0-5%	5-32%	12-56%	0-5%	0-12%
Drainage Status	Rapidly drained.	Rapidly drained, grading to poorly drained in depressions.	Well drained.	Poorly to imperfectly drained.	Poor to imperfectly drained on gentle slopes.	Well drained.	Poorly drained.	Imperfectly drained, well drained on remnant dunes.
Permeability	Moderate.	Moderate to slow.	Moderate.	Slow to very slow.	Slow to moderate.	Moderate.	High.	Moderate to high.
Erosion Risk	Extreme to Very high, especially on disturbed slopes.	Moderate to very high on steeper slopes.	Very low to low.	Very low, minor river bank erosion.	High, with some risk of landslip.	Very High to Extreme, especially on disturbed slopes.	Low when vegetated, high wind erosion risk.	Low when vegetated, High wind erosion risk if cleared.
Main Limitations	Erosion risk, shallow soil, poor nutrient and water holding capacity.	Erosion risk, shallow soil, compaction, poor nutrient and water holding capacity.	Sheet and rill erosion.	Drainage, short working window, minor flooding, soil compaction.	Stoniness, erosion, poor water and nutrient holding capacity, soil structure, drainage.	Stone and gravel, erosion risk.	Poor drainage in winter, poor natural fertility, during summer, wind erosion.	High water table, wind erosion, poor water holding capacity in summer.
Land Capability Classes	7, 6	6, 5	1, 2, 3	4, 5	5	6, 7	5 4	5, 7

Figure 14. Stylised cross-section from Sisters Hills to Seabrook.



Typical Landform	Level to gently undulating coastal platforms, alluvial plains and terraces.	Steep hills, river valleys and spurs	Gently sloping to moderately sloping hills and plateaux.	Steep river valley and long, steep hill slopes	Moderately steep hill slopes and rolling hills.	Moderately steep hills and slump complexes.	Steep hill slopes and valleys.	Very steep valleys and creek lines	Steep to very steep hill slopes	Flat topped plateaux and steep sided hill slopes.	Rolling to steep hills
Geology	Recent Quaternary sediment, beach deposits and older alluvial plains	Tertiary sediments, Precambrian sediments.	Tertiary basalt.	Precambrian sediments.	Tertiary basalt.	Precambrian sediments overlain by Tertiary basalt slumps	Devonian granite adjoining Tertiary basalt	Devonian granite and Precambrian sediments.	Tertiary basalt.	Tertiary basalt with outcrop.	Tertiary basalt with pockets of Devonian granite outcrop.
Soil Type	Aquic Podosols (Wynyard and Flowerdale Soil Associations).	Podosols (Cam and Inglis Soil Associations)	Red Ferrosols (Burnie, Lapoinya and Yolla Soil Associations).	Podosols (Cam Soil Association)	Red Ferrosols (Lapoinya, Burnie, and Yolla Soil Associations).	Podosols (Cam Soil Association) Basaltic slump complexes.	Dominated by Dermosols but Ferrosols occur at basalt margins (Natone and Riana Soil Associations)	Dermosols and Podosols (Natone and Cam Soil Assoc.)	Red Ferrosols, (Lapoinya, Yolla and Oonah Soil Associations)	Red Ferrosols, (Lapoinya and Yolla Soil Associations)	Red Ferrosols and Dermosols (Lapoinya and Riana Soil Associations)
Slope Range	0-5%	>32%	5-32%	32-56%	12-32%	<32%	>18%	>32%	18-56%	>32%	12-32%
Drainage Status	Poorly to imperfectly drained.	Well drained.	Moderate to well drained	Well drained.	Moderate to well drained.	Moderate to well drained.	Moderate to well drained.	Well drained.	Well drained.	Well drained	Moderate to well drained.
Permeability	Slow to moderately	Slow to moderate.	High.	Moderate to slow.	High.	Moderate to slow.	Moderate to high.	High to moderate.	High	High.	Moderate to high.
Erosion Risk	Very low to low.	Very high.	Very low to moderate.	Very high to extreme.	Moderate.	Very high	High to very high.	High to very high.	High	Low.	Low to moderate.
Main Limitations	Drainage, High ground watertable, inundation.	Shallow top soils, erosion.	Erosion, climate - cooler temperatures, stony soil.	Erosion, poor soil fertility.	Erosion, stony soils particularly at the break in slope, topographic complexity.	Poor fertility, shallow top soil, mass movement.	Rill and sheet erosion, Soil depth, rocky nature of the terrain (outcrop), soil fertility.	Erosion risk, shallow stony soils	Rock outcrop, erosion risk.	Rock outcrop, slumping, landslip and climate.	Erosion, climate, soil structure, rock outcrop.
Land Capability Classes	5, 4	5, 6	2, 3, 4	6, 7	3, 4	5, 6	5, 6	5, 6	4, 5	6	3, 4, 5

Figure 15. Stylised cross section from Somerset to South Riana.

5.5.2 Soils of the Inglis Area

The soil pattern within the Inglis area is very closely associated to changes in landform and the underlying parent material. This section aims to give a general characterisation of the types of soils found and their main features. Readers requiring a greater level of detail should refer to the source documents above and others found throughout this section. The following soil groupings are ordered to reflect a general trend of decreasing versatility and intensity of agricultural use.

Soils derived from Tertiary Basalt

This is the largest and by far the most important group of soils within the Inglis area in terms of agricultural production. They include the Burnie, Lapoinya, Yolla, Oonah and West Ridgley Soil Associations as well as minor soils such as the Takone and Hicks Clay Loams and the Un-named Creek Soils described by Loveday and Farquhar (1958).

Most soils formed from basalt, or “red soils” as they are locally referred to, have a high free iron content which gives them their characteristic colour. These soils are classified as Red Ferrosols under the Australian Soil Classification or Brown Ferrosols at more elevated inland locations (Isbell 1996).

These soils represent the most productive soils in the state. This is due to their freely draining nature and their strong, robust structure which makes them relatively resistant to structural degradation. Organic matter content is usually high in the topsoil but can become low if consistently cropped without appropriate organic matter retention practices.

Loveday and Farquhar identify a trend within the basalt soils where the strength of profile development relates to altitude, precipitation and temperature. The better developed soils occur closer to the coast and at lower altitudes. Soil Associations have been created to reflect such a trend. These Associations each contain a dominant soil type and a number of sub-dominant and minor soils.

The Burnie Clay Loam is the dominant soil found at lower elevations. This soil occurs on land with near level gradients close to the coast. It is a deep soil having a black to dark red topsoil colour overlying a bright red-brown, medium clay sub-soil. These soils are relatively stone free and are highly valued for agricultural use due to their relatively low erosion risk and for their ease of cultivation. The Burnie Clay Loam correlates with the Chocolate and Red Brown soils described by Stephens (1937).

On higher (>160m), often steeper country, Lapoinya Clay Loams become the dominant soil. While similar to the Burnie Clay Loam, Lapoinya Clay Loams are more stony and occur in a wider variety of landscape positions. Lapoinya Clay Loam soils often intergrade with slump complexes, stony Oonah soils and poorly drained Un-named Creek Soils. It is the largest of the basaltic soil associations and used less intensively for cropping purposes due to the changeable nature of the topography.

A typical soil profile of the Lapoinya comprises well structured reddish brown topsoil, that may become loose or “snuffy” if over worked, overlying a moderate to well structured, brighter red-brown, medium clay sub-soil. In lower landscape positions manganese nodules (indicative of periods of prolonged seasonal wetness) may occur in the sub-soil. Coarse fragments range in size from 20-250mm in the upper B horizon and are often brought to the surface by deep cultivation. These soils correspond to the Red-Brown soils described by Stephens (1937) and share similar characteristics of the Wilmot and Lebrina Association described by Hill *et al* (1995).

As rainfall increases with altitude the basaltic soils grade into the Yolla Clay Loams. These soils correlate with the Dark-Brown basaltic soils described by Stephens (1937). Yolla soils are found on hill slopes on a variety of gradients. They have both a stony phase and are found in association with slump complexes. A risk of reactivating these slump complexes exists if they are disturbed by cultivation. The soils are moderate to well structured dark brown clay loams overlying a brighter, brown medium clay sub-soil that may grade into a highly weathered horizon containing many soft fragments of basalt. Stone content is very variable.

Oonah Clay Loam soils occurs at even higher elevations (>430m asl). They are found on gently undulating plateaux and ridges with very steep hillsides. This soil is characterised by a moderate to well drained dark brown to very dark brown clay loam over a strong brown clay. Shallower topsoils with large basalt stones and boulders occur frequently on steeper slopes, while deeper topsoils are found in hollows and depressions, especially when combined with poorly draining soils.

Minor Soils that occur throughout the basalt landscape include the poorer drained Hicks and Takone Clay Loams, the Un-named Creek Soils and a small area occupied by the West Ridgley Soil Association. The latter soil is characterised by an unusually dark friable clay loam over friable clay sub-soil which in turn overlies a highly weathered basalt C horizon. Its relatively small and localised occurrence is thought to be caused by a different source of basalt parent material (Loveday and Farquhar 1958).

Evidence of erosion on the basalt soils include depleted topsoil depth, especially on paddock shoulders and upper slopes. Accumulated sediment in irrigation dams and along fence lines at the base of slopes is also an indicator. The use of preventative soil erosion measures are necessary and extremely important on all basaltic soils that are used for agriculture. Erosion rates up to 98 tonne per hectare per crop have been recorded on 5-25% slopes on Red Ferrosols in the potato growing areas of New South Wales (Elliott and Cole-Clark, 1993). A current trend of land managers neglecting to implement adequate erosion management techniques is a great concern and risks the long term viability of this valuable and finite resource.

The discovery of a molybdenum deficiency in the higher rainfall soils by Fricke (1945) and subsequent changes to nutrient applications has enabled more intensive use of both the Oonah and Yolla Soil Associations for grazing purposes.

Soils derived from Recent Alluvial Sediments

A number of soils have developed from alluvial material of fluvial, marine and estuarine origin but virtually all have limited potential for agricultural use. Most belong to the Flowerdale and the Wynyard Soil Associations and Un-named Creek Soils described by Loveday and Farquhar (1958). Unpublished work by Zund (1998) in the Wynyard area confirms that most of these soils are at best imperfectly drained and their soil pattern extremely changeable.

The better alluvial soils belong to the Flowerdale Association which occurs on older, higher river terraces and flood plains. They range from well structured Brown to Grey Dermosols with deep (30cm) sandy to silty clay loam A horizons that directly overlie slowly permeable B horizons of light-medium clay. Impeded drainage within the B horizon is indicated by the presence of soft manganiferous segregations and nodules. These soils require careful management when wet to avoid compaction and pugging. Soils similar to the Red Ferrosols have formed where colluvium and alluvium from the basalt land up slope has accumulated. These soils however suffer from slow internal drainage due to poor subsoil structure.

The poorer alluvial soils are made up of the sub-dominant and minor soils of the Flowerdale Association, found on the modern flood plain and alluvial fans, and those soils of the Wynyard Association that have formed from either marine or estuarine sediments. Both are characterised by poor drainage and have been described in detail by Loveday and Farquahar. Further west the Woolnorth Sand (Hubble 1951) equates broadly to the Wynyard Type 5 soil identified by Loveday and Farquahar. These soils classify as Aquic Podosols and have a black or dark grey loamy sand to fine sandy textured topsoil overlying a bleached A2e horizon. This in turn overlies a compact B2hm horizon at around 85cm. Type 5 soils have high seasonal water tables and receive large amounts of run-off water from scarps above. They have low fertility and are susceptible to water and wind erosion if not protected by a suitable vegetation cover.

Small areas of deep coastal peat and other organic soils are found in small depressions and water catchments. They are characterised by swamp and marsh vegetation species. Podosols and some sand clay profiles are also found on beach ridges and vegetated remnant dune areas and represent minor soils of the Sisters Hills and Wynyard Soil Associations.

Soils formed from Devonian granites

These soils include gradational soils with gritty, clay loam topsoils which are deep enough for tillage, dark organic sands that are highly erodible and shallow sandy soils overlying weathered bedrock. The former relate to the Riana Soil Association and the latter to a range of soils described by both Hill *et al*, and Grant *et al* as well as soils of the Natone Soil Association.

The better agricultural soils in this group are the moderately deep gradational profiles that occur on gently sloping land. These soils are sufficiently deep to enable cultivation but require careful management of surface run-off to minimise erosion. Intergrading with poorer granite soils is common and can occur in an intricate pattern (Photo 2). This “patchy” nature makes agricultural use more difficult and increases the potential for erosion.

Shallow soils with boulders outcropping occur mainly on hill tops where erosion processes have exposed the underlying bedrock. Most of these soils classify as Dermosols. Ferrosols occur where the association with Tertiary basalt becomes stronger.

Other granite soils include a range of duplex profiles with sandy or gritty textures. These soils have weak structure and require high management inputs to prevent water and wind erosion especially when vegetation is removed or ground cultivated for pasture renewal. Initial clearing of this land by burning can cause long term damage to fertility by incinerating what little organic matter is present in the topsoils. Most of the sandy soils are quite acidic and have poor moisture and nutrient holding capabilities. Bleached A2e horizons can occur sporadically and add to the already high erosion risk and nutrient limitation. Most of the sandy soils classify as Kurosols and Kandosols with Hydrosols forming in poorer drained locations. Many areas with these soils are best left under native vegetation or carefully developed for grazing or forestry.

Photo 2. A typical granite/basalt intergrade soil (GR E 411250, N 5437375)

Soils formed in the Deep River Valleys and Steep Ridges

Many soils have formed on very steep slopes on ancient sediments that have been revealed by the down cutting of rivers through the overlying younger sediments. They are found on a range of parent materials but predominantly Precambrian, Cambrian and Permian sediments and correlate to the Cam and Hellyer Associations and have been described as highly variable yellow podsolic soils. Hill *et al* has described similar soils within the Barren, Jetty, Mersey and Fulton Soil Associations.

On moderately steep slopes formed from Permian tillite and mudstone, deep, gradational clay soils are found. These soils relate to the Hellyer Soil Association and can be very stony in nature. Zund (1998) has identified these soils as Brown and Red Dermosols.

Very gravelly soils on ridges formed from Tertiary sediments near Wynyard correspond to the Inglis Soil Association. They are characterised by horizons that are highly permeable and erodible. These soils are low in nutrients due to the high degree of leaching and the large percentage of the profile occupied by gravel. Podosols are the main soil type found characterised by h horizons (organic pans) and conspicuously bleached A2e horizons. Tenosols have also been identified on hill tops where they overlie the Permian sediments (Zund 1998).

Very poor soils are typical of Precambrian parent materials. They are often shallow and characterised by a thin organic horizon (O1 Horizon) containing leaf and twig litter above a shallow A horizon which ranges from loamy sand, silty clay loam to silty loam textures. This horizon regularly contains angular quartz or mudstone coarse fragments. A highly erodible bleached A2e horizon may occur overlying the B horizon which in turn is slightly compacted and contains varying amounts of rock fragments. In places extremely shallow profiles exist that pass directly to rock within 30cm (Photo 3). The erosive nature of the soil and long, steep gradients combine with the low nutrient availability to severely restrict the agricultural use of these areas.

Photo 3. Cam soil profile indicating shallow depth and poor rooting conditions for plants. (GR E 416000, N 5446450)

Other soils of minor occurrence found at these locations correlate to the Roebuck and Dynan Soil Associations and the China Soil Profile Class described by Hill *et al*. Soils which relate to the Inglis, Flowerdale and Sisters Hills Soil Associations are also found. These soils have low fertility and high erosion risk or, where they occur on flat narrow river terraces, suffer from poor internal drainage and are regularly inundated by flood water.

Mountain and Highland Soils

Many soil types occur throughout the high country. This reflects a greater variety of parent materials that occurs here as well as variations in altitude, aspect, vegetation and gradient.

