FORTH REPORT

Land Capability Survey of Tasmania

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Department of Primary Industry and Fisheries
Prospect Offices
1997

with contributions from
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Forth Report
and accompanying 1:100 000 scale map

Tasmania

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Staff at the Land Information Section, Department of Environment and Land Management, prepared the map for printing and DELM also provided the digital land information data used during the field survey.

The National Landcare Program for jointly funding this work.

SUMMARY

This map and report describes and classifies the land resources occurring on privately owned and leased crown land within the area defined by the limits of the Forth 1:100 000 scale topographic map (sheet No. 8115). The area lies in central northern Tasmania and includes the major population centres of Devonport, Ulverstone and Sheffield and many smaller centres such as Wegeena, Claude Road, Wilmot, Castra, North Motton, Railton and Penguin. The survey area extends over 163 800 ha of agricultural and forested land of which 50 623 ha are mapped as Exclusion area.

The land is described and the capability classes defined according to the published system for Tasmania (Noble 1992a). 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 range of crops that can be grown 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 Mt Roland 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 valleys, aligned roughly south-east to north-west, and dissected plateaux fragments. These areas are composed of Tertiary basalt rocks which weather to Ferrosols and provide some of the best agricultural soils in the State. Higher ranges of hills are associated with other rock types - Bonneys Tier and the Badger Range, for example, comprise Permian mudstones and sandstones with occasional Jurassic dolerite, while to the west and south Ordovician, Cambrian and Precambrian conglomerates are evident.

Agricultural activities on the Ferrosols are dominated by intensive vegetable production. This can mean three crops a year in the best areas and includes the production of peas, potatoes, carrots, onions, beans, brassicas, poppies and pyrethrum. Prime areas for vegetable production are Sassafrass, Kindred and North Motton. There is only limited cereal production in the area but extensive dairy areas occur at higher elevations on basalt soils or on soils derived from other parent materials less suited to intensive vegetable production. Despite moderate average annual rainfall, the winter dominant rainfall pattern necessitates regular irrigation of crops throughout the summer. The majority of this irrigation is supplied from on-farm storage.

Table 1 below indicates the extent of the separate land classes identified within the confines of the survey area. These include COMPLEX units in which 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, occupying 50-60% of the unit, while the second class occupies only 40-50%. Across the survey area only limited areas of Class 1 are identified amounting to about 0.5% of the total map sheet area. There are more extensive areas of Class 2 and 3 land (4.4% and 10.3% respectively). Class 4 land is the most dominant occupying almost 29% of the area. Class 5 land is also fairly widespread with over 20%, while Classes 6 and 7 occupy only 3.8% and 0.4% respectively. The remaining 31% of the survey area is defined as Exclusion and comprises reserves, state forest, and other land tenure classes. In estimating the extent of

individual land classes above a 60-40 split of complex units is assumed. Thus, for example, the total area of Class 2 land equals “the area of Class 2 only + (60% of the area of Class 2+1 and Class 2+3) + (40% of the area of Class 1+2 and Class 3+2)”.

The land capability boundaries have been determined by a combination of field work, aerial photo interpretation and computer modelling. The major limitations to agriculture identified are poor soil conditions (poor internal drainage, occurrence of rocks and stones, shallow effective soil depth), topography (irregular, uneven microrelief) and erosion (rill, sheet and landslip). 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 of greater significance on other soil types.

Capability Class	Area (Ha)	% land area of map sheet
1	734	0.45
1+2	178	0.11
2	6506	4.0
2+1	98	0.06
2+3	382	0.23
3	14735	9.0
3+2	710	0.43
3+4	1205	0.73
4	40841	24.9
4+3	2060	1.3
4+5	7149	4.4
5	29033	17.7
5+4	1163	0.7
5+6	2157	1.3
6	4894	3.0
6+5	441	0.27
6+7	367	0.22
7	520	0.32
E	50623	30.9
TOTAL	163796	100.0

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

1. INTRODUCTION

This report continues a series of land capability reports published by the Department of Primary Industry and Fisheries as part of a 1:100 000 scale land capability survey of Tasmania's agricultural land first started in 1989. This report and accompanying map describes and depicts the land capability of the agricultural land within the Forth map (sheet no 8115). The information printed here and in the accompanying map is intended for use at a regional planning level and is inappropriate for farm scale planning. However, the system and the methodology can be applied at any level (see Section 3).

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 Farmwi$e and Best Farm Practice.

The land capability classification system for Tasmania (Noble 1992a) 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 this report have been reproduced from earlier reports produced by Noble (1991, 1992b, 1993) and Grose and Moreton (1996).

With ever increasing demands placed on our agricultural land to produce greater yields per unit area, the limitations imposed by extreme climatic conditions and the continuing uptake of good agricultural land for urban development and subdivision, there is a growing risk of Tasmania's agricultural resource being utilised beyond it's capability. Inevitably this will lead to the loss of prime agricultural land and degradation of the soil resource if left unchecked. Thus the conservation of the soil resource is vital for sustained productivity and for Tasmania to continue to support a healthy agricultural industry. The basis for soil conservation is the proper management and use of the land, ie. using land within it's capability. Much of Tasmania's agricultural land has limitations which restrict the variety of crops that can be grown. The land capability classification system recognises these limitations and uses physical characteristics of the land, together with climatic criteria, to evaluate the capability of an area and classify it accordingly. Also, by determining where Tasmania’s better quality agricultural land occurs, and its extent, it is hoped that this land can be protected from loss to non-agricultural use or degradation through inappropriate land management practices.

The red soils associated with basalt parent materials, found throughout north-west and central northern Tasmania, have long been considered the State’s best agricultural soils. They are not, however, immune from degradation. In 1958, Loveday and Farquhar, conducting a survey of similar soils in the Burnie area, recognised that, as a result of intensive agricultural practices, sheet erosion of the surface soil, and consequent loss of organic matter and nutrients, was widespread on these red soils even then. Today, the Kindred Landcare Group, located in a prime vegetable growing area of the Forth region, identifies that *"Every year, thousands of tonnes of the farming community's life blood - its soil- finds its way into our watercourses"* (Kindred Landcare Group, 1994) and recognises the importance of erosion control measures to prevent soil loss.

Despite the observations of Loveday and Farquhar and the efforts of groups like the Kindred Landcare Group, degradation of the agricultural resource is still clearly evident in many parts of the survey area. If this degradation is to be further reduced better matching of land use against the land's ability to support that use is essential. This can be achieved at all levels from land owners and managers to industry and government leaders - but good management decisions have to be based on good information. It is the purpose of this work to provide the necessary information to allow better decisions to be made with respect to the management of land, which in turn should help bring about a reduction in the degradation of Tasmania's agricultural resource.

This report and map evaluates the land capability of private freehold and leased crown land only. Other areas are considered non agricultural and are mapped as exclusion areas.