The best soils within this group are developed on Cambrian volcanic material. Zund has described these soils as Red Ferrosols/Red Dermosols similar to the Minnow Soil Profile Class described by Hill *et al*. These soils may be the best but are not widely found. They display a deep, well structured, well drained profile of clay loam over a light medium clay sub-soil.

Soil chemical analysis from the Minnow soil show that these soil have low cation exchange capacity (CEC) and are strongly nutrient deficient. High rainfall and consequent strong leaching further compounds the low nutrient status. Also, the organic carbon level is high in the topsoil but drops off strongly in the B horizon which indicates that natural soil fertility is gained predominantly from the organic surface litter nutrient cycle (Zund *pers. comm*.). Large and regular fertilizer inputs would therefore be required should these areas be used for intensive agriculture.

Soils formed from Cambrian sandstone and mudstone also have limited nutrient retention. Well drained profiles correlate to the Castra and Gaunt Soil Profile Classes described by Hill *et al*, while poorly drained profiles correlate better with the Gregory Soil Profile Class. Acid soils with poor rooting depth and sodic B3 horizons were identified by Zund and represent soils that would be dispersive should their sub-soils be disturbed.

In areas within the Sisters Hills and the Dip Range, near the north coast, sandy Podosols are the dominant soils. Here Precambrian rocks including quartzite, conglomerate, siltstone and schist have produced highly acidic, dark grey to black, organic sand containing fragments of parent material, overlying a lighter grey fine sand. Where the topography is steep, erosion and rock outcrops are common. On the flatter land however, the soils become poorly drained and in places peat soils (Organosols) can occur.

Organosols also occur at highland locations and support extensive Button Grass plains. Here high rainfall combined with landscape position has lead to high water tables and organic matter accumulation. Within this cool environment organic matter decomposition is slow and builds to form a peat soil (Photo 4). The depth to underlying gravels or bed rock ranges from a few centimetres on gently undulating plains to a number of metres in the swampy depressions. These soils are extremely acidic and pH measurements are often recorded at < pH 4.

Photo 4. Organosols supporting button grass vegetation. (GR E 408000, N 5399350)

At inland locations shallow, poorly developed profiles are found on the steep, stony slopes of mountains formed from Precambrian, Cambrian and Ordovician rock types. These soils have shallow organic (O) horizons with minimal underlying A and B horizons that directly overlie bed rock.

These soils do not recover well from disturbance, such as fire and clearing, and areas that have failed to regenerate may be seen as scars on hill slopes in some locations. Soils similar to the Barren, Gaunt and Bramich Soil Profile Classes described by Hill *et al* (1995) are common and are dominated by Semi-aquic Podosols. Gritty, fine sandy clay loam soils also occur over a paler light clay that contains many coarse fragments. Many of these soils support only native vegetation and can be very stony. Soils on more gentle slopes at higher altitudes formed on fan deposits or talus show more soil development but are still exceedingly stony and shallow. An un-named poorly drained, shallow soil on Ordovician limestone was found to the east of St Valentines Peak.

On ridges and hills formed from Jurassic dolerite, shallow soils on steep slopes occur. Rock outcrop and surface boulders are plentiful and native vegetation has not been removed in these locations. Shallow soils of the Calder Association with red friable clay loams over a friable clay form in the better drained areas while yellowier brown profiles occur in those areas that have poorer drainage.

5.6 Vegetation

Much of the vegetation information below describes the typical vegetation communities found across the survey area. It has been prepared from observations and identifications made during the field work using " A Guide to Flowers and Plants of Tasmania" produced by the Launceston Field Naturalist Club (1992) and the text "Native Trees of Tasmania" by Kirkpatrick and Backhouse (1997). Some general facts and climatic relationships have been noted from personal communications with local land holders and from Richley (1978), Land Systems Survey of Tasmania Region 3.

Much of the Inglis area has been cleared for agricultural land uses and urban development, particularly those areas closer to the coast. Many of the major river valleys, areas with poorer soils or less hospitable climate, still have a native vegetation cover. Selective logging was undertaken in some of these areas during the early days of settlement but little evidence of this exists today.

Complete clearing of native species and replacement with plantation forestry species has also occurred in some locations. Blue Gum (*Eucalyptus globulus*), is planted at lower altitude and/or on aspects that are relatively frost free. Shining Gum (*Eucalyptus nitans*) and Radiata Pine (*Pinus radiata*) are found in areas at higher altitudes or which have harsher growing environments. This section however will only focus upon the remnant native vegetation communities.

The northern coastal area represents the driest portion of the map with approximately 1000mm of rain per annum. The vegetation species found here seem to be endemic to this climatic zone and the soil types found. In areas around Sisters Beach and inland along the Dip Range, heath and scrub comprised of Black Peppermint (*Eucalyptus amygdalina*) and Smithton Peppermint (*Eucalyptus nitida*) dispersed with

Leptospermum sp., Banksia sp., Melaleuca sp. and Blackboys (*Xanthorrea australis*), cover the shallow top soils that have formed from Precambrian quartzite, slate and mudstone. In the poorly drained, peaty depressions heath predominates, namely Pink Swamp Heath (*Sprengelia incarnata*).

Around Wynyard on the poorly drained flats of Quaternary sand deposits, a heath and sedgeland community consisting of *Melaleuca sp., Leptospermum sp., Lomandra longifolia* and *Juncas sp.* predominates with Smithton Peppermint, Swamp Gum (*Eucalyptus ovata*) and White Gum (*Eucalyptus viminalis*) growing on the better drained low rises.

Along the steep valley sides of the Emu and Stowport Rivers infertile Precambrian soils support Stringybark (*Eucalyptus obliqua*) with an understorey of Black Peppermint, Manuka (*Leptospermum scoparium*), heath and bracken fern.

Further inland near Elliott, Myalla, Lapoinya, Mt Hicks, Ridgley, Natone and Highclere greater rainfall and lower temperatures are experienced. Remnant vegetation is found on the steeper hill slopes and natural drainage lines. Species include Swamp Gum on poorer soils and Stringybark, Myrtle (*Nothofagus cunninghamii*) and Sassafras (*Atherosperma moschatum*) on deeper soils with better drainage.

South west of Hampshire, annual rainfall increases to in excess of 1500mm per annum and temperatures decrease further, with altitude rising to above 500m asl. Here basalt soils support temperate rainforest communities including Stringybark, Myrtle and Sassafras. On better drained sites Swamp Gum and Woolly Teatree (*Leptospermum lanigerum*) are more common.

With increasing altitude the nature of the vegetation is determined by “an interplay between rainfall, soil types and the frequency and intensity of fire” (Ritchley, 1978). Mountain species such as White Gum (*Eucalyptus dalrympleana*), Stringybark, Cider Gum (*Eucalyptus gunii*) and Snow Gum (*Eucalyptus coccifera*) occupy the high alpine mountains and ranges near Guildford, Waratah and Companion Hill with Myrtle and Sassafras in gullies and hillsides. Button Grass (*Gymnoschoenus sphaerocephalus*), *Liliacea sp.* and *Iridaceae sp.* occur in the open highland plain, river flats and poorly drained depressions. Native *Poa sp.* are the dominant grasses where the basalt soils occur.

Small pockets of Black Peppermint and Stringybark with heaths of *Epacris sp., Banksia*, and button grass occur around St. Valentines Peak, Mt. Pearse and Mt. Cripps.

Heaths of Manuka, *Bauera rubiodes* and sedgelands with *Melaleuca squamea* and Button Grass, are interspersed with a more sparse coverage of Gum Topped Stringybark (*Eucalyptus delegatensis*) and Stringybark occurring on the elevated slopes around Black Bluff and south to Mayday Mt.

In the southern most regions of the survey area, the climate is most severe and rainfall at its highest. Here the areas around Pencil Pine Creek support heaths of Pineapple Grass (*Astelia alpina*), Button Grass with Cushion Plants (*Donatia novae-zelandiae*) occurring amongst a more open cover of *Leptospermum sp*. Woodland communities of Snow and Cider Gum, King William (Billy) Pine (*Athrotaxis selaginoides*) and Pencil

Pine (*Athrotaxis cupressoides*) occur with an under storey dominated by grasslands of *Poa sp.* and Button Grass.

5.7 Land Use

Land use throughout the area is determined by a number of physical factors such as climate, soil type and topography, but also to some degree by the traditional farming enterprises. Conflict in recent times between traditional land uses (eg Dairying and Seed Potato Production) and "new" displacing land uses (such as plantation forestry and urban and rural subdivision) have been occurring and are mainly being driven by the economic environment in the agricultural sector as well as the expansion of urban centres.

Agricultural production locates itself where the best physical environment occurs. Intensive vegetable production requires the best conditions and occupies the red Ferrosol soils closer to the coast, while intensive dairy farming and other grazing activities generally occur in more upland locations and/or on the poorer quality soils.

There are extensive areas of private forestry in the central and southern parts of the survey area, in upland locations and in areas less suited to traditional farming pursuits.

On soils derived from basalt in the northern coastal and central parts of the area, the land supports a wide range of vegetable crops including onions, carrots, potatoes, peas, beans and sweet corn, as well as poppies, pyrethrum and cereal crops. The best land can support three crops a year with frost tolerant brassicas being grown in late autumn or early spring. Some areas on Table Cape are being utilised for commercial flower and bulb production, primarily for export.

As altitude and rainfall increase and temperature drops with distance from the coast, climate becomes an increasing limitation to agricultural production, and vegetable production eventually gives way to dairying. The "quality" of the Ferrosol soils also deteriorates, with increasing amounts of stone being found making them less suited to intensive vegetable production.

Traditional agricultural activities such as seed potato production, dairying and other grazing are still carried out around Tewkesbury and Preolenna, but the economics of these enterprises at the time of this survey, have caused more landowners here and in Takone to sell to private forestry companies or convert to plantation forestry. Extensive areas of private forestry development are occurring around Hampshire, Surrey Hills and south to the Waratah area. Native timber is also being harvested in areas for chipping and saw milling. These areas are then replanted with specialised plantation species.

Other minor land uses include emu, ostrich and deer farming. A small area producing hops occurs at Gunns Plains, and a private forestry propagation area has been established near Ridgley.

Other non agricultural activities occur such as gravel quarries for construction and road material. These are found mainly on Ordovician conglomerate around Moory Mt. and extensive gravel pits on Tertiary sediments east of the Inglis River and south of Wynyard. The now abandoned Preolenna coal deposits were once mined and transported by rail to Burnie. A large mine producing silver/lead ore is located at Mt. Bischoff close to Waratah and a number of smaller mines near Kara Road extract tungsten (scheelite).

Several large water storage areas occur in the area, at the Pet, Guide and Companion Reservoirs, Talbot’s Lagoon and Lake Kara. These water bodies are utilised for recreation fishing, fire fighting purposes and to supply water for domestic use and also the woodchip mill at Hampshire.

6. LAND CAPABILITY CLASSES ON THE INGLIS MAP

The following sections of this report describe the different classes of land that have been identified during the course of the survey. General information on the nature of the land, soil type and geology are given together with an indication of the major limiting factors and any other information that is considered relevant. Each class is described according to broad geological groups found within it.

For each class of land a simple diagram is presented indicating the distribution of that land class across the map together with a table listing the total hectares that each occupies. These diagrams and tables include all complexes that occur in combination with that class.

The following graph shows the spread of land capability classes recorded within the Inglis area together with their proportion of total map area. Apart from the large extent of Exclusion areas (E), Class 5 land is the most abundant making up 26.6% of the Inglis area. Class 1 represents the smallest class with only 0.3%.

In calculating the class percentages for Figure 16, complex areas where two capability classes are identified have been split 60:40 and the relative proportion of each combined with the appropriate class. For example, the total area of Class 2 land equals “the total area of Class 2 + (60% of the area of Class 2+1 and Class 2+3) + (40% of the area of Class 3+2)”.

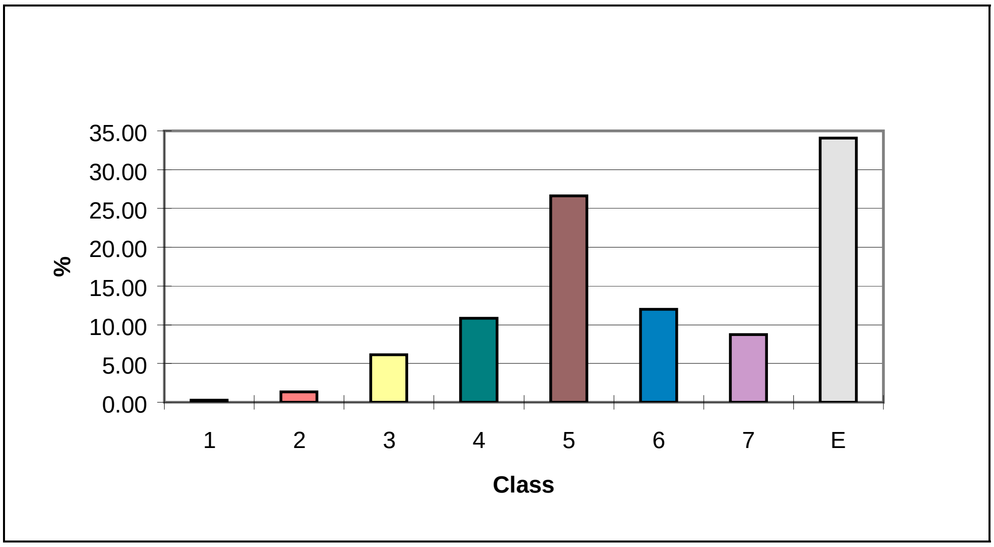
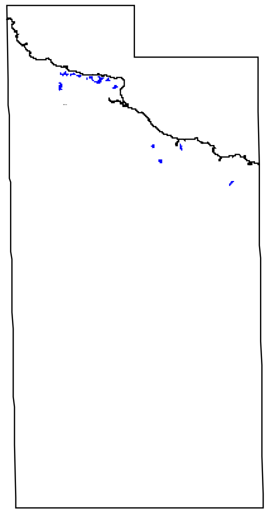


Figure 16. Proportion of Land Capability classes in the Inglis area.

The land capability information within this section is arranged firstly by class and secondly by geological type on which that class occurs.

6.1 CLASS 1 LAND

Class 1	705ha
Class 2+1	108ha



Class 1 land in the Inglis area is found only on Tertiary basalt parent materials and only where the soils are found to be freely draining and stone free, the land is almost level and the climate suitable for a wide range of crops with virtually a year round growing season. Despite being the best land in the State, care is still essential to prevent structural decline and erosion on this land.

Class 1 Land on Tertiary Basalt

Several small and scattered areas of Class 1 land on soils derived from basalt parent materials have been mapped. Most are to be found within 5km of the coast and below 180m elevation. The main areas occur on flat to gently undulating rises found on the Tertiary lava flows north of the Bass Highway between Boat Harbour and Table Cape while smaller areas are to be found east of Stowport on Minna road, around Somerset near Seabrook, Messengers and Hoares Roads.

Only the red, iron-rich Ferrosols that form from Tertiary basalt and described by Loveday and Farquhar (1958) as Burnie Clay Loams occur within Class 1 land. These soils are deep (typically >1m), freely draining, have a well developed structure and are relatively stone free. The landforms are characterised by level to very gently sloping (<5%) rises, that experience very low levels of natural erosion (Photo 5). The free draining nature, gently sloping landform and robust structure of the soil makes the land easy to cultivate with minimal degradation impact over a wide range of moisture contents. Soil chemistry indicates that fertility of these soils is good, with high levels of organic matter in well maintained topsoils. This excellent resource does, however, require constant maintenance to preserve the soil structure and condition. The incorporation of organic matter through green manuring and stubble retention helps to retain essential nutrients, such as calcium, potassium, nitrogen and phosphorous, which are otherwise supplied to the soil through expensive fertiliser applications, as well as maintaining a robust structure.

Despite the low topographic gradients, the intensive use and cultivation of this land makes the risk of degradation through sheet and rill erosion the main limitation.

Risk of erosion (e), is particularly increased when the crop grown requires a fine seed bed, such as onions or carrots, or when planting and harvesting occurs early or late in the season when there is a greater chance of high intensity rainfall events occurring. The risk of soil loss and nutrient depletion via sheet and rill erosion is the main limitation for Class 1 land on Tertiary basalt even on the lower gradient slopes.

Rose and Dalal (1988) have found that up to 90% of the nitrogen that is removed in erosion events arises from the eroded sediment rather than from the run-off water.

Simms (*Pers comm*.) has also measured high turbidity levels up to 0.38 grams/litre in run-off waters from paddocks after rainfall events indicating high sediment load. “Consequently soil erosion can play an important role in long term fertility decline of soils” (Teixeira and Misra, 1994). Erosion control measures as outlined in “Keeping your soil on your farm” (Kindred Landcare Group, 1994) are very effective in the prevention of these types of erosion and are often neglected by land managers.

The risk of structural degradation is also a concern when this land is cultivated intensively. This is particularly the case where the soil is cultivated while still wet, leading to compaction and smearing. These wetter sites are often associated with minor depressions or very flat land where run-off is slow. The risk of structural degradation can be reduced by minimising trafficking and harvesting when soils are wet, ensuring regular pasture phases and/or green manuring to maintain organic matter levels.

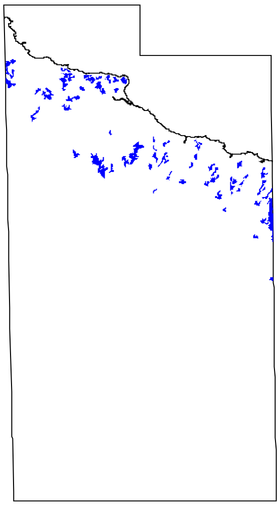
With the proximity to the coast and lower elevation, Class 1 areas experience the longest growing seasons. Frosts are generally confined to winter months and the risk of out of season frosts that could cause significant damage to young crops is not great. While summer rainfall is low, moisture deficits during the growing season are overcome by irrigation using water mainly from on-farm water supplies. Class 1 land is often intensively used and is capable of supporting two or even three crops a year.

Complexes

No Class 1 complexes occur where Class 1 is dominant. (See Section 6.2 for Class 2+1 land.)

Photo 5. Class 1 land on Tertiary basalt - onion harvest (GR E 391750, N 5464800).

6.2 CLASS 2 LAND



Class 2	3 156ha
Class 2+1	108ha
Class 2+3	293ha
Class 3+2	1 179ha

As for Class 1 land areas, Class 2 land is only found on basalt parent materials in the northern coastal and near coastal regions of the Inglis map. The major limitation for this land class is the increased risk of erosion (e) on slopes between 5 and 12%. Climate (c), particularly frost risk, is also considered a limitation as land elevations rise above 180m.

Class 2 Land on Tertiary Basalt

Areas of Class 2 land on basalt occur in a number of scattered locations including land near the small settlements of Boat Harbour, Myalla, Table Cape, Montumana, south west of Somerset along the Murchison Highway, immediately south of Burnie and at West Pine. It occurs on gently sloping land or on undulating hills with gradients up to 12%, in areas where soils are limited by depth (65-90 cm), or areas where cultivation or harvesting is slightly hindered by the presence of stone (Photo 6).

The basaltic soils found within the Class 2 land are similar to those described for Class 1 land but can be shallower, less well drained or have slightly increased stone content.

Photo 6. Class 2 and Class 1 on very gently inclined basalt hill slopes (GR E 389900, N 5466500).

Burnie clay loam as well as soils of the Lapoinya Soil Association occur on gently sloping ridges.

The level of limitation within Class 2 land is slightly greater than that for Class 1 and can result in reduced yields or make cultivation or harvesting slightly more difficult. The slope gradients are steeper than those that occur in Class 1 areas and require more intensive management and care to protect the soils from sheet and rill erosion. Creation of a fine seed bed for onions or poppies for example, increases the erodibility of the soil and should not be undertaken without appropriate soil conservation measures. With high intensity rainfall events being common throughout the Inglis area the importance of using appropriate soil conservation measures to reduce rilling and sheet erosion, particularly on longer slopes, should not be under estimated. Care also needs to be taken to reduce soil compaction which can lead to increased run-off and erosion.

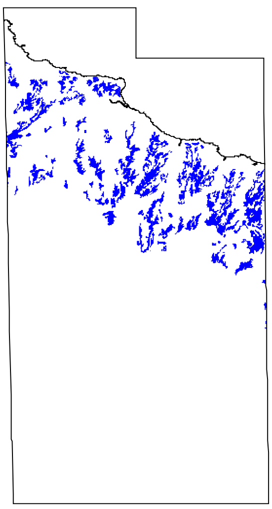
Generally the range of crops that can be grown on Class 2 land is similar to that of Class 1 areas but a higher level of management is required to avoid degradation and reduced yields. In most areas climate is suitable for several crops a year including winter brassicas. Areas of Class 2 exist between 180 and 260m above sea level where minor climatic limitations occur restricting the growth of very frost sensitive crops such as Sweet Corn.

Complexes (2+1, 2+3)

In some areas, Class 2 land is mapped as a complex with Classes 1 and 3. These complexes usually occur only where there is significant variation in the slope and degree of dissection by drainage lines which cannot be separated at the scale of mapping or where rocky patches occur sporadically within the relatively stone free more uniform Class 2 land. Class 2+1 occurs east of Moorleah along Preolenna Road. Class 2+3 occurs west of Gates Road at Boat Harbour and at the junction of Costellos Road and the Bass Highway where gradients range between 5% and 18%.

6.3 CLASS 3 LAND

Class 3	16 258ha
Class 3+2	1 179ha
Class 2+3	293ha
Class 3+4	623ha
Class 4+3	191ha



Land classified as Class 3 occurs predominantly on Tertiary basalt parent materials but also in other small areas where good soils have developed on recent alluvium or on basalt/granite intergrade areas. The dominant limitations for agriculture include erosion risk, stoniness and climate (particularly increased frost risk and a short growing season).

Class 3 Land on Tertiary Basalt

This land is mainly found further inland and at higher elevations than Class 1 and 2 land, or on the steeper slopes where erosion risk and stoniness is more limiting. Areas of Class 3 on basalt are found along Stotts Road at Riana, on much of the sloping land adjacent to the Murchison Highway near Elliott and Yolla, the valley sides adjacent to Heybridge Rivulet and Sulphur Creek, at Lower Mount Hicks and Milabena in the west. They are characterised by more irregular and rolling basalt hills with gradients up to 18% which consequently require more intensive management to control soil erosion (Photo 7).

While the soils in these areas are Ferrosols they are more variable in terms of topsoil depth and stone content than those found on Class 1 and 2 land. Much of the Class 3 land on basalt is found toward the margins of basalt lava flows or on lower slopes where soils of the Lapoinya Association (stony phase) are dominant. Here the abundance and size of coarse fragments hinders cultivation and/or affects yields and crop quality (3r). It appears that stony land is more common inland than along the coast although it is acknowledged that this could be partly due to a greater level of stone picking in areas with better climate.

In some areas, Class 3 land receives substantial run-on of water from upslope areas. This can impact significantly on the timing of cultivation and harvest activities and potentially reduce the length of growing season. Such areas can often be identified by soils which are browner or blacker in colour, reflecting poorer site drainage than where the redder soils occur. Earthworks to safely divert such water, together with grassed waterways, can help reduce the severity of this limitation.

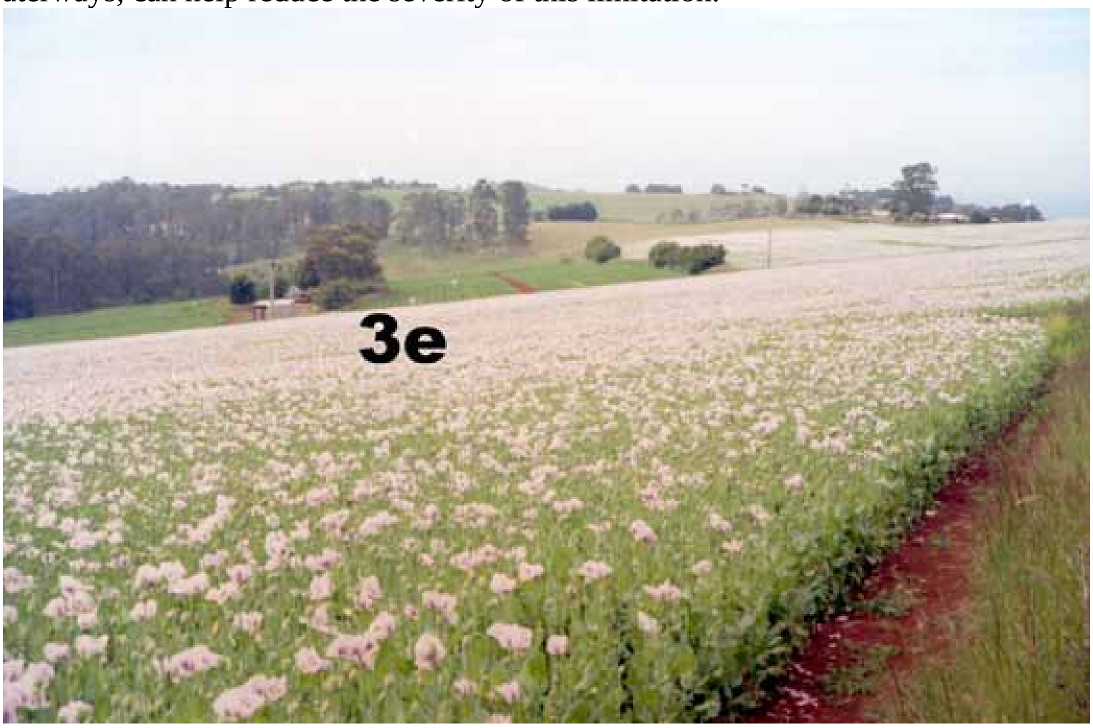


Photo 7. Class 3e poppy crop on basalt hill slopes (GR E 413900, N 5447500).

Increasing elevation, harsher climatic conditions (particularly frost risk) and shorter growing season, have an increasing impact upon the capability of the land. The occurrence of frost hollows and the risk of out of season frosts is determined to some extent by topography and local microclimatic conditions. Determination of microclimates lies beyond the scope of this report and for the purpose of this report, elevation is used as a surrogate for frost risk. A height of 260m is considered to be the cut-off between Class 2 and Class 3 land.

Where Class 3 land is identified above 260m crop choices are considered to be significantly limited by frost risk and cooler average temperatures resulting in a shorter growing season (c limitation). These areas often coincide with more exposed locations or areas that receive cold air drainage from surrounding higher elevations. The risk of damage from out of season frosts here is considerable and potential crops are limited to those which have greater frost tolerance and shorter rotation lengths. Even the practice of growing winter brassicas may be severely restricted in some areas of Class 3 land.

Some areas of Class 3 land on basalt are limited by frequently changing slopes or dissection by creeks and stream channels or by small areas which lie wet for long periods of time. These conditions can result in rapidly changing conditions over short distances and this inherent variability in the land in its self creates a limitation of access and trafficability by machinery.

Other Class 3 Land

Other small areas of Class 3 land are identified on the lower slopes of basalt hills. Here basaltic colluvium and material from other geological units such as Quaternary alluvium and Devonian granite have combined to form flat to undulating terraces and fans south west of Camena and near Wyllies Road west of Riana. The soils here are limited by inferior soil structure, reduced soil depth or increased stone content or rock outcrop compared to the true Ferrosols and therefore will not withstand the intensity of cropping that Classes 1 and 2 land will support.

Small level to gently sloping areas occurring in lower landscape positions and dominated by soils of the Flowerdale Association have been identified as Class 3. These areas are less well drained than areas with red Ferrosol soil but have a moderate structural stability. In some areas, usually closer to the river bank where gravels and stone have been deposited, it is the amount of stone within the profile that limits this land.

The adoption of irrigation practices in some of these areas has led to a more intensive use of this land. With this has come an increased risk and rate of degradation, and a need for very high levels of management to keep the soil in top condition. Where such management has not occurred, compacted, cloddy soils are to be found, especially in low lying areas that are often wet at harvest time. Soil moisture monitoring is critical in the management of these soils to identify optimum moisture contents for cultivation and harvesting, thereby reducing degradation from harvest and planting machinery.

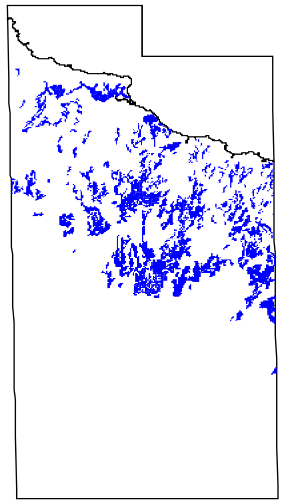
Complexes (3+2, 3+4)

Areas of Class 3 land are complexed with areas of Class 2 land only where the soils have formed from Tertiary basalt, where the slopes fluctuate between 5% and 18%, and in areas where flatter, stone free areas exist within areas of Class 3 land. These areas were identified at Lower Mount Hicks, Oldina and east of Boat Harbour.

Class 3+4 often represents areas of varied and complex landforms on a mixed geology of basalt, granite and alluvial sediments. Such areas have been identified north west of South Riana and at Mitchells Creek on Table Cape. Slopes range between 12% and 28% and soil drainage and stone content are similarly variable.

6.4 CLASS 4 LAND

Class 4	27 330ha
Class 4+3	191ha
Class 3+4	623ha
Class 4+5	4 641ha
Class 5+4	1 105ha



Class 4 land ranges over many geological types and landforms and has a correspondingly wide range of limitations to agricultural use. The most noticeable feature of its distribution is its absence from the lower portion of the map. This is due to the increase in abundance of poorer soil types and the increasing severity of climate as elevation increases. Above 500m the climate is considered too harsh for cropping activities and this includes most of the southern parts of the Inglis area.

Class 4 Land on Tertiary Basalt

Areas of Class 4 land on Tertiary basalt occur in more northern parts of the survey area, below the 500m contour level, where climate is more amenable to cropping activities. They include areas of *insitu* basalt parent rocks and basalt derived soils occurring on colluvium and landslip materials. Most of the basalt derived soil associations described by Loveday and Farquhar (1958) can be identified within these areas of Class 4 land however Yolla and Lapoinya association are the most common. The soils are inherently well structured and range from moderate to imperfectly drained. Agricultural capability is limited mainly by high erosion risk (including landslip) on gradients of 18-28%, excessive rockiness, and by climatic limitations that severely restrict the length of growing season.

Where Class 4 land is identified on moderately steep slopes of 18-28% it is the high risk of sheet, rill and gully erosion of cultivated land that is the major limitation and which limits the use of this land to grazing activities and occasional cropping (Photo 8). High intensity rainfall events can occur at anytime throughout the year and can result in unsustainable losses of topsoil if falling upon bare or recently cultivated land. Careful management practices, and implementation of soil conservation earth works, can minimise the risk of soil loss and degradation in these areas. Land falling within this category was identified on the eastern side of Heybridge Rivulet and west of Stowport Road surrounding Chasm Creek.

Significant areas of mass movement were identified on the eastern part of Elliott Agricultural Research station, north west of Natone Creek and west of Chasm Creek south of Stowport. While many of these slips are old they are easily reactivated by increased water infiltration as a consequence of cultivation. Areas of old landslip and slumping are clearly evident and display an uneven, hummocky land surface. This uneven land is difficult to cultivate and manage and is best reserved for grazing purposes and should only be cropped on a very occasional basis using the strictest soil conservation measure available as outlined by the Kindred Landcare Group, with their publication "Keeping your soil on your Farm" (1994).