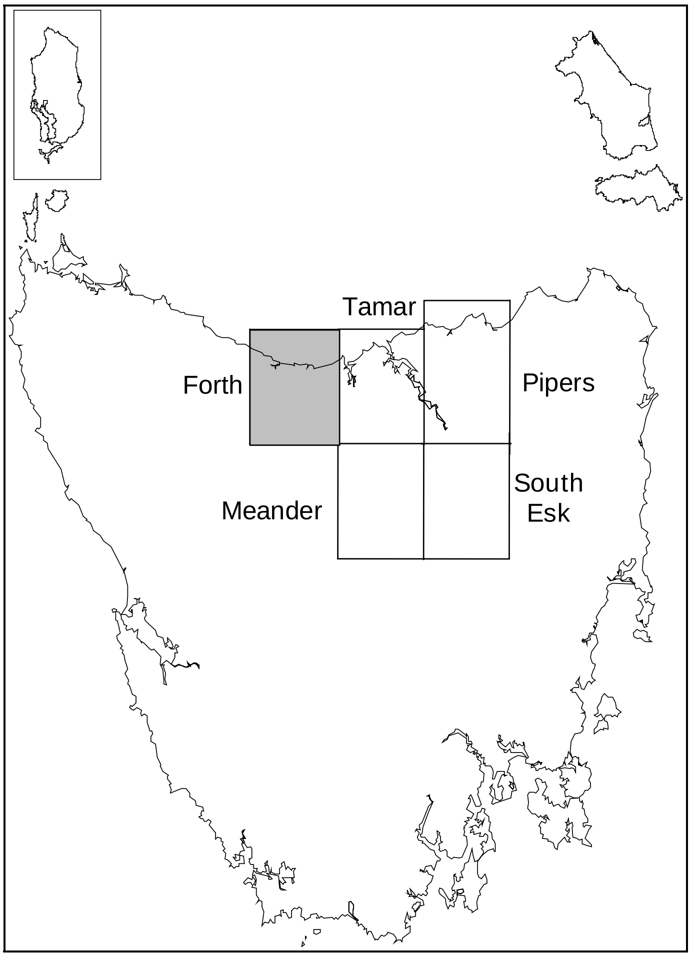


Figure 1. Forth Survey Location and Previous Land Capability Surveys in Tasmania

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 4 of the report. Further detail about each of the land capability classes occurring on the Forth map 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 64 ha have been mapped where they are identifiable on the basis of clearly visible boundaries (usually topographic). Impurities in map units will occur where land class changes are a result of less obvious changes in land characteristics or qualities.

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

COMPLEX map units (eg. 4+5) have been identified in some areas where, due to the complexity of soils and landscape, 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 this issue and the method of labelling units is to be found in Section 3.

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 some discrepancies have been identified in comparison to the published 1:100 000 scale Land Tenure maps. The exclusion boundaries that appear in this report and accompanying map should be used with caution and do not purport to identify the exact cadastral location of said boundaries. It is hoped that all future publications will utilise a uniform digital format thus avoiding such discrepancies.

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. More detailed discussion of the methodology is available in Section 3.

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

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

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

While intended for use by regional and State planning authorities, the information supplied in this report is useful at catchment and farmer level as a general indication as to the quality of land that may be found in a particular locality. For example, a new comer to the area wishing to purchase good quality land for cropping would be better concentrating efforts in the North Motton, Kindred or Sassafras areas, where land of Class 1 and 2 has been identified, rather than around Spreyton or Wilmot where the land is considered Class 4.

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) together with the development of an appropriate implementation framework, including legislative and administrative support, responsible for putting land use policies into practice. The protection of high quality agricultural land from non-agricultural use is an issue of particular concern in this survey area and the information included in this map and report will help to support the proposed State Policy on the Protection of Agricultural Land currently under preparation by DPIF and DELM.

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 discusses the survey methodology used while Section 4 provides more information about land capability classification and definitions for the individual land capability classes. A detailed description of the survey area, including land use, climate, geomorphology and geology appears in Section 5. A discussion of soil and land management options is presented in Section 6 and a detailed account of land capability classes occurring within the survey area is presented in Section 7. The land capability information is arranged firstly by class and secondly by geological type on which that class occurs.

2.3 Copyright

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 maps which have been published to date are indicated in Figure 1.

Land Capability Publications currently available :

Pipers Report and Accompanying Map ($15)
Tamar Report and Accompanying Map ($15)
Meander Report and Accompanying Map ($20)
South Esk Report and Accompanying Map ($30)
Land Capability Handbook ($8)
Land Capability Classification in Tasmania, Information Leaflet (free**)**

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

Department of Primary Industry and Fisheries
Resource Management and Protection Division
Land and Water Assessment Branch
GPO Box 46
Kings Meadows, TAS. 7249.

3. SURVEY METHODOLOGY

The land capability map is produced through a combination of field work and aerial photo interpretation (API) together with the computer modelling of some relevant information such as slope class. For the Forth map sheet field work commenced in May 1996 and initially focused along three transects of various length and about 2 km in width. The transects were identified on the basis of good accessibility for field work, and the fact that they provided a good range of representative rock types and landforms. Each transect was examined at a level of detail appropriate to 1:25 000 scale mapping with the specific intention of determining the relationships between landform, geology, soil and the associated land capability. API for each transect was undertaken using 1:25 000 scale colour photographs taken in February 1994. The location of each transect is outlined in Figure 3.

This transect approach has been used for the first time while undertaking field mapping for the Forth survey area and a number of issues have arisen. The detailed mapping of each transect has certainly provided a significant amount of detailed knowledge but the progress has been slow. As well, it soon became clear that a number of geological types and land systems were not covered adequately by the transects and that additional detailed investigations would be required in some areas.

During field work considerable use has been made of computer generated slope maps using 1:25 000 scale contour information (10 m contour intervals). These maps interpret slope from a digital elevation model created from the contour information and provide a 50 m resolution. This information has proved invaluable in determining some class boundaries where access has been difficult or areas are extensively forest covered. Use has also been made of a rainfall isohyet map created from ESOCLIM software. This map approximates very closely to an isohyet map at 1:500 000 scale created by the HEC (1986) but has not been tested to determine it's precision.

Field work progressed along public access roads and on private property to assess land capability on-site and to check soil type, geological boundaries etc. Soils have been examined using a Proline drilling rig with 10 cm corer or 25 mm push-tubes, a hand held soil auger or by examination of soil exposures in ditches or road cuttings to determine depth of soil horizons and other important soil properties. No attempt has been made to identify or map soil boundaries.

Once investigation of the transects was complete, field work moved to intervening areas. Information gained from the transect studies was extrapolated to these areas wherever possible and the intensity of site observations reduced to a level more appropriate to 1:100 000 scale mapping.

Land capability boundaries have been determined in the field, by using existing soil, geological and climatic data and through interpretation of 1:42 000 scale black and white aerial photographs taken during March 1988. These boundaries have been transferred to 1:50 000 scale field maps before transferring to base maps of the same scale. 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 survey area and information extrapolated from other similar units. Interpretations of existing land information and aerial photographs have been used to predict land capability in some areas. 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. In assessing land capability consideration has been given to a wide range of land factors together with information supplied by farmers, land managers and agricultural advisers within DPIF.

Within the study area some 440 land capability observations have been recorded. This site information is stored on a data card (see example, Appendix A) and also in a database using EXCEL software. The data card records a range of site information relevant to evaluating land capability and records both land capability class and subclass information. An example of a completed site card appears in Appendix A. A further 150 sites have recorded brief notes on soil types and there are an additional 141 detailed soil descriptions confined to the transects only. Base maps, with land capability boundaries appended, have been digitised and information captured and stored using ArcInfo at a scale equivalent to 1:50 000. Final publication scale is at 1:100 000. Field checking of land capability evaluation has been undertaken by peers within the DPIF who have experience in agriculture, soils and evaluation techniques.

Traditionally, four limitation sub-classes have been identified: erosion (e), wetness (w), soils (s) and climate (c). Examples of different kinds of limitations are: erosion hazard, slope, climate, flooding, stoniness, rock outcrops, salinity, poor soil structure, poor internal drainage, low fertility and low soil moisture holding capacity. There may be one or a number of limitations present at any one site, in these situations it is the dominant limitation which is assigned to the capability sub-class. During the course of the fieldwork it became evident that four subclass codes 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 limitation. In this survey, site records denote it as an ‘r’ (rockiness) limitation. Similarly, some parts of the survey area were considered to be limited by the irregular nature of the surface topography. This did not fit well within any of the existing limitation codes and thus a limitation ‘t’ (topographic) was created. The extension of sub-class limitation codes makes little difference to the mapping program at 1:100 000 scale but will affect more detailed levels of mapping. The concept of creating additional limitation codes is currently under development.

Throughout the fieldwork attempts have been made to identify the key type of limitation to agricultural use at each site. Despite the obvious value of including this information on the published map this has not been done for a number of reasons. In many parts of the State, identification of sub-class boundaries would lead to unnecessary complication and detail when published at 1:100 000 scale. This is particularly so for map sheets like the Forth where land capability subclass, and even class, can change over short distances resulting in very complex boundary patterns. The detailed site information is available to other users on request to DPIF.

When using the land capability information for the Forth 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.
- 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 indicated on the map by the letter E and appear without a colour shade.
- The evaluation procedure is as outlined in Noble (1992a).
- Land capability is assessed on the ability of the land to support rainfed agriculture except where irrigated agriculture is considered normal practice and water is readily available from on-farm storage or a recognised irrigation scheme.

Photo 1. The description and characterisation of soil types forms an important part of land capability mapping.

For 1:100 000 scale surveys the issue of irrigation and it's 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 availability of water, 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.

However, it is recognised that summer irrigation of crops from water stored in on-farm dams is standard practice throughout many parts of the Forth survey area. As a result, land capability in the Forth survey area has been assessed assuming that irrigation water is freely available and that appropriate conservation and drainage measures are undertaken to minimise degradation.

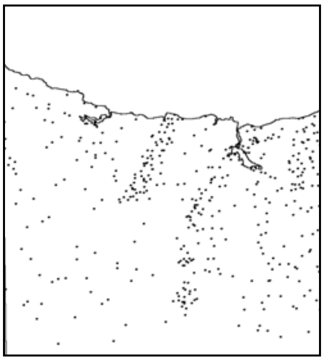


Figure 2. Distribution of Land Capability Observation Sites on the Forth Map Sheet.

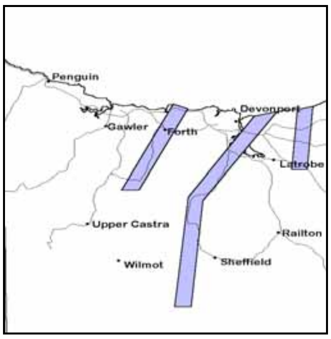


Figure 3. Location of detailed transects**.**

4. 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 4).

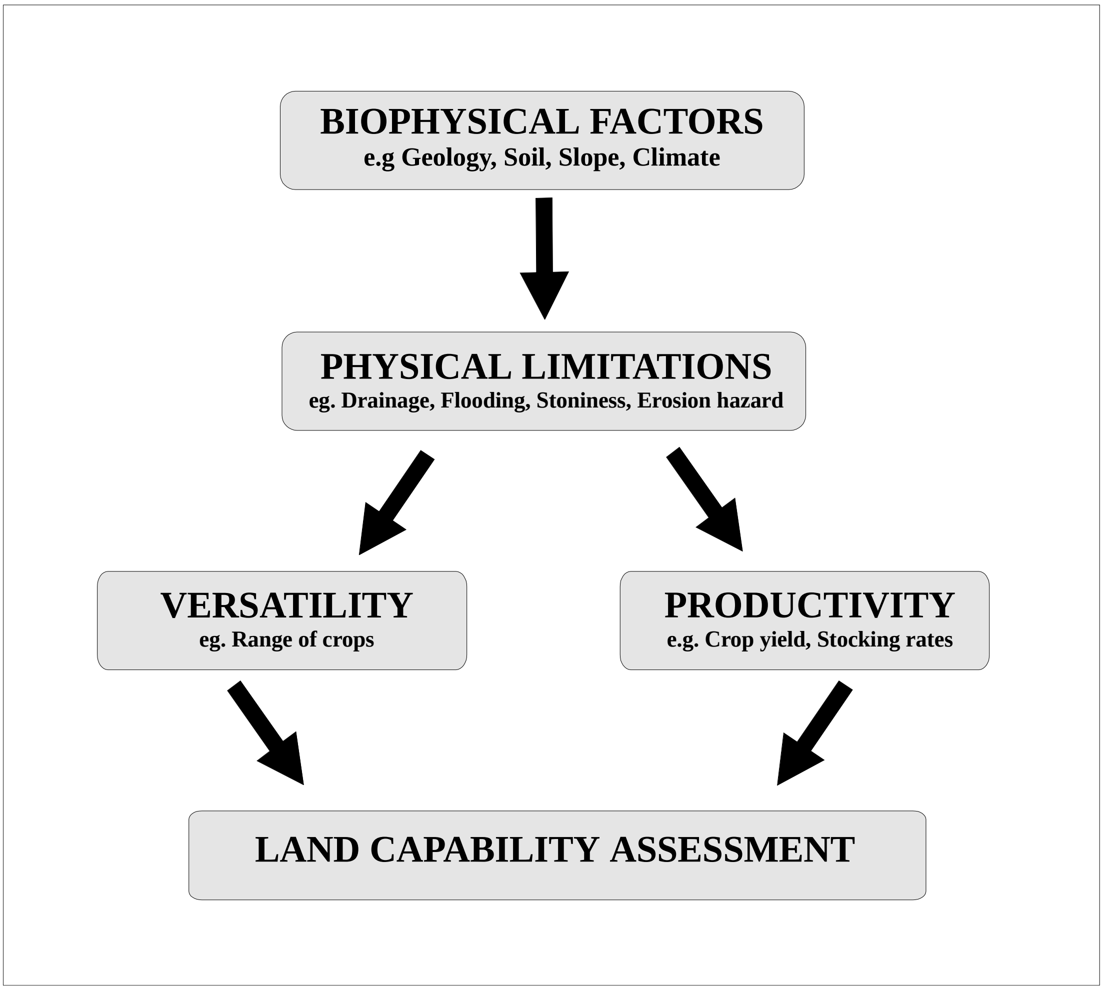


Figure 4. Factors in land capability assessment.

Land capability assessment takes into account the physical nature of the land (e.g. geology, soils, slope) plus other factors (e.g. 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, e.g. 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 a specific management systems.

The basic principle of land capability brings together both facets of conservation - protection of the land and its potential production. In other words, the balance between use of the land and the risk of degradation of the land resource.

4.1 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 Noble (1992a). 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 (e.g. perennial horticulture, silviculture).

The classification relates primarily to three permanent biophysical features of the landscape - soil, slope and climate - and their interactions. These three factors have a major influence in determining the capability of the land to 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.