Class 4 land limited by coarse fragments and rock outcrop (r) is identified west of Highclere, at Milabena and on land adjacent to St. Georges Road, north of Tewkesbury. Land is restricted to Class 4 where 10-20% of the soil profile displays rock outcrop, 20-35% has stones or cobbles 60-600mm in size or where between 35 and 50% of the soil profile contains gravel or pebbles (<60mm). At some locations the large number and size of coarse fragments necessitates frequent stone picking to reduce the impact on crop yield and cultivation and harvest machinery when this land is being used for cropping. Grazing enterprises are not as severely limited by stoniness, and land managers will often choose to roll stone back into the soil rather than removing it.

Today, large areas of Class 4 land are being converted from predominantly pastoral enterprises to plantations of *Pinus radiata* and *Eucalyptus nitens*. A major plantation management practise has been the deep ripping and mounding of soil. This has resulted in increased surface stone accumulation, when coarse fragments are lifted from deeper in the profile to the surface. In some cases this practise may be affecting the capability of the land to support other agricultural enterprises in the future. Deep ripping is considered unnecessary on this land where the soils are naturally well structured and freely draining with little impediment to root development for trees.

At the break in slope between ridge crests and the steeper valley sides, narrow swathes of land exist that would normally be classified as Class 5 land due to excessive stone and rock outcrop. These units are often too narrow and too small to be portrayed on a 1:100 000 scale map and have therefore been absorbed into the adjacent Class 4 units.

Where Class 4 land on basalt occurs at elevations between 380-500m climate (c) limitation is often the major limitation for agricultural use. These areas include land adjacent to Coal Mine Road, south of Preolenna, at Hampshire and Talunah Road near Tewkesbury. These locations are identified as having a short growing season due to generally cold temperatures or poor aspect, being exposed to strong, cold winds or having a severe frost risk.

Class 4 land is also found in low lying areas and drainage depressions where soils are imperfectly drained and are characterised by a dark, loamy topsoil and brown, mottled clay sub-soil. In such areas excessive wetness shortens the period that the soils can be safely worked and the anaerobic sub-soil conditions restrict root development and plant growth. Trafficking of the soils for cultivation and harvest purposes while they are wetter than their plastic limit leads to compaction and structure degradation. Continued use over many years of these areas without appropriate resting and remedial action can result in further problems such as deep plough pans and surface crusting, which further decrease the land's viability and are costly to ameliorate. Grazing these areas in the wetter periods should also be minimised where possible to avoid pugging, smearing and loss of soil structure which will compound the wetness problem and result in poor pasture growth in following years.

Class 4 Land on Alluvium

Class 4 land on Alluvium occurs on gently sloping to flat river valley floors or coastal platforms. These areas are often characterised by heavy clay sub-soils and highly variable topsoil textures. Main areas include east of Wynyard, adjacent to Seabrook Creek and inland at Gunns Plains.

While the alluvial soils are often quite fertile a number of other factors particularly soil drainage status limit the versatility of this land for agricultural production. Due to its low lying position, areas of this land receive run-on from up slope and have seasonally high groundwater tables. The gently sloping terrain and slowly permeable sub-soils cause many areas to lie wet for long periods each year. These lengthy wet periods severely restrict the window of operation for cultivation and harvest purposes thus limiting the length of growing season and restricting the choice of suitable crops. In some coastal locations the periodic planting of short rotation crops such as buckwheat and beans in combination with surface and sub-surface drainage has helped maximise the returns from this land (Photo 9). Care needs to be taken with grazing to minimise degradation through trampling and pugging of the soil by stock.

Stocking rates need to be carefully monitored and if possible stock relocated to graze drier upland areas to minimise damage. It was observed during the field work stage of this study that these preventative measures can significantly reduce the time spent preparing this land for cropping in later months.

Some of the alluvial land on coastal platforms or directly adjacent to river systems has areas with cobbles and gravel beds occurring within the soil profile. While these features can sometimes assist the internal drainage they pose a problem to cultivation and harvest machinery, causing excessive wear on implements and restricting agricultural versatility. Stones and cobbles can also affect rooting depth and nutrient supply to plants when they occur in sufficient quantities. The level of limitation imposed by coarse fragments on land use is a function of size and abundance. Generally speaking Class 4 land is recognised where coarse fragments severely impact on cultivation and harvesting operations and/or severely limit the range of potential crops.

Class 4 Land on Devonian Granite and Jurassic Dolerite

Class 4 land on granite is identified where slope gradients occur between 12-18% and top soil textures are sandy-loam or coarser. These areas are constrained by a high erosion risk on these light soils. Such areas are classified as Class 4e and occur at Horns Road, west of Riana and south east of South Riana. In some other areas, boulders and rock outcrop restrict agricultural use and a rock outcrop limitation (r) is given. Further inland, areas such as Upper Natone Road north of Lake Kara, are more constrained by restrictive climatic conditions and have been classified as Class 4c.

Small areas of Class 4 land on Jurassic Dolerite are identified north of the Rattler River near Takone and in scattered locations surrounding Henrietta where soils are moderately stony or shallow. Topography is typically gently undulating to moderately steep. Many areas retain a natural vegetation cover which are used as sheltered grazing areas for stock during the winter months. In areas where soil depth and stone content allow, occasional cropping can be sustained.

Photo 8. Class 4e on Tertiary basalt with 5w in drainage area below (GR E 413900, N 5447500).

Photo 9. Class 4s on Quaternary alluvium, (GR E 413900, N 5447500). Narrow working window allows short rotation cropping - buckwheat crop

Class 4 Land on Permian and Tertiary Sediments

Small scattered areas of Class 4 land on Permian and Tertiary sediments occur south and south east of Wynyard and at Upper Mt. Hicks on gently to moderately sloping land with stony and gravelly soils of the Hellyer and Inglis Soil Associations.

Stoniness and erosion risk limit these areas. The Class 4 land on Tertiary sediments occur on gentler slopes but has gravelly soils that restrict the nutrient and moisture holding capabilities of the soil. Those areas on Permian tillites however are generally found on steeper slopes, and contain larger, cobble sized coarse fragments. Occasional cropping is possible in these areas using the strictest soil conservation measures, but they are mainly utilised for grazing and tree growing.

Other Class 4 Land

Minor areas of Class 4 land have been identified on a range of other rock types including Precambrian shales and schists, Ordovician limestone and Cambrian siltstone. On gentle slopes the degree of rock outcrop and amount of stone within the soil profile are the major limitations to use. Poor soils developed on these rock types are often found in association, or combining in an intricate pattern, with better soils developed from colluvial basaltic material. Despite the presence of these better soils, the overall pattern is such that the soil characteristics are so variable, that the land can at best be classified as Class 4. In some cases it is the degree of variation, which poses such a challenge to land use and management, which limits the land to Class 4. Examples of this land class can be found adjacent to Preolenna Road, Gunns Plains, east of South Riana near the Dial Range, and some of the more gently sloping upper slopes along the major river valleys.

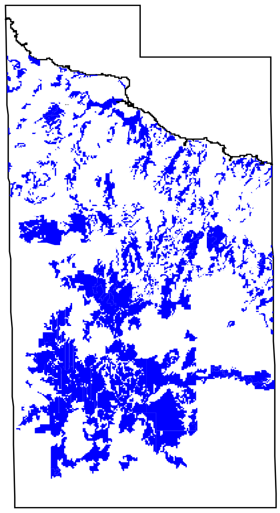
Complexes (4+3, 4+5)

Complexes of Class 4 and Class 3 represent areas of varied and complex landform pattern, often including basalt, granites and alluvial sediments. A few areas occur north west of Wynyard where Class 4 land on Tertiary basalt and Quaternary alluvium combines with more gently sloping Class 3 land on Tertiary basalt. The Class 4 component of this land is represented by the steeper hill slopes, creek lines and drainage depressions.

It is common to find Class 4 land that is limited by erosion risk, stoniness or imperfectly drained soils in association with areas of more severe erosion risk, greater stoniness or poorer drainage, classified as Class 5 land, in a complicated pattern too intricate to separate at 1:100 000 scale. Where this happens, and the Class 4 area makes up the majority of the landform unit, the two classes have been mapped as a complex. Examples of this Class 4+5 land occur on the basalt hills at Dowlings Creek west of Yolla, at Gates Road north of Flowerdale and at Gunns plains on the alluvial soils. Some of this land is able to be worked for intensive cropping uses but requires high levels of management and implementation of soil conservation measures to alleviate the high erosion risk and drainage problems found in these areas. Paddock layout and size may also be restricted by topographic fragmentation by drainage lines, posing more logistical problems for the land manager.

6.5 CLASS 5 LAND

Class 5	66 035ha
Class 4+5	4 641ha
Class 5+4	1 105ha
Class 5+6	5 205ha
Class 6+5	10 627ha



Class 5 land in the Inglis area is found where land is particularly stony, steep or dissected, as well as areas with active landslips, poorly drained soils, steep gradients or those with highly erodible soils. It also includes those areas at elevations above 500m that are restricted by climatic conditions. This is the most common class in terms of distribution and area and there are significant areas of complexes with both Class 4 and Class 6.

Class 5 Land on Tertiary Basalt and Associated Material

This is by far the largest of the Class 5 groups. It is found throughout the survey area in valleys and gullies or where the steepness of slope, stone content of the soil, climatic conditions and topographic fragmentation severely limits agricultural use. It is most dominant in the southern two thirds of the map. Grazing and plantation forestry enterprises are the main land use in these areas.

The stone content of some areas within the Inglis areas makes regular cultivation impractical without costly and thorough stone removal (Photo 10). Even pasture renewal becomes very challenging in these instances and cultivation of the soil can severely damage farm implements. Surface stone picking has taken place in a number of areas in an attempt to maximise pasture productivity but the value of such activities, with respect to any increased productivity, is questionable. These areas are also utilised for farm forestry which can better tolerate high levels of stoniness. Such areas are identified where stones of 60mm or more in size exceed 35% of the soil profile.

Closer to the coast Class 5 land on basalt is limited by high erosion risk on steep land that is characterised by areas of landslip and slumping. Such areas are common on valley sides and coastal escarpments where highly variable microrelief makes cultivation dangerous and often impossible. Erosion risk at these sites is high to very high especially where concentrated surface run-off occurs. In some areas even the establishment of improved pastures requires high management inputs. High erosion risk also occurs where gradients exceed 28%, although evidence of landslip may not always be present.

Extensive areas of Class 5 land on basalt occur on the southern basaltic plains that make up the North Forest Products Holdings of Surrey Hills and Snowdon Plain and other areas at Waratah, Takone, Parrawe and Loongana. Soils are dominated by the stony phase of the Oonah Clay Loam. The landform is flat to gently undulating and dissected by many creeks and rivers. The majority of this land occurs above 500m and the severity of the cold temperatures, risk of out of season frosts and snowfalls, as well as the strong winds that occur for much of the year, are deemed too restrictive for all but the hardiest fodder crops and pasture varieties. Poa species and Yorkshire fog are the dominant grasses utilised for grazing at these locations.

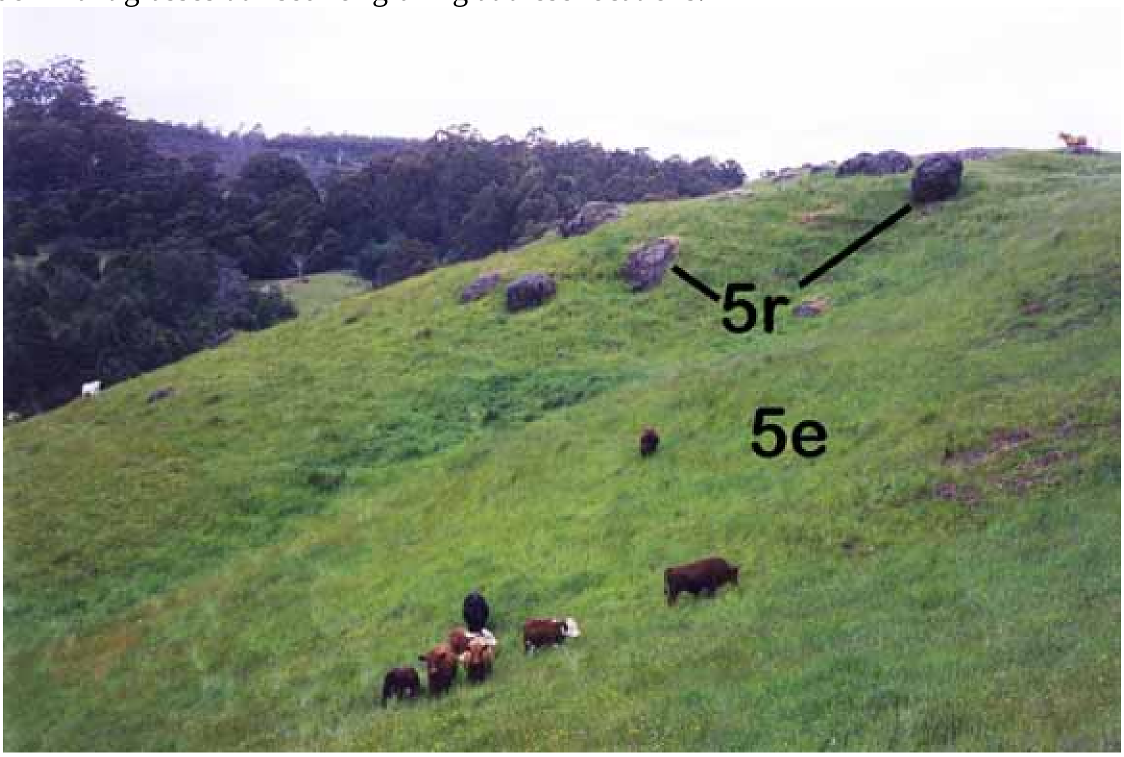


Photo 10. Class 5e and 5r on Tertiary basalt slopes (GR E 399400, N 5443400). Steep grazing country with sporadic rock outcrop.

Slow growth rates of pasture and maintaining stock condition over winter are the main concerns for farming in these areas. Low stocking rates and good spring growth however produces good grazing during the warmer months of the year. Areas do exist where the pastures have been improved in the past for higher intensity grazing uses, including parts of Parrawe and Waratah, but the high levels of management input required to maintain vigour and density seem now to be out weighed by the current economic returns from plantation forestry enterprises.

Throughout this southern area the amount of stoniness and rock outcrop is highly variable. A coarse fragment limitation has been recorded where the amount of free stone that occurs within the soil profile becomes so great that it borders upon being unreasonable to work with conventional machinery for pasture establishment purposes. In some areas deep ripping and mounding for forestry plantations have resulted in more stone being brought to the surface, further exacerbating the surface stone limitation. Examples of this stony land occur near Goodwood Siding, south of Deacons Rd and parts of Snowdon Plains. Bedrock outcrop and boulders are common features and occur throughout this land proving a barrier to deeper rooting plants but also restricting soil drainage and causing ponding of surface water on very flat areas which then lie wet for long periods. Mounding across the subtle but important natural fall of the land has also impeded surface run-off, further compounding natural drainage limitations.

Class 5 Land on Quaternary Alluvium

Scattered areas of Class 5 land on Quaternary alluvium have been identified in the Flowerdale River valley, at Sisters Beach and immediately west of Somerset.

Class 5 land with a drainage (s) limitation is identified where topographic position, relatively high rainfall and slowly permeable soils combine to create poorly drained soils which restrict trafficability. Such areas are often found in association with springs and drainage lines and where run-off is being concentrated by surrounding landforms.