Three levels are defined within the Tasmanian land capability classification:

- The land capability <u>Class</u> - which gives an indication of the general degree of limitation to use

- <u>Sub-class</u> - which identifies the dominant kind of limitation

- and the Unit - which groups land with similar management and conservation requirements, potential productivity, etc.

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. The levels of the land capability classification system are shown in Figure 5.

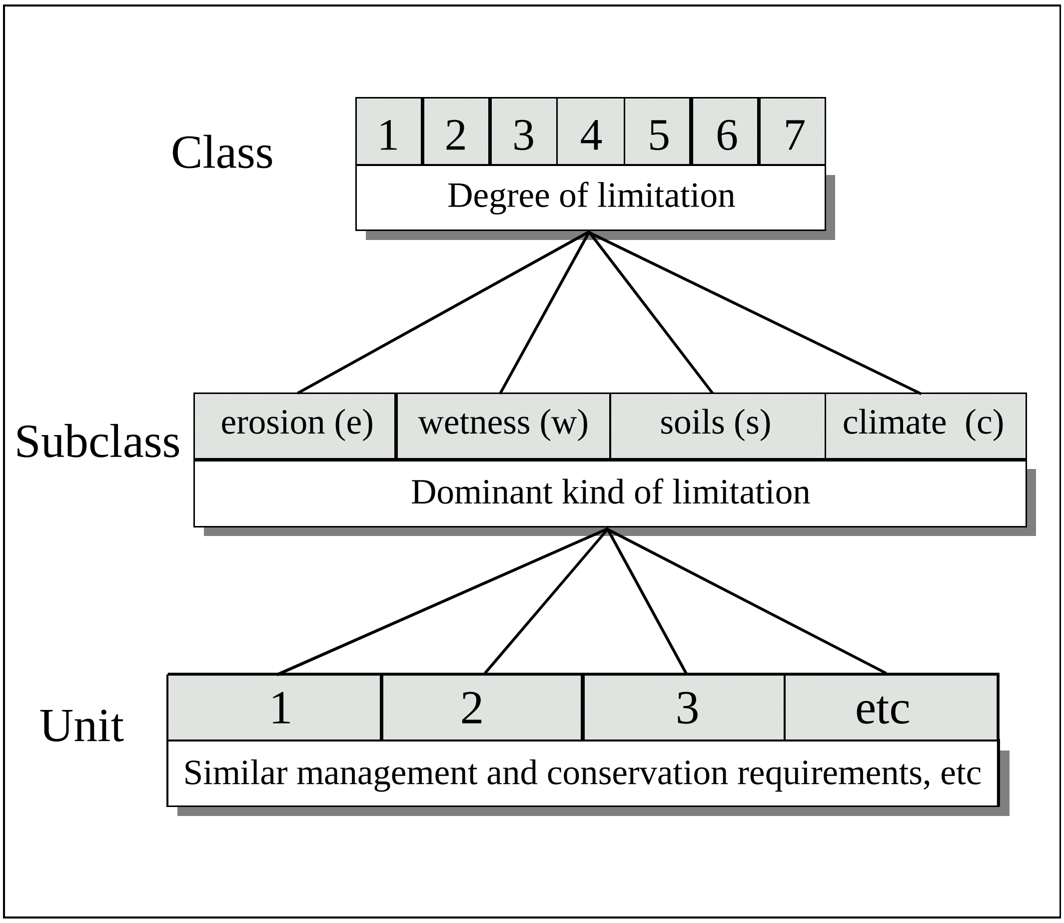


Figure 5. Levels of the land capability classification system.
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land Resources. (NWASCO), Wellington, New Zealand.)

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.

Each land class can be subdivided into sub-classes depending on the nature of the dominant limitation or hazard to the use of that land. 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. Some limitations are able to be removed or modified through normal management practices or other means. Where such improvements are considered feasible, both physically and economically, land may be classified higher than it's current condition might indicate. Such improvements do not include the use of irrigation water but may include drainage or stone picking.

Each subclass may be further subdivided to unit level. Land capability units are areas of land with similar management and conservation requirements or differences in productivity which may not be significant at higher levels within the classification system. Thus an area identified as Class 4e may be further subdivided into 4e1 (Class 4e land requiring conservation practices appropriate to wind erosion) and 4e2 (Class 4e land requiring conservation practices appropriate to water erosion).

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 is another activity that the system does not consider. The main agricultural land uses that are considered when evaluating land include cereals, poppies, broadacre vegetable production (potatoes, peas, beans, onions etc), pyrethrum and essential oils plus 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.

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

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

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

(c) Appropriate soil conservation measures have been applied.

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

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

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

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

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

(i) 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.

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

(k) 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.

4.2 Class Definitions

The criteria used to define classes are based on observation and experience only, and not on experimental work. Figure 6 outlines the main features of the capability classes. Classes 1-4 only are considered capable of supporting cropping activities on a sustainable basis; Classes 5 and 6 are suitable for grazing activities only although pasture improvement may be possible on Class 5 land (Class 6 land remaining as native pasture); Class 7 land is unsuitable for any form of sustainable agricultural activity.

Also, there is a range of land that can 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.

<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>moderate</td><td>reduced</td><td>major</td></tr>
<tr><td>4</td><td>severe</td><td>restricted</td><td></td></tr>
<tr><td>5</td><td rowspan="3">Under pastoral use</td><td>slight
to
severe</td><td>grazing</td><td rowspan="3">major
+
careful management</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 6. Features of land capability classes

Land capability class definitions are as follows:

CLASS 1

Multiple use land with only minor limitations to intensive cropping and grazing. It occurs on flat land with deep, well drained soils, and in a climate that favours a wide variety of crops. It is 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 intensive cropping and grazing. Limitations to use are slight, and these can be readily overcome by management and minor conservation practices. Limitations present increase the risk of damage to the soil resource through over cultivation or the risk of yield loss is such that the length of the cropping phase is reduced to five to eight years out of ten in a rotation with pasture or equivalent during 'normal' years.

CLASS 3

Land suitable for cropping and intensive grazing. Limitations are such that either cultivation for cropping should be limited to two to five successive crops in a rotation with pasture or equivalent to prevent damage to the soil resource, or the risk of crop failure or yield reduction with average climatic conditions is such that significant losses can be expected 5-7 years out of ten. Soil conservation practices and sound management are needed to overcome the moderate limitations to cropping use. The range of crops able to be grown is generally more restricted than on Class 1 or 2 land.

CLASS 4

Land marginally suitable for cropping because of severe limitations which restrict the range of crops that can be grown, and/or make major conservation treatment and careful management necessary. 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 or are limited by severe climatic conditions such that there is a very high risk of crop failure or yield decline in most years. This land is well suited to intensive grazing.

CLASS 5

Land with slight to moderate limitations to pastoral use. This land is unsuitable for cropping, although some areas on easier slopes may be cultivated for pasture establishment or renewal. 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 levels of production, high risk of erosion, low natural fertility or other limitations that severely restrict agricultural use.

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 land currently being developed as part of a limestone quarry at Railton.

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

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

Also, the classification system takes into account the *variety* of crops that can be grown (see also page 15 for examples of crops considered). 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.

Irrigation of crops is generally considered essential for economic production of crops in most parts of the survey area. The capability classification does not take into account the potential for irrigation nor the increased productivity that might result from the use of irrigation nor on the availability, or otherwise, of irrigation water. Capability is based solely on the land’s ability to produce under normal rainfed agricultural systems. This approach is necessary to ensure consistency in methodology for mapping around the State. It is recognised however, that, in today’s economic climate, production of some crops is only economically feasible by using irrigation water. The land capability methodology does not assess the *suitability* of land to irrigated agriculture.

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.

5. THE FORTH SURVEY AREA

5.1 Introduction

The study area lies on the north west coast of Tasmania (see Figure 1). It includes the local centres of Devonport, Sheffield, Latrobe, Forth and Ulverstone and numerous other smaller settlements. The total area is some 1637 km^2 of which just over 500 km^2 are exclusion areas, most of which comprise State Forest and Forest Reserve.

The Forth survey area includes some of the best agricultural land in the State but it's sustainable development is threatened by urban expansion and rural subdivision, particularly in the vicinity of East Devonport. Another issue of concern in the area is the erosion of, and soil structure damage to, the Ferrosols, or red soils, under intensive horticultural production where proper soil conservation and soil management practices are not employed.

In recognition of the value of these red Ferrosols the Kindred Landcare Group published "*Keeping Your Soil on Your Farm*" (1994), a glossy brochure outlining various conservation practices for the Ferrosols (also known as 'red' soils or krasnozems). Several farmers in the area have won awards for the conservation measures that they have implemented on their properties.

The area as a whole has a diverse range of landscapes, climate and land use. The land's capability to support sustainable agricultural development is equally diverse and there is a recognised need amongst many landowners to protect the prime agricultural resources that remain.

5.2 Climate

The climate of the Forth survey area is considered Temperate Maritime with cool, drier summers and mild, wetter winters. Within this broad climatic type the area does experience a range of climatic conditions which can be directly related to distance from the coast (and proximity to the hill ranges) and elevation. The main agricultural areas lie nearer the coast with intensive agriculture giving way to grazing and dairying with increasing elevation and distance from the sea. Towards the southern extent of the survey, agricultural activities give way to forestry, partly as a result of more severe climatic limitations but also due to increasing severity of various soil limitations.

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

5.2.1 Precipitation

Precipitation in the Forth survey area is winter dominant with roughly 25% of annual rainfall falling during the months of July and August. January through to March is the driest period with 15% of annual rainfall. There are a number of rainfall recording stations throughout the area and Table 2 shows average monthly rainfall for a selection of stations in coastal and inland areas. This data, and also Fig 7, indicate a distinct increase in rainfall away from the coast and also towards the west. North-eastern parts of the survey area are the driest, recording about 800 mm at Northdown and south-western parts are the wettest - over 1600 mm per annum at Erriba.

	J	F	M	A	M	J	J	A	S	O	N	D	Tot
Erriba	83	75	84	133	165	161	215	204	146	132	114	106	1615
Forthside	52	47	58	78	100	102	131	118	92	84	74	74	1010
Devonport	42	40	50	64	84	82	105	93	71	68	58	56	813
Sheffield	52	61	62	90	115	125	159	147	113	102	79	76	1181
Kimberley	50	46	53	71	95	94	122	109	80	71	65	62	882
Penguin	63	46	58	89	107	115	143	130	100	92	77	77	1075
Av. Monthly Evaporation	170	140	118	69	46.5	33	37.2	49.6	72	105	126	155	1121

Table 2. Average monthly rainfall for selected stations and average monthly evaporation for Forthside (mm).

The information in Fig 7 has been created using ESOCLIM software, the results of which fairly closely reflect previous data presented by HEC.

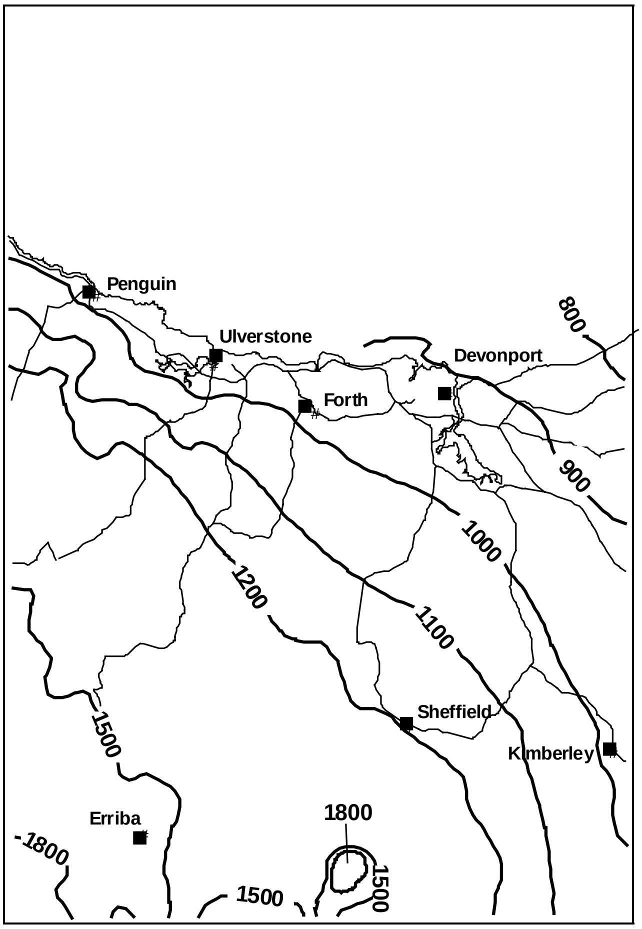


Figure 7. Simplified rainfall isohyet diagram for the Forth survey area (mm/annum) (based on ESOCLIM model)

Snowfalls and hail storms are largely confined to upland areas and snow may remain for several days on the mountain summits at the southern edge of the survey area. Snow falls are not uncommon on inland basalt plateaux surfaces but it rarely remains for any length of time.

5.2.2 Evaporation

One station recording evaporation data, Forthside, is located within the survey area. Figure 8 shows the number of months in which rainfall exceeds evaporation across the survey area (as derived from ESOCLIM data) while average monthly evaporation figures for Forthside appear in Table 2. The data indicates that monthly precipitation is likely to exceed monthly evaporation for at least six months each year for all but north eastern parts of the survey. In wetter areas, towards the south-west, precipitation may exceed evaporation for eight or nine months each year.