Around Wynyard poorly drained soils with prominent bleached A2 horizons have been classified as Class 5s. Shallow water tables (eg 65cm) and evidence of significant seasonal height fluctuations are further evidence of the poorly drained nature of these Wynyard Association soils. In places this soil intergrades with a number of better but minor soil types (Class 4s areas) that relate to the Flowerdale, Hellyer and Inglis Soil Associations. These soil types occur in such a sporadic pattern throughout this landscape and represent such small areas that they have been absorbed into the adjacent Class 5 units.

Some attempts have been made to artificially drain the lower lying areas through surface drainage, but they still often remain very wet in winter. While producing good spring growth the pastures tend to “brown-off” rapidly during early summer. In addition, soil reaction is often moderately acidic and yet lime applications are rapidly leached to the underlying watertable.

Cultivation of these soils is constrained to a very small operating window due to balancing the moisture requirements for successful germination and growth with the moisture contents that actually allow trafficking by machinery. During this time however a severe risk of wind erosion is present which necessitates the use of minimum tillage techniques and direct drilling to avoid the unsustainable loss of topsoil. The use of “Hump and Hollow” cultivation to artificially create soil depth and improve drainage is being used in some areas with encouraging results.

Too many limitations are present in these areas which would require extra-ordinary levels of management inputs to result in the land being capable of sustaining intensive cropping. The use of single pass cultivation and seeding techniques together with the use of permanent raised bed are some of techniques used for both pasture establishment and fodder cropping which can alleviate some of the restrictions that occur.

Class 5 Land on Devonian Granite and Jurassic Dolerite

Class 5 land on granite is mapped north of Upper Natone, South Riana, east of Highclere and south west of Lake Kara. It occurs in areas of moderately steep hills with gradients in excess of 18% where the erosion risk of coarse sandy topsoils is high. Soil creep and sheet erosion are also evident at many locations. Other areas of Class 5 are limited by stoniness and rock outcrop.

Class 5 land on dolerite and associated talus has been identified on ridges, low hills and colluvial fans. This very stony land, often occurs on moderate to steep gradients, and is characterised by sporadic rock outcrop and surface boulders. Examples can be found at Takone and south of Henrietta Plains. Where land occurs over 500m a significant climatic limitation exists.

Class 5 Land on Precambrian Quartzite & Other Related Sediments

This Class 5 land is found on the gentle to moderately sloping land adjacent to Sisters Hills and Rocky Cape. It is found in areas occupied by the Sisters Hills Soil Association and on moderately steep upper slopes of major river valleys and creek lines south of Burnie, Somerset and Round Hill where the Cam Soil Association is dominant.

The Sisters Hills soils are sandy, shallow and underlain by quartzite and other related siliceous sediments. They have poor nutrient and water holding capacities and, while reasonably permeable, they become poorly drained where they occur in lower landscape positions and found in association with peaty soils. These areas can sustain limited grazing but stocking rates need to be monitored and carefully managed (Photo 11). Removal of stock from lowland areas during wetter months preserves soil structure. Occasional fodder crops and opportunistic cropping of beans has been observed on small areas where deeper soils exist and drainage implemented.

Other areas of Class 5 land are found along steep river valleys associated with Precambrian sediments. The soils developed on a range of quartzites, shales, schists and phyllites are all low in nutrients, have shallow topsoils and are highly erodible. Class 5 land has been mapped on more gentle gradients and in areas of deeper soil related to the Cam Association.

The majority of this land remains under natural vegetation although some has been cleared for grazing. Care is needed when developing this land to minimise the risk of erosion caused by run-on of surface water from up slope. Best management practices keep the length of time these areas are left bare for pasture establishment to a minimum. Small areas with extensive rock outcrop, normally classified as Class 6 land, are included in some map units as they are too small to map as separate units.

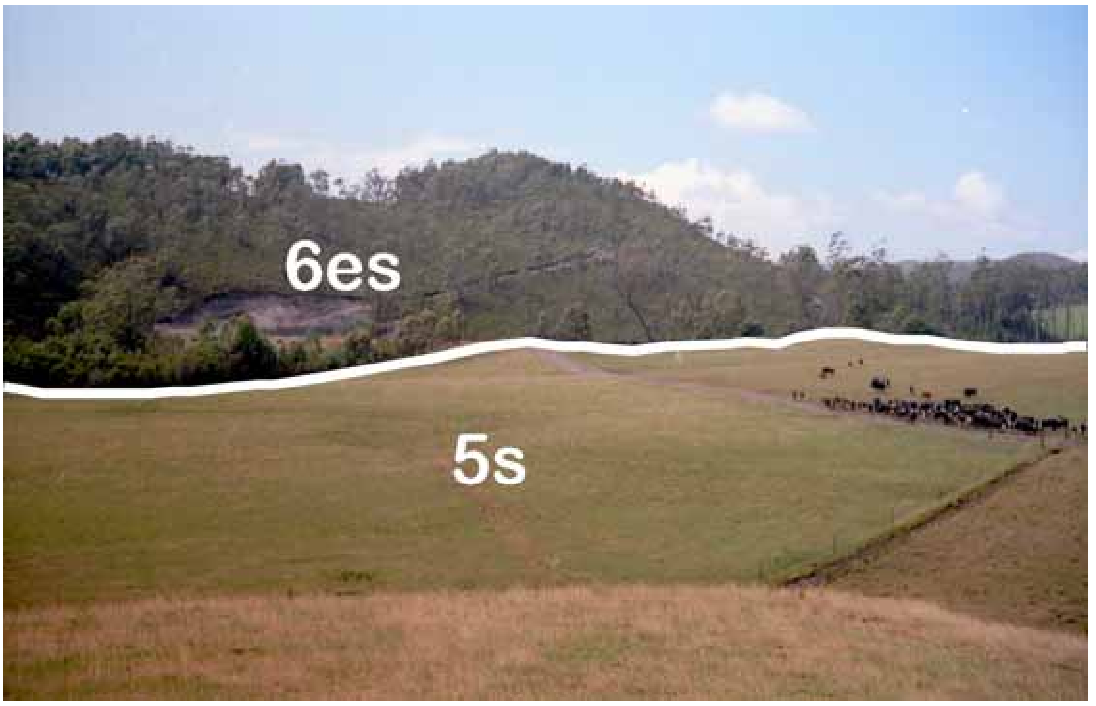


Photo 11. Class 5s and Class 6es land at Sisters Hills (GR E 375000, N 5468100).
Good grazing country requiring strict stock management. Highly erodible Class 6 land on hills.

Other Class 5 Land

Class 5 land on Permian and Tertiary sediments has been identified in conjunction with the Inglis and Hellyer Soil Associations, surrounding Oldina Forest Reserve, Seabrook and Camp Creeks, south of Takone and the low undulating hills directly south of Wynyard. It is usually the high erosion risk attributable to steep slopes and highly erodible topsoils or the stony nature of the soil profiles that limits the agricultural use of this land to grazing.

Small areas of Class 5 on Ordovician limestone and sandstone exist at Gunns Plains, Kara Road east of Hampshire and adjacent to Loongana Road. Here the land is gently to steeply sloping and has sporadic outcrops of bedrock. Steeper slopes are capable of supporting only grazing and forestry activities due to severe erosion and rockiness limitations. In more level, poorly drained sites a deeper soil exists but the poorly drained nature of the soils restricts agricultural activities to grazing and opportunistic fodder cropping in drier years. Sink holes and slumps affect trafficability, can pose a danger to stock, and are indicators of mass movement.

Complexes (5+4, 5+6).

Class 5 land is mapped in complexes with Class 4 and Class 6 at a number of locations throughout the Inglis area. However the majority of these complex units appear where Class 5 is the sub-dominant class ie. 4+5 or 6+5 and are discussed in the Class 4 and Class 6 sections of this report.

Significant areas of land mapped as complexes of Class 5 occur where soils have restrictive characteristics (ie. poorly drained, very stony, highly erodible) or where gradients range between 18% and 56% in a highly changeable pattern.

Class 5+4 land is found predominantly in the north of the survey area at Lapoinya and east of Myalla where the Sisters Hills or Cam Soil Associations combine with the Lapoinya or Yolla Soil Associations. Often the Class 5 component of this land is steep or has non basaltic soils that are inherently more erodible, infertile and/or have shallow soil depths. In areas near Coast View Hill (Kingsclere) moderately sloping non-stony land on Tertiary basalt (Class 4) occurs intricately between very stony land or erodible creek lines (Class 5). Another example is the steep and rocky areas of Class 5 land on Devonian granite and Cambrian sediments, which combine with better Class 4 land (of the same parent material) at Loyetea and (with Tertiary basalt land) at Riana.

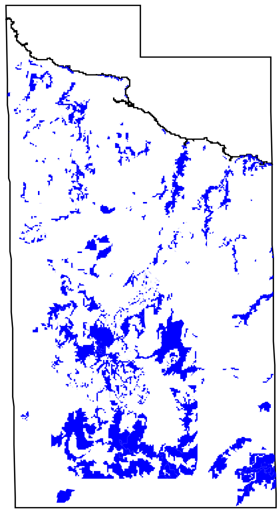
Class 5+6 land occurs mainly in the south of the survey area where complex soil or topographic patterns occur. Examples of Class 5+6 land is found east of Preolenna Road and South of Marshalls Road, west of Wynyard, where areas of both the Inglis and Flowerdale Soil Associations occur. These areas have been amalgamated to incorporate the poorly drained valley flats of the Flowerdale soil (Class 5s) and the surrounding hill slopes with the Inglis soils on gentle sloping areas with little gravel (Class 5s and 5e) and those areas that are exceedingly steep and gravelly (Class 6e and 6s).

Other areas of 5+6 are found in the granite country north of Upper Natone and adjacent to the Emu River where steep granite areas that are moderately stony combine with even steeper land with rock outcrop and sandier topsoils of the same parent material (Class5s+6er).

Much of the basalt land above the 500m mark is at best classified as Class 5 due to climate limitations. Where these areas combine in a proportion of 60/40 with poorly drained steep or rocky land on Tertiary basalt, Quaternary alluvium and marsh deposits, Cambrian volcanics or Permian tillite they have been classified as 5c+6sr. Examples of this land occur at Tewkesbury, at the source of the Cam River, north west of Mount Cattley and Gatcomb Plain north of Fingerpost.

6.6 CLASS 6 LAND

Class 6	18 360ha
Class 5+6	5 205ha
Class 6+5	10 627ha
Class 6+7	10 403ha



Class 6 land in the Inglis survey area identifies all land considered marginal for sustainable agricultural production. Agricultural use of these areas is severely limited by a range of limitations including poor soil drainage, shallow soil depth, erosion risk, rock outcrop, stoniness, slope steepness and climatic limitations. The majority of the Class 6 land may be found in the south of the map but some areas do occur on steep country or on poorer soil types skirting the exclusion areas closer to the coast. Much of this land is "Complexed" with Classes 5 and 7 and is a reflection of the highly variable and changing nature of the limitations to agriculture. An increased reliance upon aerial photo interpretation and existing geological information was used to determine boundaries in the more remote areas.

Class 6 Land on Tertiary Basalt and Associated Talus

Found around Middlesex Plains and throughout the North Forest Products Holding at Surrey Hills, the majority of this land is limited by climate. Here low minimum temperatures and frequent frosts throughout the year, together with snowfalls in the winter, create a harsh climatic environment. Even though tillage by mechanical means is possible in selected areas, despite the stone content of the soil, pasture establishment using introduced species is rarely possible due to the high risk of failure and poor vigour due to cold conditions. Limited seasonal grazing of native species occurs but stocking rates are low. Rough summer grazing has been practiced in the Vale of Belvoir and at Middlesex Plain since the early 1800's but the climatic limitations of the area have always been acknowledged (Haygarth 1998). In the past, improvement of native pastures has been through clearing and firing of the heath country (Photo 12).

Areas of Class 6 within the old Surrey Hills holding are limited by stone content within the soil profile (r) (Photo 13), and/or wetness either through the poor soil drainage (s) or from the slow surface run-off rates on this very gently sloping to flat terrain (w).

Class 6 land is also found on steep river valley sides throughout the Inglis area and is limited by very high erosion risk (e), rock outcrop (r) and shallow soil depth. Examples are seen along the Blythe, Emu, Cam and Flowerdale Rivers valleys.

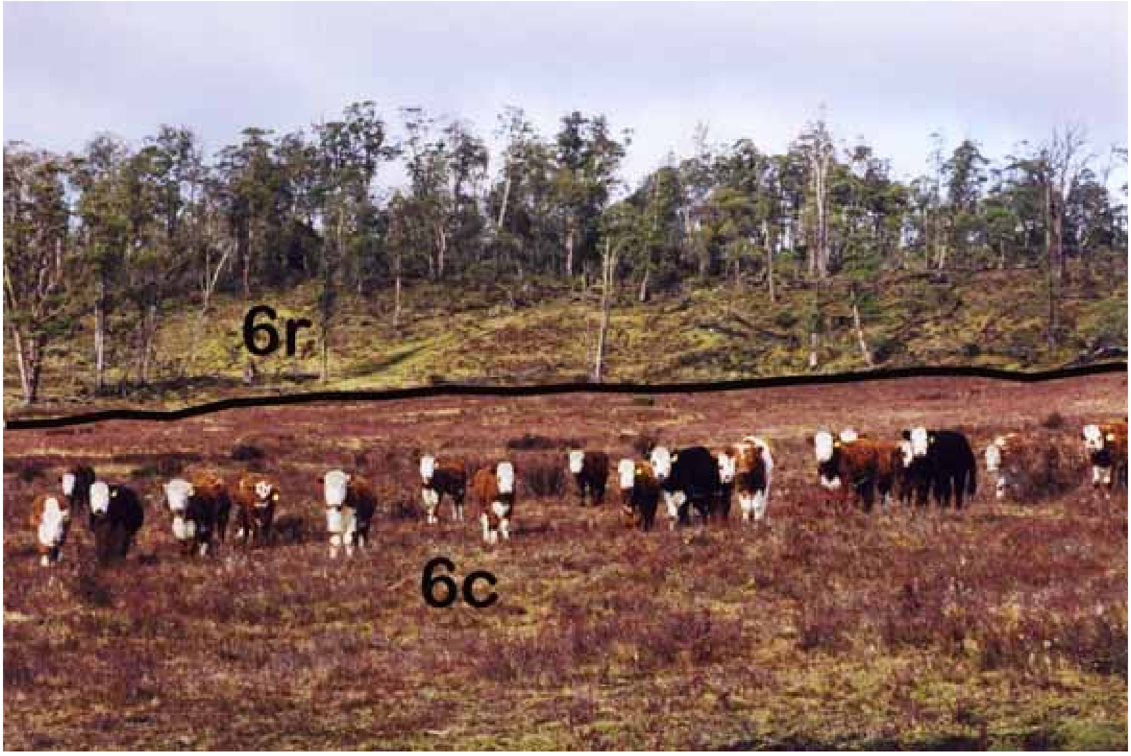


Photo 12. Class 6r and 6c on Tertiary basalt (GR E 414500, N 5400000).
Climatic conditions shallow soil result in seasonal grazing at Middlesex Plains.

Photo 13. Class 6r on Tertiary basalt above 500m (GR E390000, N5423000).
Rocky knoll near Goodwood rail siding.

Class 6 Land on Quaternary and Tertiary Sediments

This land is mainly restricted by site drainage and the rocky nature of some of the colluvial soils. The wet areas are often associated with marshes and swamps, such as Micklethwaite Marsh, south east of Fingerpost and Whites Marsh further to the south.

Here the soils are wet for the majority of the year and have formed a deep, fibrous peat. This soil is very acid and, together with the high water tables, encourages the growth of only shallow rooting pasture species and the hardy button grass and native sedges. Limited rough grazing for beef cattle is available for short periods in the summer months but this is considered to be marginal country for such an activity and care is needed to choose appropriate stocking rates to avoid hoof damage to this land.