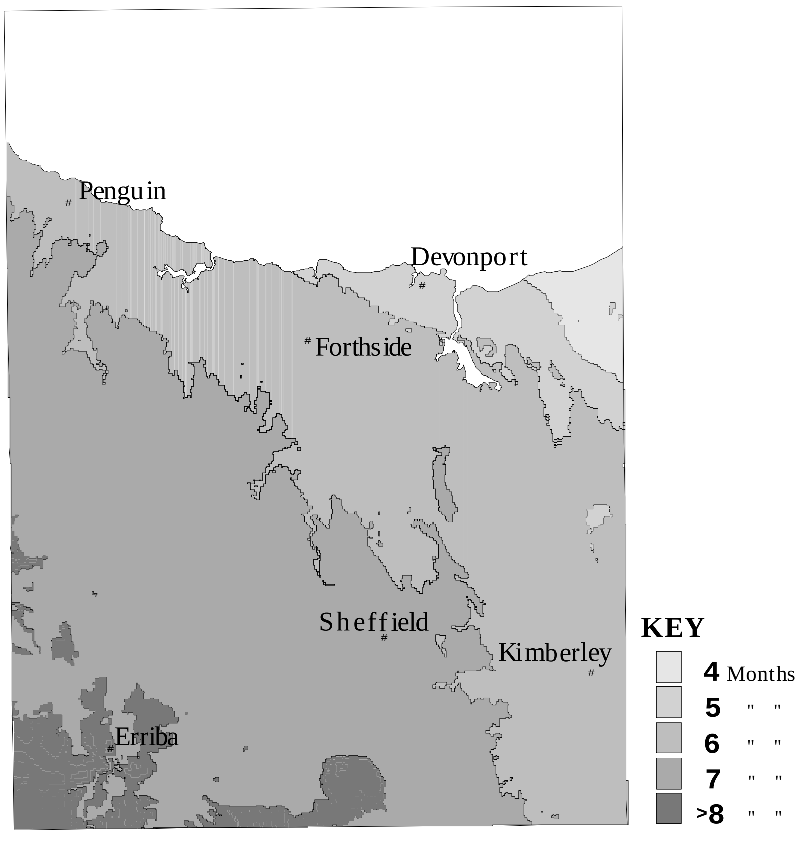


Figure 8. Number of months that rainfall exceeds evaporation across the Forth survey area (as calculated from ESOCLIM data)

Calculations of effective rainfall using the evaporation figures in Table 2 and Prescott's formula (Prescott and Thomas, 1949) suggest that, with the exception of drier areas in the north and north east of the survey area, there should be sufficient rainfall to support agricultural production without requiring irrigation. However, despite these figures, experience has shown that, without supplementary irrigation through the summer months, the risk of crop failure or yield loss is very high and consequently irrigation remains common practice throughout the survey area. This irrigation is essential to maintain the high levels of production currently demanded by growers to ensure economic viability.

The excess of winter rainfall over precipitation can result in localised waterlogging and surface ponding even where soils are inherently well drained. This can be a problem on the Ferrosols which are prone to smearing and structure decline if subjected to vehicular traffic while in a wet condition.

5.2.3 Temperature

Average temperatures for selected stations are presented in Figure 9 and display a distinct seasonality with maximum temperatures occurring during January and February and minimums during July. Proximity to the coast and elevation have a significant affect on mean daily maximum and minimum temperatures. Devonport airport for example, at an elevation of just 9 m and right on the coast, has maximum and minimum temperatures of 20.8°C and 4.2°C while Sheffield, at 280 m and 25 km from the coast, has corresponding temperatures of 21.5°C and 2.5°C.

Low temperatures, leading to the formation of frosts, can occur anywhere within the survey area at almost anytime of year (see Table 3) although greatest risk is generally between April and October for inland areas and May through to September for more coastal locations.

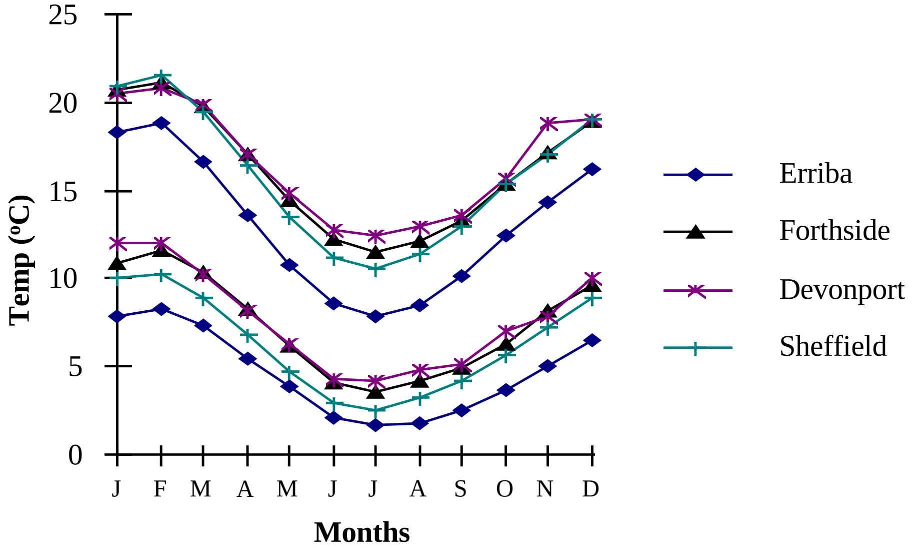


Figure 9. Mean Monthly Maximum and Minimum Temperatures for Selected Stations (Source: Bureau of Meteorology, unpublished data, 1997)

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 aspect and local topography can also affect the frequency and severity of frost. Several local farmers have spoken of the significance of frost hollows in determining the impact of frost rather than elevation *per se*.

		J	F	M	A	M	J	J	A	S	O	N	D
Erriba	Mean days below 2.2°C	0.7	0.8	2	4.8	9.6	15.2	18.7	17.5	13.9	9.7	5.9	2.3
	Mean days Frost	0.4	0.7	1.1	2.9	7.3	11.8	13.5	12.1	9.7	6.6	3.3	1.3
Forth	Mean days below 2.2°C	0	0	0.1	1.3	3.2	9	10.5	8.4	6	2.8	0.6	0.1
	Mean days Frost	0.1	0.1	0.2	1.4	3.9	9.7	11.4	9.4	7	4.1	1.2	0.4
Devonport	Mean days below 2.2°C	0	0	0.3	1.7	3.2	8	8.2	6.4	4.8	1.6	0.4	0.2
	Mean days Frost	0	0	0	0	1.2	3.4	3.6	3.6	1.8	0	0	0
Sheffield	Mean days below 2.2°C	0.1	0	0.5	2.1	7.3	12.3	14.9	11.3	7.6	4	1.3	0.4
	Mean days Frost	0.1	0.1	0.3	1.4	4.9	9	11	7.8	4.7	3	0.8	0.2

Table 3. Mean number of days with frost or with temperatures below 2.2°C
(Source: Bureau of Meteorology, unpublished data, 1997)

Local experience indicates that there are several small plateaux at about 280-300 m which tend to shed cold air and are thus 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 these areas are rarely identified with sufficient reliability to map them individually.

5.2.4 Growing Season

The length of growing season in the Forth survey area is determined by rainfall 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 that yields would be significantly reduced and, perhaps, unviable. Irrigation certainly extends the length of a reliable growing season well into the summer months and probably allows the growing of more than one crop a season in some areas.

As discussed earlier, altitude has been used as a surrogate for temperature in assessing the risk of frost and the period for which daily temperatures are suitable for germination and crop growth. The 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 Forth survey area are as follows:

Class 1 land	200m (long season, low frost risk)
Class 2 land	270m
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 for example, 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 two geological maps, 'Devonport' 1:63 360 (Burns, 1964) which covers the northern part of the sheet and 'Sheffield' 1:63 360 (Jennings 1959 (map) and 1979 (report)) to the south.

The area as a whole has a complex geological make-up covering a substantial time-span from Precambrian through to the present day. Figure 10 presents a simplified geology of the area over a digital elevation model.

In the north-west section of the map sheet, Cambrian and Ordovician volcanics, mudstones and conglomerates form the prominent Dial Range. The volcanics include Motton Spilite, a Cambrian basaltic material interbedded with tuff and breccia. Other significant rock types include the Barrington Chert, which directly underlies the Spilite, the Cateena Mudstone, the Ordovician Duncan Conglomerate and Moina Sandstone.

East of the Dial Range are scattered outcrops of Precambrian metamorphic rocks including schists and quartzite. Further east still, and to the south of Devonport, is a region of heavily faulted Permian sediments. These are dominantly mudstones but include the Mersey Coal Measures and Tasmanite oil shale. These sediments extend south to Kimberley, gradually giving way to Moina Sandstone. To the south of Sheffield, at Claude Road and Beulah, areas of intermediate lavas and pyroclastic materials making up the Beulah Formation occur.

To the south of the Dial Range, at Gunns Plains, is an area of Ordovician Limestone. Cambrian Gog Range Greywacke occurs extensively at Nietta, Leven Canyon and Lower Wilmot. This fine grained mudstone is interspersed with a variety of minor sediments and acid volcanics. To the east of Lower Wilmot and also at Lower Barrington substantial areas of quartz conglomerate occur as the Ordovician Dial Conglomerate and the Cambrian Bott Conglomerate.

At the southern edge of the survey area rise a prominent range of mountains including Mts Roland, Vandyke and Claude. The lower slopes of these mountains comprise Cambrian Minnow Keratophyre (mainly acid volcanics) and Gog Range Greywacke unconformably overlain by Ordovician Roland Conglomerate. The junction between the Cambrian and Ordovician rocks is often obscured by significant thicknesses of post glacial quartzite and conglomerate talus, most clearly evident below Mt Roland, at Claude Road. Capping the conglomerate is more Moina Sandstone.

Much of the survey area has a capping of Tertiary basalt and it is the soils derived from these rocks that constitute some of the best agricultural soils in the State. The pre-Tertiary landscape of the area has been defined by Burns (1957) as a dissected plateau. Volcanic eruptions of basaltic material during the Tertiary period are thought to have led to the infilling of many valleys in some areas and the overflow of basalt in others to form minor plateaux. Subsequent erosion has left the Tertiary basalt surface dissected with much basalt now occupying ridge crests, particularly in northern parts of the survey. At the margins of the existing basalt flows extensive deposits of basalt talus and landslide debris occur. Many of these deposits are considered to be of Quaternary age. Tertiary deposits of sands, gravel and clays occur in a number of deep leads. At Sheffield, extensive areas of Tertiary sediments occur as a result of one of these leads becoming blocked by basalt and sediments built up behind the basalt in the resulting "Lake Sheffield". Around Wesley Vale, in the north-east of the survey, Wesley Vale Sands appear to lie sandwiched between two phases of basalt lava flow - the Thirlstane basalt and the slightly younger Moriarty Basalt. Around Moriarty and Wesley Vale the thin cover of Moriarty Basalt has been removed in patches resulting in a complex pattern of basalt with small areas of Wesley Vale sand outcropping. The Wesley Vale sediments have a significant impact on land capability but many areas are either too small, or occur in too complex a pattern, to be accurately mapped at the publication scale of the geology maps.

Quaternary alluvium occurs along major riverine plains and coastal margins. The best developed examples can be found along the Mersey, Dasher, the Lower Forth and Leven Rivers. Many of these rivers have remnants of well developed terraces which are often better drained than the current flood plains. Coastal alluvial deposits, including dune formations, are evident from Ulverstone to well east of Devonport.

Other minor rock types that are to be found include occasional outcrops of Jurassic dolerite around, and to the east of, Devonport, north-west of Railton and at Weegena. Minor outcrops of Devonian granite and microgranodiorite occur at Beulah. Geological deposits of economic value include thin seams of coal at Railton and Nook; oilshale occurs at Kimberley, Beulah and Latrobe. A wide range of metallic minerals are to be found over the survey area. Iron ore has been mined at Penguin Creek as well as in the south west where copper, tin, tungsten, lead, silver and gold are also found. Many of these deposits are very minor however, and today there is virtually no exploitation of these deposits. The conglomerates and quartzite, are currently exploited for construction materials and limestone is quarried at Railton for the manufacture of cement.

The entire survey area is heavily faulted and minor earthquakes are not uncommon in the area. At Kimberley a small thermal spring exists, producing tepid water.

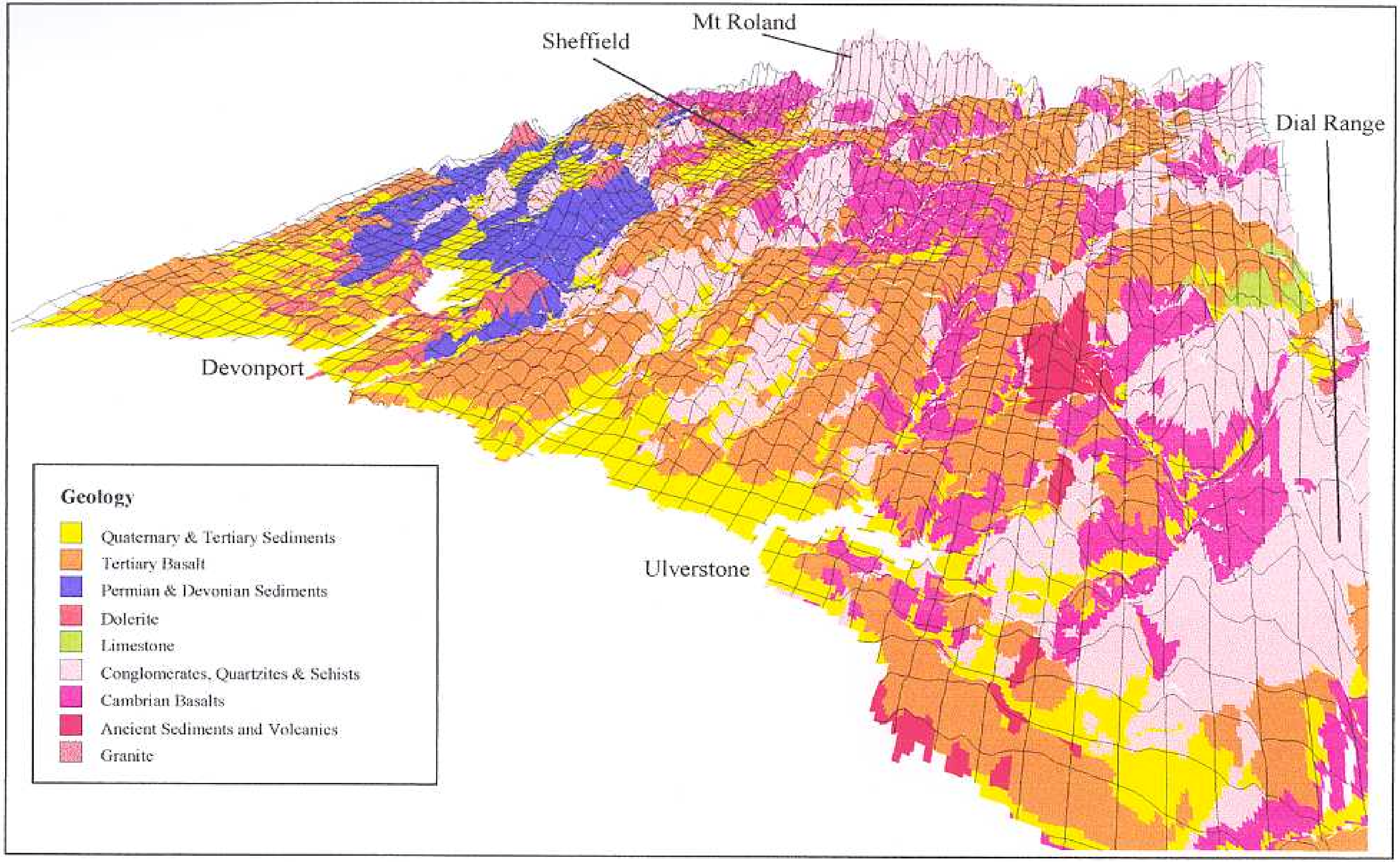


Figure 10. Digital elevation model and simplified geology of the Forth survey area.