Other areas include the Tertiary gravel deposits east of the Inglis River and near Seabrook Creek in the north of the study area. These areas are often left with their native vegetation intact to avoid erosion while some areas have been quarried. The very shallow and often stony soils are limited by moisture availability in the summer months, giving rise to native pastures of very low quality. These areas are rarely used for rough grazing even though native pastures occur in the forest understoreys.

Other small areas of Class 6 land occur on the south eastern side of Bonds Range where periglacial deposits have resulted in stony soils and a very rocky land surface.

Class 6 Land on Permian Sediments, Cambrian Sediments and Cambrian Volcanics

Class 6 land on Permian sediments is found predominantly in the north western quadrant of the survey area whilst Class 6 on the Cambrian sediments are found in the southern parts. Most of this land is rocky (r) and has a very high erosion risk (e) especially when they occur on steep slopes.

Class 6 land on Permian sediments includes those areas with soils formed from tillite. These soils are characterised by highly erodible topsoil textures ranging from sandy to silty loams. The shallow nature of the soil, high stone content and the steep slopes on which they are often found also combine to further increase the erosion risk. This land is found along Reservoir Drive and Blackfish Creek, south of Wynyard, and areas adjacent to the Calder and Inglis Rivers. Often slopes exceed 200m in length and gradients range to 56%. Slope gradients and stone content makes clearing or tillage for pasture establishment impossible. Farm or plantation forestry, as well as native forests, occur on much of this land.

Other Class 6 land on Permian sediments, includes those areas formed from mudstone and sandstone. These areas are found in the steep river valleys throughout the north west where they have been exposed through incision by rivers and creeks. These areas are dominated by the Hellyer Soil Association which are noted for their variable nature.

Class 6 land on Cambrian sedimentary and volcanic rocks occur to the south and are dominated by greywackes, mudstones chert and quartz feldspar porphyries. These areas are characterised by very shallow, stony soils and are often limited by rock outcrop (r). Erosion risk on the steeper country and excessive rockiness pose a physical barrier to cultivation and limit this land to grazing of native pastures only. Areas north east of Parrawe and at Upper River road adjacent the River Leven are examples of this land.

Class 6 Land on Precambrian and Ordovician Sediments.

Class 6 on Precambrian and Ordovician sediments is found where very poor soils have developed on a number of sedimentary materials including quartzite, conglomerate, siltstone, slate, sandstones and shales. These rock types are highly siliceous in nature and represent the poorest parent materials for any of the Class 6 land identified. Soils in these areas are often shallow, infertile and extremely rocky.

Apart from the poor soil condition the main limitation for this land is the very high risk of erosion (e). Erosion risk is greatest where steep slopes and fine topsoil textures are found, and particularly where vegetation has been removed or the ground disturbed. Shallow soil depths which limit plant root development occur where gravels, structureless sub-soil layers or bed rock are found close to the surface.

The terrain is often characterised by steep hills and valley sides and examples may be found at the foot slopes of Sisters Hills, the Cam, Guide and Emu River valleys and areas adjacent to the Cradle Mountain Link Road, south of African Marsh. Rough grazing of native grasses is possible in these areas but stocking rates need careful monitoring to avoid excessive degradation of the vegetative cover and damage to the thin organic topsoil layer from hoof impact. Much of this land is often left under native vegetation or has only been partly cleared for timber harvesting, highway construction or for rough grazing purposes.

Other Class 6 Land

Small extents of Class 6 land occur on Devonian granite, Jurassic dolerite and Ordovician limestone. Class 6 on granite occurs on steep sloping hills and valley sides, often with considerable outcrop or large boulders on upper slopes (Photo 14). The soils tend to be highly variable in nature but nearly always gritty or sandy.

They are highly erodible and often have a bleached layer. These erosion and soil depth limitations restricts this land to limited grazing uses only. Examples of this land may be seen north east of Upper Natone along the Blythe River Valley.

Class 6 land on Jurassic dolerite is found on rocky knolls and land with considerable amount of boulders and rock outcrop at Mundays Hill north of Henrietta and north of Takone.

Complexes (6+5, 6+7).

Much of the Class 6 land described in the sections above have been mapped in places as a complex with Class 7 or Class 5 land. Areas of Class 7+6 and 5+6 occur and are discussed in the Class 7 and Class 5 Land sections of this report respectively.

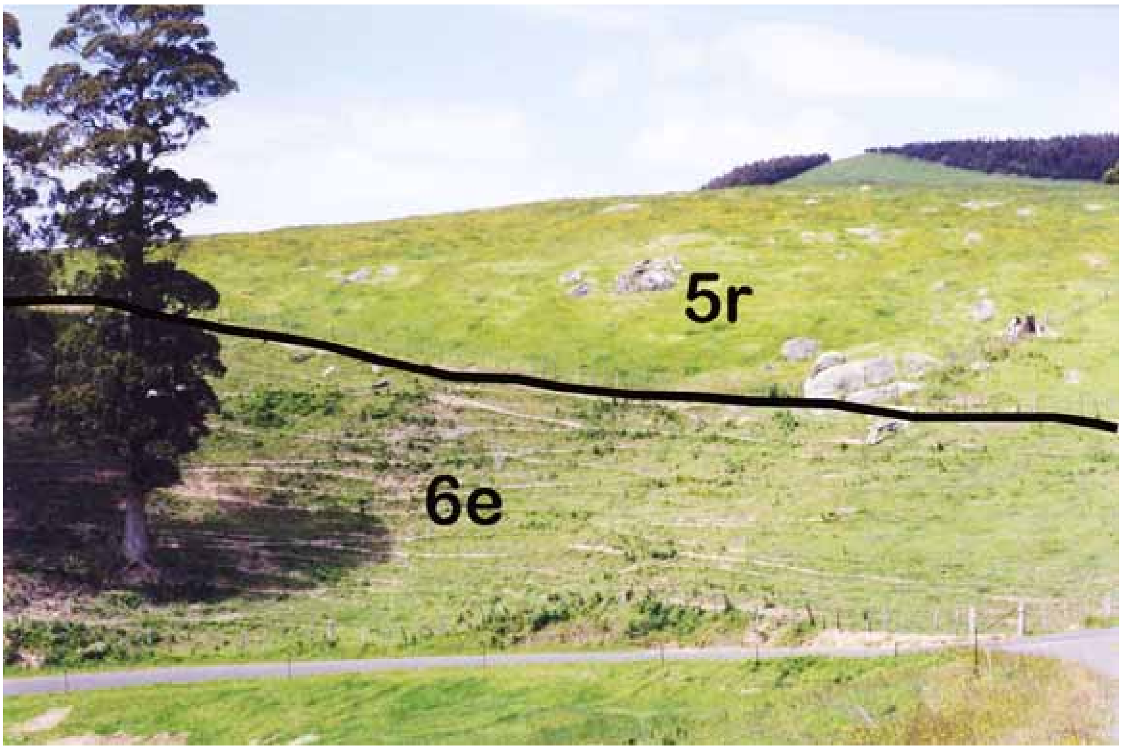


Photo 14. Steep and erodible Class 6 and rocky Class 5 land on Devonian granite.
(GR E 414000, N 5438300).

The majority of the Class 6 complexes occur south of Hampshire and Hellyer Gorge but smaller extents nearer the coast also exist. The areas mapped as Class 6+7 are characterised by extremely changeable geology, soil type, topography and drainage status and it is these variations and there affect on land capability which cannot be adequately mapped at this scale of mapping. These areas are often found adjacent to areas of pure Class 6 land and frequently indicate areas of transition between Classes 5 and 7.

By far the largest group of Class 6 complexes is the Class 6+5 and 6+7 land on Tertiary basalt or related talus. The Class 6+5 land includes Class 6 land limited by rockiness, poor drainage, harsh climatic conditions or erosion risk which combine with better areas of Class 5 land. These areas occur at lower elevations, are less rocky and are less constrained by climatic conditions than the Class 6+7 on basalt land. Often the poorer areas of basalt occur as rocky knolls and hills and have poor soil depth and high erosion risks. Examples of this land occur surrounding Mt Pearse and the rocky knolls south of Goodwood rail siding.

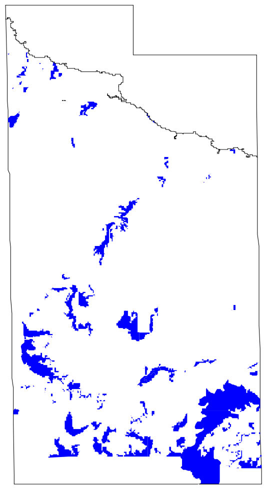
Other Class 6 Complexes occur on a variety of geological types. They are mainly limited by poor soil depth, rockiness, abundance of outcrop, poor drainage, erosion risk or prolonged periods of wetness. Such areas occur east of St. Valentines Peak on Ordovician limestone at Round Hill Point at Burnie on Precambrian sediments, north east of Companion Hill on Devonian granite and at Mt Catley and The Vale of Belvoir on Ordovician sediments in the far south east.

Other areas mapped as Class 6+5 occur at Sisters Hills on Precambrian siltstones and quartzites, east of the Calder River on Permian tillites and Tertiary sediments and west of Loyetea Peak on Devonian granites. The dominant limitation of these areas pertains to the quality of the soil resource and the steepness of the slopes that they occur on. Shallow or gravelly Class 6 soils occur together with deeper or less gravelly soils to limit these areas to grazing activities only with improvement of pastures where soil depth, slope and depth allows.

In small areas Class 6+7 and 6+5 occur where the drainage pattern itself produces a complex landform pattern, such areas occur near Companion Reservoir, parts of the Vale of Belvoir and Middlesex Plain. Here land that is seasonally inundated or lies wet for much of the year, due to low relief and low run-off rates, combines intricately with better drained areas or areas that are exceedingly stony to such an extent that a complex unit is needed to classify them.

6.7 CLASS 7 LAND

Class 7	19 018ha
Class 7+6	2 814ha
Class 6+7	10 403ha



Class 7 land in the Inglis area represents land which is unable to support agricultural activities on a sustainable basis. Limitations often pertain to the landform with which these areas are found. Class 7 land has been mapped in areas which lie wet for most of the year, have extremely acidic soils, in areas with extremely steep gradients and/or shallow soil depths. The majority of Class 7 land is identified in the southern parts of the Inglis area and is due to the increasingly mountainous terrain, associated with poor and often shallow soils. Limitations to land use are so severe that any form of agricultural production is impossible or sustainable. An increased reliance upon aerial photo interpretation and existing geological information has occurred to determine boundaries in the more remote areas.

Class 7 Land on Quaternary Sediments

Button grass plains and marshes are the main areas where Class 7 land on Quaternary sediments occurs. Examples are at Micklethwaite marsh, Black Marsh, Yellow Marsh, White Marsh, Romney Marsh, Champion Heath and parts of the Vale of Belvoir. These areas are unsuited to agricultural uses due to their strongly acidic peat soils (pH range between 3 and 4) and very poor internal drainage. Groundwater tables are almost always within 75cm of the surface and the areas lie wet for most months. Conditions within the rooting zone are not conducive to establishment of pasture species and the vegetation is dominated by button grass and sedges.

Class 7 land on Quaternary sediments also includes the talus, moraine and peri-glacial deposits of various parent materials found in the south of the survey area. Some of the areas are found around St. Valentines Peak, the Black Bluff Range, Mt Pearse and Bonds Range. These areas are generally limited by the very steep and exceedingly rocky nature of the country. Native vegetation occurs in these areas on very shallow soils.

Class 7 Land on Tertiary Basalt

Small areas of Class 7 land on Tertiary basalt have been mapped where excessive rock, soil wetness and erosion hazard due to very steep slope gradients occur. These tend to be small slithers of land that occur in conjunction with other units of Class 7 land on other geological types. The areas of highly erodible rocky land occupy the steep river valleys where the incision of the river has exposed bedrock or where rocks outcrop at the apex of low hills and peaks. This rocky nature and steep gradients prevents any form of agriculture being feasible. Examples of this land may be viewed at Doctors Rocks on the north coast.

Other areas of Class 7 land on basalt are identified as swamps and marshes and are limited by prolonged periods of wetness. Such areas include Tommy Walkers Marsh, and Painter Plain and areas adjacent the Fall River north of Middlesex Plains.

Class 7 Land on Precambrian, Cambrian, Ordovician and Other Siliceous Materials

This land represents some of the poorest within the state in terms of agricultural capability, much of it being extremely rocky and/or steep with poor soil development. It mainly occurs in mountainous areas of the far south of the survey area but also occurs at Sisters Hills, Rocky Cape and on the steep river valleys and coastal headlands in the North (Round Hill Point). This land is characterised by the distinctive white colour of the underlying parent materials and both the Sisters Hills and Cam Soil Associations dominate.

The northern areas are limited by high erosion risk on steeper slopes particularly where the soil is sandy. However within the Sisters Hills some small areas of peat have formed on the gentler country and are susceptible to high water tables and have very acidic soil. Other areas such as Round Hill Point also have a soil depth limitation as well as extreme erosion risk. Disturbance on such areas results in long term scarring and very slow vegetation regeneration. Much of the soil development in these areas relies upon the accumulation of organic matter from leaf and bark litter. These fragile areas should be left under native vegetation to avoid the loss of topsoil and exposure of bedrock.

In the south, Class 7 land is also limited by shallow soil depths and high risk of erosion. On the mountain peaks of Mt Pearse, Black Bluff, St. Valentines Peak and Rocky Mount rock outcrops prevent any form of land use. Some areas are precipitous and have talus material at their base. Soil depth is often negligible providing an inhospitable environment for most plants. Photo 15 and road cuttings near and to the west of Rocky Mount Lookout give a good indication of the nature of this land and the shallow soils that occur on them.

On more gentle terrain button grass plains have formed on the organic soils which are highly acidic and often pass directly onto quartz gravels and bedrock only some 30cm from the surface. Such areas occur at Bonds Range and Champion Heath in the far south west of the survey area.

Other Class 7 Land

These areas include land with soils formed from Permian tillite, Tertiary sediments, Cambrian greywackes, mudstones, cherts and basalts, Ordovician limestone and related materials. Often on this land it is the shallow soil depth and rockiness that make them unusable for agriculture. Many areas have been quarried for gravels and other material for road construction purposes, such as areas east of the Inglis River near Upper Calder. Other areas have been left in their native vegetated state due to their steep slopes, such as south east of the Hellyer Gorge. Clearing of these areas would lead to high levels of erosion and re-establishment of a vegetative cover would be a long and costly undertaking.

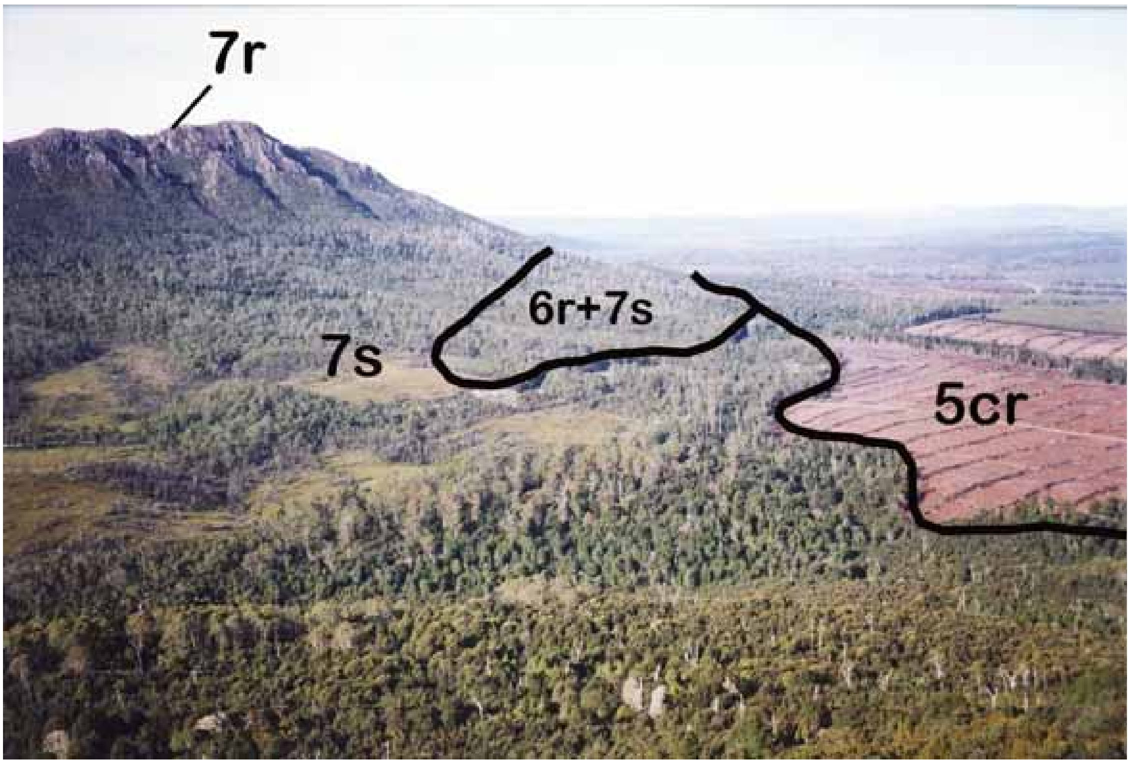


Photo 15. Class 7s and 7r land on Ordovician and Cambrian Sediments (GR E390000, N5423000). St Valentines Peak, and fan deposits produce poor soils for agriculture.

Other Class 7 land occurs on the northern coastal margins at Doctors Rocks east of Wynyard. Here the rocky headlands cliffs and coastal platforms formed predominantly from Permian tillite and Precambrian quartzite prevent any form of use, agricultural or otherwise due to the extent of rock outcrop and precipitous nature of the slopes.

Complexes

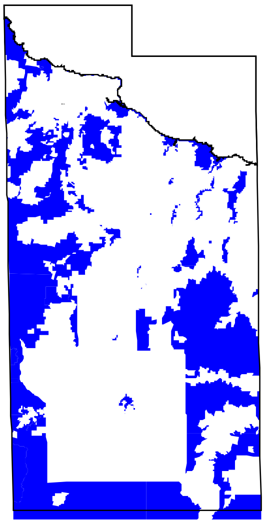
Land which is predominantly Class 7 but is complexed with Class 6 land may be found where both the slopes and soil depth are highly variable or where rock outcrop or poor drainage are the limiting features of the landscape.

Highly variable soil depths occur on the Sisters Hills and Inglis Soil Association in the south of the survey area. Erosion risk is high in these areas due to the sandy and gravelly nature of the soils, which often occur on steep slopes. Much of these areas have been left under native vegetation such as those mapped near the Dip Range, or have been highly disturbed through quarrying, such as at Ballast Pit Road.

Other areas of Class 7+6 complex occur in the south of the map where very rocky and extremely steep land occurs in combination with less steep land with shallow soils on the long valley side that descend into Deep Gully Creek north east of Waratah. Other areas occur at the base of Grass Tree Ridge which is formed from Ordovician rocks. Here shallow stony soils exist but are surrounded by low lying wet areas on Tertiary basalt that lie wet for much of the year.

6.8 EXCLUSION AREAS

Exclusion areas 97 127ha



The Inglis survey area contains extensive areas (approximately 34%) which are not included in the Land Capability Survey. These exclusion areas can be grouped into four categories;

1) Land administered by the Forestry Commission,
2) Land Administered under the National Parks & Wildlife Act
3) Land Administered under the Crown Lands Act, and
4) Other Exclusion Areas.

The digital data from which these boundaries have been obtained have been supplied by Forestry Tasmania and are deemed to be accurate to 1998.

All exclusion areas appear white on the map and are identified with the letter **E**.

Land Administered by the Forestry Commission

The majority of the exclusion areas within the Inglis land capability map are State Forests, Forestry Reserves and Deferred Forest Areas. These areas often represent land at higher altitude, such as south of the Cradle Link road and east of St. Valentines Peak, as well as the rugged hill country near the Black Bluff Range and native forests found adjacent to the major river valleys.

Land Administered Under the National Parks & Wildlife Act

Two National Parks occur within the limits of the survey area. Rocky Cape National Park is to be found in the north west and Cradle Mt.-Lake St Clair National Park in the south east. One Conservation area and a State Recreation Area exist at Detention Falls and Hellyer Gorge respectively.

Land Administered Under the Crown Lands Act

Many small areas are designated as reserves within the map area and can be divided into the following categories; Quarries, Water, Coastal and School. Examples include Fossil Bluff and Table Cape Coastal Reserves at Wynyard and Detention Fall north of Milabena. Areas reserved for agricultural research such Elliott Research Station have not been regarded as exclusion areas and have been included as part of the survey area.

Other Exclusion Areas

Other Exclusion Areas include major urban areas, Commonwealth Administered areas such as at Wynyard Airport and major inland water bodies such as Talbots Lagoon. In addition, some boundaries around urban centres, have been defined by the survey team in conjunction with local council planners and represent areas excluded from agricultural activity on the basis of current land use. Such boundaries are not intended to represent the boundaries of individual land titles. Therefore, the published exclusion boundaries in this report and accompanying map should be used with caution and do not purport to identify the exact cadastral location of said boundaries.

6.9 SUMMARY TABLES

A summary of the land capability classes, their land characteristics and the important land management issues for these classes is presented in Table 4 over the next 3 pages. The Table is not intended as an exhaustive list of all the map units identified within the Inglis area. It contains the most common groups within each class and aims to display the link between land capability, the associated land features and the range of limitations that may be expected.

The management practices necessary to keep the land within each land capability class in top condition as well as maximising productivity are indicated and a guide to the agricultural versatility of each land class is found in the last two columns of the table.

	Land Characteristics						Land Management Issues		
Land Capability Class	**Geology**	**Slope**	**Topography and Elevation**	**Erosion Type and Severity**	**Climatic Limitation**	**Soil Qualities**	**Main Limitation to Agricultural Use**	**Main Land Management Requirements**	**Agricultural Versatility**
1	Tertiary basalt.	0-5%	Flat and very gently sloping land. <180m.	Very minor sheet and rill erosion risk.	Very minor frost risk.	Well drained. Stone free.	Erosion (e).	Minimal. Very minor soil conservation practices.	All annual crops and grazing.
2	Tertiary basalt.	0-5%	Flat and very gently sloping land. 180-260m.	Very minor sheet and rill erosion risk.	Minor frost risk.	Well drained. Stone free.	Climate (c).	Minimal. Very minor soil conservation practices.	No frost sensitive crops. Grazing.
2	Tertiary basalt.	5-12%	Gently inclined undulating rises. <260m.	Minor sheet and rill erosion risk.	Very minor frost risk.	Well drained. Stone free.	Erosion (e).	Minor soil conservation practices.	All annual crops and grazing.
3	Tertiary basalt.	0-12%	Gently inclined undulating rises and low hills. 260-380m.	Minor sheet and rill erosion risk.	Moderate frost risk.	Well drained. Some stone	Climate (c).	Minimal. Minor conservation practices for some crops.	Restricted range of crops. Grazing.
3	Tertiary basalt.	<12%	Gently inclined undulating rises and low hills. <380m.	Minor sheet and rill erosion risk.	Variable frost risk.	Moderate soil drainage. 10-20% stones or rocks.	Soil drainage(s). Rockiness (r).	Soil drainage. Stone picking. Minor soil conservation practices.	Restricted range of crops. Grazing
3	Tertiary basalt.	12-18%	Moderately steep rolling hills and rises. <380m.	Moderate sheet and rill erosion. Slight gully erosion risk.	Variable frost risk.	Well to moderately well drained. Up to 15% stones or rocks.	Erosion (e).	Moderate soil conservation practices.	Slightly restricted range of crops. Grazing.
3	Tertiary basalt.	12-18%	Moderately steep rolling hills and rises. <380m.	Moderate sheet and rill erosion. Minor mass movement.	Very minor frost risk.	10-20% rocks.	Undulating, broken terrain (t). Rockiness (r).	Moderate soil conservation practices.	Slightly restricted range of crops. Grazing.
3	Alluvial sediments.	0-5%	Flat and very gently sloping land. <380m.	Minor wind on sandy soils and slight rill and sheet erosion risk.	Minor frost risk.	Up to 20% stones and rocks. Moderately well drained.	Occasional winter flooding (w). Soil drainage (s). Erosion (e). Low structural stability (s).	Soil drainage and flood protection.	Restricted range of crops. Grazing.
4	Tertiary basalt.	0-18%	Very gentle to moderately steep undulating to rolling rises and low hills. 380-500m.	Moderate sheet, rill and gully erosion risk.	Severe frost risk and shortened growing season.	Up to 30% stones and rocks.	Climate (c).	Moderate soil conservation practices.	Severely restricted range of crops. Grazing.

Table 4. Characteristics of the main land capability classes identified in the Inglis survey area.
(NB. Not all map units are described. Some generalising of unit descriptions has been undertaken to avoid excessive repetition of data)

Land Capability Class	Land Characteristics						Land Management Issues		
	Geology	Slope	Topography and Elevation	Erosion Type and Severity	Climatic Limitation	Soil Qualities	Main Limitation to Agricultural Use	Main Land Management Requirements	Agricultural Versatility
4	Tertiary basalt.	0-18%	Very gentle to moderately steep undulating to rolling rises and low hills. <500m.	Moderate sheet, rill and gully erosion risk.	Low to moderate frost risk.	Imperfect soil drainage or 30-40% stones and rocks.	Soil drainage (s). Stoniness (r).	Soil drainage. Stone picking. Minor soil conservation practices.	Severely restricted range of crops. Grazing.
4	Tertiary basalt.	18-32%	Moderately steep rolling rises and low hills. <500m.	Moderate sheet, rill and gully erosion risk. Moderate mass movement.	Low to moderate frost risk.	Variable soil drainage. Variable stoniness.	Broken terrain (t). Erosion (e).	Major soil conservation practices.	Severely restricted range. Grazing.
4	Permian and other alluvial sediments.	0-18%	Gentle to moderately steep, undulating and rolling rises and low hills. <500m.	Minor sheet, rill and gully erosion risk.	Low to moderate frost risk.	Imperfect soil drainage. Up to 30% stones and rocks.	Soil drainage (s). Low structural stability (s).	Soil drainage. Soil structure maintenance.	Severely restricted range. Grazing.
4	Jurassic dolerite and Permian sediments.	5-18%	Gentle to moderately steep undulating and rolling rises and low hills. <500m.	Moderate sheet, rill and gully erosion risk.	Low to moderate frost risk.	Up to 40% stones. Up to 35% rock outcrop.	Rock outcrop and Stony soils (r).	Stone picking. Soil structure maintenance.	Severely restricted range. Grazing.
4	Jurassic dolerite.	18-32%	Moderately steep rolling rises and low hills. <500m.	Severe sheet, rill and gully erosion risk.	Low to moderate frost risk.	Up to 20% stones.	Erosion risk (e).	Major soil conservation practices.	Severely restricted range. Grazing.
4	Tertiary or Cambrian sediments.	0-18%	Very gentle to moderately steep undulating rises. <380m.	Minor wind erosion on sandy soils. Moderate sheet, rill, and gully erosion risk.	Low to moderate frost risk.	Imperfect soil drainage. Up to 40% gravel and stones in topsoil.	Soil drainage (s). Gravelly soils (s)	Soil drainage. Minor soil conservation practices. Stone picking.	Severely restricted range. Grazing.
5	Tertiary basalt, conglomerates, mudstone and Cambrian volcanics.	0-32%	Very gentle to moderately steep undulating and rolling rises and low hills. >500m.	Moderate to severe sheet, rill and gully erosion risk. Severe mass movement	Very severe frost risk or generally low temperatures.	Variable soil drainage and stone content. Low nutrients due to leaching.	Climate (c). Growing season. (c)	Managing stocking rates and cultivation for pasture renewal	Grazing activities and occasional fodder crops.
5	Tertiary basalt.	0-32%	Very gentle to moderately steep undulating and rolling rises and low hills. <700m.	Moderate to high sheet, rill and gully erosion risk. Severe mass movement.	Very low to severe frost risk.	Greater than 40% stones, rocks and rock outcrop.	Stoniness and rock outcrop (r).	Stone picking. Managing stocking rates Selective improvements of pasture where possible.	Grazing activities.
5	Tertiary basalt	32-56%	Steep rolling hills. <500m.	High rill and gully erosion risk or severe mass movement.	Very low to moderate frost risk.	Up to 40% stone and rock outcrop.	Erosion risk (e). Broken Terrain (t)	Managing stocking rates. Stone picking.	Grazing activities and very occasional fodder crop.

Table 4 (continued)

Land Capability Class	Land Characteristics						Land Management Issues		
	Geology	Slope	Topography and Elevation	Erosion Type and Severity	Climatic Limitation	Soil Qualities	Main Limitation to Agricultural Use	Main Land Management Requirements	Agricultural Versatility
5	Permian and alluvial sediments.	18-32%	Moderately steep rolling rises and low hills. <700m	Moderate to high sheet, rill and gully erosion risk. Severe mass movement.	Very low to severe frost risk.	Imperfect soil drainage. Dispersive soils.	Erosion risk (e). Soil structure decline.	Erosion control. Managing stocking rates.	Grazing activities and occasional fodder crops.
5	Permian and alluvial sediments.	0-32%	Valley flats to moderately steep rises and low hills. <700m	Low to moderate erosion risk.	Very low to severe frost risk.	Poorly drained soils and moderately high groundwater tables.	Soil drainage (s). Flood risk (w).	Soil drainage. Managing stocking rates.	Grazing activities.
5	Quartzite, schists, shale and Tertiary sediments.	5-32%	Gentle to moderately steep valley sides and ridge crests. <700m	Very high rill and gully erosion risk.	Low to severe frost risk.	Shallow soils. Low nutrient levels.	Erosion (e). Soil depth (s), (r).	Managing stocking rates.	Grazing activities.
6	Quartzite, schists and shale.	32-56%	Steep rolling hills. <700m	Very high rill and gully erosion risk.	Low to severe frost risk.	Low nutrient levels.	Erosion (e). Soil depth (s). Stoniness (r).	Managing stocking rates.	Limited grazing potential.
6	Cambrian and Permian sediments.	32-56%	Steep rolling hills. <700m	Very high rill and gully erosion risk. Very severe mass movement.	Low to severe frost risk.	Poor soil structure stability. Low nutrient retention	Erosion (e). Dispersive soils.	Managing stocking rates.	Limited grazing potential.
6	Recent Alluvium.	Level	Seasonal swamps and marshes. <700m	Low sheet erosion risk.	Low to high frost risk.	Saturated soils.	Soil drainage (s). High groundwater tables. (w)	Land drainage.	Limited grazing potential.
6	Jurassic dolerite.	0-56%	Level to steep rolling hills. <700m	Low to moderate sheet erosion risk.	Low to high frost risk.	Up to 60% rock outcrop and boulders.	Rock outcrop (r).	Stone clearance.	Limited grazing potential.
7	Quaternary sand dunes.	Variable	Coastal sand dunes. <30m	Very severe wind erosion risk.	Very low frost risk.	Very low fertility.	Wind erosion (e). Soil nutrients (s)	Unsuitable for agriculture.	Nil.
7	Recent sediments.	Level	Alluvial and estuarine flats. < 10m.	Very low erosion risk.	Very low frost risk.	Saturated soils. High salt levels.	Soil drainage (d). Salinity (s). High groundwater tables.(w)	Unsuitable for agriculture.	Nil.
7	Any	>56%	Mountains and hills >950m.	Very high-severe sheet erosion.	Very severe frost risk and low annual temperatures.	Shallow rocky soils.	Stone (r). Soil depth (s). Climate (c).	Unsuitable for agriculture. Conservation of native vegetation.	Nil
7	Any.	Any	Rocky foreshores and very steep cliffs at any altitudes.	Moderate rock fall risk in cliff areas.	Low ranging to very severe frost risk at higher elevations.	Predominantly rock outcrop.	Shallow soil depth (s). Rock outcrop (r). Steep Slope (e)	Unsuitable for agriculture.	Nil.

Table 4 (continued).

7 DISCUSSION

In context of the whole State the Inglis area represents an important agricultural production area. However its sustainable development is threatened by a number of forces relating to shifts in management practices and land use change. The Inglis area is not alone, this is also a State, national and global trend.

It can be understood from the previous sections of this report that the Inglis area has a diverse range of landscapes, climate and associated land uses. The ability of the land to support sustainable agricultural development is also equally diverse. With only a small but valuable area (about 12%) of agricultural land identified as 'Prime Agricultural Land' a need exists to preserve these important areas for use by future generations of farmers and address the issues relating to the sustainable management of agricultural land.

During the study of the Inglis area a number of issues concerning the long term sustainability of the agricultural resource became evident. These are outlined below.

Issues relating to Soil Conservation and Management

It was noted during the fieldwork period of this study that little use was being made of soil management and conservation practises in the areas used for intensive cropping.

Soil conservation practices have been promoted extensively in recent times by extension staff from the DPIWE and TIAR (Tasmanian Institute of Agricultural Research), as well as by Landcare groups such as at Kindred, near Devonport. Publications such as the "step by step" farmers' guide to planning and constructing soil erosion control measures (Kindred Landcare Group, 1994) have been produced and distributed. Other attempts to promote these practices include demonstration farms, field days and newspaper articles.

Despite this, farmers, land managers and agricultural industries within the Inglis area do not appear to be taking the issue of soil conservation seriously. Is this because they believe that the preventative measures demonstrated are not worthwhile? Or do they perhaps believe that soil degradation does not occur or is not significant?

Physical measurements by DPIWE staff in areas of the north west coast have recorded soil losses of up to 427 tonnes from a 3 hectare paddock after a heavy rainfall event (Cotching *etal* 1996). Although this is a severe case it is not isolated (Simms *pers comm*). Measurements using radio active caesium-137 techniques at other sites on the north west coast also indicate soil loss due to erosion. These studies indicate an average of 5.3 tonnes of soil per hectare lost annually from cropped paddocks with a slope of only 13% (Richley *etal* 1997). If such losses continue to occur at this rate the areas that are currently used for intensive cropping and are unprotected by soil conservation measures will become incapable of supporting agricultural uses in the future due to the lack of soil to plant crops in.

Most soil conservation measures are relatively inexpensive to implement, take little time to construct but require good planning to achieve best results. Some soil conservation measures, if constructed properly, need be done only once and left as permanent fixtures in the paddock regardless of crop types grown. Such measures are described in detail in the publication by the Kindred Landcare Group.

In some areas the use of grassed irrigator runs was a common sight. However combining these structures with contour drains, cut off drains and grassed water ways, to form a coordinated approach to managing soil erosion, was rare. Soil loss and erosion risk are easily minimised by the implementation of simple erosion control measures, even on the gentlest of slopes (Photo 16).

The benefit of these measures is the retention of soil for use by future generations. It is difficult to measure the worth of implementing soil conservation measures in dollar terms until it is too late.

Farmers seeing evidence of soil erosion on their farms such as sediment accumulated around fence posts in lower slope positions and discolouration of dam waters after heavy rain are urged to put in place the appropriate control measures. In some areas crops are being planted into sub-soils rather that topsoils, especially on paddock shoulders and crests.

In 1994 CIG Pyrethrum was revolutionary in recognising that soil erosion is a major problem and stipulated that erosion control measures had to be established as part of their contracts with growers. Even this is now no longer the case, Why? Perhaps it is timely and appropriate for all companies involved in intensive cropping to encourage growers to protect the long term production viability of their properties by requiring soil conservation measures as part of contract agreements. The forestry industry has specific management guidelines which it has to follow. Shouldn't our intensive cropping industries have a similar set of guidelines specific to sustainable management of agricultural land?

A more future focused approach by industries and growers to address land degradation issues will ensure continued use of this finite resource by generations to come.

Land Use Issues affecting Agricultural Land

A number of issues affecting agricultural land in the Inglis area have become evident during the course of the survey.

The rapid loss of good quality agricultural land to non agricultural uses, such as urban subdivision surrounding urban centres has been a major concern in recent times, but this will now be addressed by the Policy on the Protection of Agricultural Land Tasmania (1998). This Policy aims to protect 'Prime' and regionally 'Significant' land from non agricultural uses.

The land capability information found on the Inglis 1:100 000 map identifies the areas of 'Prime Agricultural Land' (Classes 1, 2 and 3 land) and therefore will assist councils developing their planning schemes and implementing the principles of the State Policy. It does not however identify the 'Significant Agricultural Areas'. Local councils will have to determine regionally significant areas through consultation with industry groups and local communities. For example in some small inland communities that have traditionally produced seed potatoes and milk, land owners of non 'Prime' land are experiencing encroachment from plantation forestry activities.

Due to current low returns for these traditional commodities, much of the land in their region is being converted to plantation forestry use. The State Policy correctly considers intensive tree production as just another agricultural use and therefore can not and does not attempt to restrict plantation forestry from agricultural land. Here a land use conflict exists between two agricultural uses (Photo 17).

This current trend is leading to a decline in rural populations in affected areas, leading to greater isolation of those remaining but also the loss of some land well suited to specific agricultural enterprises. Concern has bee expressed by some locals as to the future of the Tasmanian potato industry should the traditional seed potato growing areas be replaced by plantation forestry. Are there other areas into which the seed potato industry can move? Are these areas regionally significant for certain agriculture purposes? Perhaps this is a timely opportunity for all stakeholders, industries, councils, local communities and land managers to consider some of these issues.

Conclusion

The main points are summarised below

- The use of erosion control measures aimed at preventing land degradation needs more serious consideration by cropping farmers in the Inglis area.
- Describing land capability information through this report and accompanying map 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).
- A review of management practices for those areas within the prime agricultural land may be required to achieve sustainable production from these areas and protection from degradation.
- The protection of high quality agricultural land from non-agricultural use is an issue of particular concern in this survey area due to the close proximity of Prime Agricultural land to the urban areas.
- Permanent loss of agricultural land to non agricultural uses and more efficient use of the existing resource can be achieved through the use of agricultural land capability information in urban and rural residential subdivision planning.
- The information included in this map and report will help assist councils meet their obligations under the State Policy on the Protection of Agricultural Land.
- Planners, industries, producers, agricultural communities etc. will need to identify agriculturally significant areas within their regions. Once identified these areas will receive protection from the State Policy
- The impact of changing land use patterns, (for example the conversion of seed potato and dairy land to plantation forestry), on the future of rural communities and specific industry groups should be addressed by all stakeholders.

Photo 16. Soil loss and erosion risk can be minimised using simple erosion control measures.
(GR E 414150 , N 5446125)

Photo 17. Traditional agricultural and forestry land uses can co-exist.
Dairying on less stony, gentler slopes (left), plantation forestry on steeper, stonier areas (right)
(GR E 380900, N 5434750)

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GLOSSARY

Alluvial sediment: Material transported by rivers.

CEC (Cation exchange capacity): The total amount of exchangeable cations that a soil can absorb, being made up of calcium, magnesium, potassium, sodium, aluminium and hydrogen. CEC affects soil properties and behaviour, stability of structure, the availability of some nutrients for plant growth and soil pH.

Clay: Soil particles <0.002 mm.

Coarse fragments: Particles >2 mm, but not segregations of pedogenic origin (formed in soil profile).

Colluvial deposits: Weathered material transported by gravity.

Complex: The term complex is used to refer to a map unit where two land classes are identified but cannot be separated at the scale of mapping. In a complex unit the proportion of the two land classes is at least 60-40.

Conglomerate: A group of sedimentary rocks with particles greater than 2 mm which are rounded and subrounded and cemented together by a finer matrix.

Degradation: This is the deterioration of a resource through inappropriate or uncontrolled management or use.

Dispersive Soils: Refers to those soils which contain a high proportion of sodium on the exchange sites of the clay minerals. The high sodium content causes soil aggregates to break down as they absorb water. Dispersive soils are inherently unstable and easily eroded.

Dolerite: A medium grained, basic igneous rock that has crystallised near the surface of the earths crust.

Drainage: How water drains from the soil profile. Rapid drainage will cause water to move past the root zone in a short period limiting water uptake by the plant, while slow drainage will cause the soil profile to become saturated with water. A saturated profile will exclude most of the oxygen from the soil which leads to root cell death and greatly reduced uptake of moisture by the plant. Drainage depends on landscape position (which controls external drainage eg. run-off and run-on), permeability of soil (texture, structure and distribution of pore spaces) and impediments in the profile to water movement such as hardpan and rock.

Duplex Soils: These soils contain a strong texture contrast between the A and B horizons. Strong texture contrast is defined according to the *Australian Soil Classification* (Isbell, 1996).

Erosion risk: The potential for wind, sheet, rill or gully erosion to occur on a land surface. The land surface is most prone to erosion when cultivated and/or when little or no vegetative cover is present. Land management to suit site conditions can minimise the severity, and often prevent most occurrences of water erosion. Erosion hazard depends on soil erodibility (loose, weakly structured soils are most at risk from wind erosion), amount of ground cover, slope gradient, rainfall (intensity and amount), and the amount of run-on received.

Ferrosols: A soil order defined in the *Australian Soil Classification* (Isbell 1996) as having a free iron content in the B2 horizon greater than 5%.

Fine sand: Particles from 0.06 to 0.1 mm, just visible with the naked eye and which feel similar to coarse flour or table salt.

Geanticline: Broad uplifted area, commonly associated with mountain building events such as vulcanism.

Horizons: Layers within a soil profile which have morphological properties different from those above and below (Northcote 1979).

Lacustrine deposit: A sediment accumulated in a lake.

Land Suitability: Identifies the suitability of an area for a defined land use. Land suitability usually considers the economic and cultural suitability of a land use in addition to the land requirements. A comparison of land suitability evaluations for a range of different uses can identify the most suitable use for a particular area.

Limitation: Refers to the physical factors or constraints which affect the versatility of the land and determine it's capability for long term agricultural development.

Lithology: The general characteristics of rocks and sediments.

Moisture availability: This is a measure or rating of the amount of moisture held in the soil which is available to the plant. It is defined as the difference between the field capacity of the soil and the wilting point. Field capacity occurs when the soil's large pores (>30 microns) have drained but when all the small pores and capillary channels are still filled with water. Wilting point is when the soil is dry to the point where the plants can extract no more water. Soil texture has the greatest effect on availability of water to the plant.

Nutrient availability: The ability of a soil to retain and supply nutrients for plant growth. Depends on the content and type of clay, organic matter content and pH.

Orogeny: Period of mountain building

pH: Soil pH is a measure of the acidity or alkalinity. A pH of 7 denotes a neutral soil with a log scale of increasing alkalinity of pH 7 to 14, and a log scale of increasing acidity of pH 7 to 1.

Plastic limit: The water content of a soil corresponding to an arbitrary limit at which it passes from a plastic state to a more or less rigid solid state; the state where a plastic soil begins to crumble.

Podosols: A soil order defined in the *Australian Soil Classification* (Isbell 1996) as being soils that have B horizons dominated by the accumulation of compounds of organic matter and aluminium, with or without iron.

Prime Agricultural Land: Defined as areas identified as land capability Class 1, 2 or 3. See definition within the “State Policy on the Protection of Agricultural Land”

Quartzite: Thermally or regional metamorphosed rocks of sedimentary origin rich in silica. The original grains recrystallise to form an interlocked mosaic texture with little or no trace of cementation.

Slump Complexes:. A hummocky and extremely changeable landscape created by a series of mass movement events that have subsequently stabilised.

Sodic, Sodicity: This is a measure of the sodium attached to clay particles in a soil. A soil is considered sodic when the sodium concentration reaches a level that begins to affect soil structure (usually above 6% Exchangeable Sodium). Used to describe soils or horizons within soils that are likely to be dispersive eg. sodic soil, sodic B horizon

Soil Association. A related group of soils that contains a dominant soil and a number of sub-dominant and minor soils within it.

Soil compaction: The development of a traffic (compaction) pan below the soil surface, usually 10 to 30 cm deep. Pans restrict root growth and drainage into the sub-soil. Pan development can occur in most soils. Yield responses can be obtained on some soils by deep ripping to break the traffic pan.

Soil structure decline: The degradation of the soil structure. Soil aggregates may be destroyed by excessive cultivation/harvesting or trampling by stock, leaving a compacted, massive or cloddy soil. Soils are particularly susceptible when wet.

Sustainable: The concept of sustainability in the agricultural context has given rise to considerable discussion. Very simply, *sustainable* land use implies a land use which can be continued in the long term without damage to the environment or the natural resource. It is generally agreed that agricultural inevitably results in some damage but for land use to be considered sustainable the damage has to be kept to an acceptable minimum and allow the continued long term use of that land.

Talus: Accumulation of rocks and boulders at the foot of a cliff or steep slope (also referred to as scree).

Tholeiitic, Tholeiite: Type of basalt consisting of basic plagioclase and pyroxene with interstitial glass or quartz-alkali feldspar intergrowths.

APPENDIX

APPENDIX A. Example of a Completed Land Capability Site Card

PROJ NAME	SITE NO	DATE	DESCRIBER	MAP NAME	MAP SCALE	RAINFALL(mm)
LC INGL	58	19/2/98	MORR	WYNYARD	1:25000	1120

GRID REF: E. 383700 N. 5463900	SLOPE % 40	ELEV. 40m
PHOTO Y (N) ASPECT 120° GEOL (field) Pcj (map) Pcj		GEOL MAP NO. 22
SOIL NAME	SISTERS HILLS	A.S.C.
TOPOGRAPHY	ST, M, HCL, ST, L, LOW	

LAND SURFACE EROSION			SURFACE COARSE FRAGMENTS		FLOODING	
Degree of Erosion (0-4)			Abund. Coarse Frags. (0-6)	1	Inundation Frequency (0-5)	0
1	1	2	Size of Coarse Frags. (1-7)	4	Duration of Inundation (1-4)	
State of Erosion (eg: A)						
1	P	2	ROCK OUTCROPS (0-5)	1	LAND CAPABILITY ASESSMENT	
Type of Erosion (eg: R)					Class (1-7)	6
1	S	2	DRAINAGE (1-6)	6	Sub-class (eg: e)	e

Vegetation Type:
MELALEUCA, EUCALYPTUS SPP.

Current Land Use:
NATIVE FOREST, ROUGH GRAZING

Location Note:
1.25K S.E. OF MORRIS RD AND BASS HIGHWAY INTERSECTION.

General Note:
GULLIES ARE SUSCEPTIBLE TO WATERLOGGING DUE TO THE HIGH RUNOFF FROM THE HILLS ABOVE

NOTE: Record Topsoil Depth as 'A' Horizon depth.
NOTE: Record Depth to Impenetrable Layer as 'B' Horizon depth.

SOIL HORIZON INFORMATION

Horizon Designation	A11	A12	B1	R		
Horizon Upper Depth	0	20	40	+110		
Horizon Lower Depth	20	40	110			
Matrix Colour (moist)	10YR 3/1	10YR 4/1	10YR 5/1			
Mottle Abundance						
Mottle Type						
Mottle Size						
Field Texture Qualifier						
Field Texture	SL	LS	S			
Primary Structure Grade	G	S	S			
Primary Structure Size						
Primary Structure Type						
Field pH	5.7	5.8	5.8	5.9		
E.C. (Soil Salinity dS/m)	0	0	0	0		
Coarse Fragments (size)			4	5		
Coarse Frags.(abundance)			2	6		