Photo 2. Basalt plains east of Barrington. Such areas represent some of the best agricultural land in the State (GR E440500, N54242500).

Photo 3. Rolling basalt country is typical of the agricultural landscape of the area. Mount Roland forms a seemingly ever present backdrop (GR E447500, N5416600).

5.4 Topography and Geomorphology

The topography of the area is dominated by rolling low hills and hills, with broad ridge crests and steep-sided intervening valleys. Many of these ridges and valleys have a prominent north to north west alignment and are a prominent feature when driving across the grain of the country.

Along the coast, west of Ulverstone to the eastern edge of the survey area at Northdown, a prominent coastal plain is evident. This plain varies from several hundred metres to almost 2 km in width and is backed by a steep escarpment marking the limit of the basalt outcrop. This prominent escarpment represents a former shore line which subsequent sea level changes have now left high and dry. The escarpment has been modified by Quaternary talus and landslip deposits as erosion along the face of the scarp has occurred. West of Ulverstone, and also at Penguin, the coastal plain does not occur and the basalt rocks drop almost abruptly into the sea. Several major rivers have created breaks in the scarp, notably the Mersey and the Forth, and their estuaries are often associated with extensive tidal flats.

Inland, the basalt surfaces form dissected ridges with broad, undulating crests and moderately steep valley sides. Further inland the landscape resembles more a dissected plateau with many basalt remnants - around Sheffield, for example and at Sunnyside, north-west of Kimberley, - separated by broad deep valleys. Areas of basaltic talus and landslip materials are evident in many places around the margins of the basalt. The landslips are most common at the junction of the basalt and underlying sediments and at the terminal end of the basalt flows. There is some evidence to suggest that many of these landslips are relatively ancient, and now stabilised features although Jennings (1979) does suggest that the slips are a result of active erosion following clearing of the natural vegetation combined with intensive agriculture practices and the presence of lubricating clays within the lava flows. Landslips also occur on the steeper Permian sediments especially where removal of native vegetation has occurred. While many of the larger slips now appear stable, small slips do still occur, particularly after heavy rain. Another feature common at the junction of the basalt and underlying, less permeable sediments, are springlines. At some places these springlines are prone to significant erosion while at others they are utilised by farmers as a source of on-farm water supplies for irrigation.

Elevations vary across the map sheet from sea level in the north to a maximum of 1233 m at the summit of Mount Roland at the southern edge of the survey area. This mountain dominates the surrounding area and is a clear landmark for miles around. Other major summits, which form part of the same range as Mt Roland, include Mount Vandyke (1084 m) and Mount Claude (1034 m).

Lower, but still prominent hill ranges occur throughout the area and are often characterised by rock types more resistant to erosion than the surrounding country rocks. The Dial Range south of Penguin, rising to 680 m at Mt Duncan, comprises Ordovician quartzites and conglomerates while the Badgers Range and Bonneys Tier (548 m and 466 m), north of Sheffield, are capped by Jurassic dolerite.

At Gunns Plains, caves of tourist quality have developed in limestone of Ordovician age.

The land systems of the area have been reported by Richley (1978). The major land systems of the agricultural area include:

Moriarty System - an area of low hills comprising Tertiary basalt and non-marine sediments in the north-east parts of the survey.

Beulah System - gentler topography at rims of steep valleys of Forth and Leven rivers, also around Paradise-Beulah.

Latrobe System - areas of low hills formed on Permian sediments around Latrobe and Railton. *Elliott System* - rolling low hills, with NE-SE trend, on remnants of Tertiary basalt scattered throughout the area to about the 300 m contour.

Guide River System - Tertiary basalt deeply incised by river valleys.

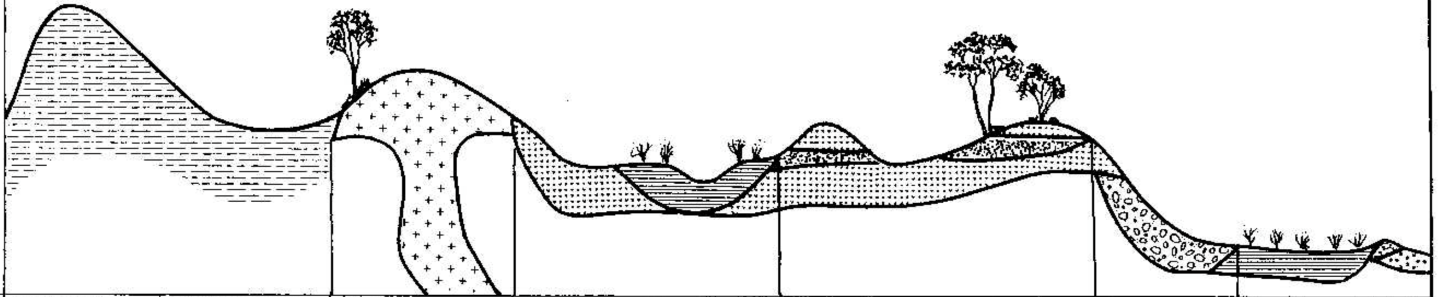
Highclere System - similar, and often adjacent to, the Elliott System but generally above 300 m.

The major river systems include the Mersey, Forth, Wilmot and Leven Rivers. The Mersey occurs in the east of the survey area and flows north from near Weegena to its mouth at Devonport. The Forth River, which originates in the hills to the south of Cethana, flows north-east and then northwards to its mouth near Turners Beach. This river has been dammed at Devils Gate, west of Barrington, to create Lake Barrington which is a substantial provider of hydro-electric power. Below the dam the river has cut a deep gorge through Cambrian Chert and Ordovician conglomerate. The Wilmot River occupies a narrow and steep-sided V-shaped valley from its source to the south-west of Moina to its junction with the Forth just south-west of Paloona. The Leven River is found at the western margin of the survey area and flows through a range of rock types before flowing into Bass Strait to the west of Ulverstone. To the west of Nietta, the river has cut a spectacular gorge through Cambrian sediments while slightly further north, at Gunns Plains, the valley is far broader with Quaternary sediments overlying Ordovician limestone. Before reaching Ulverstone, the Leven River follows the east side of the Dial Range.

Other smaller rivers occur throughout the area. The Dasher River flows east north east from Cethana to its junction with the Mersey at Kimberley. The Don River rises north of Paloona and exits to the sea west of Devonport and the Gawler River rises near Sprent and exits into the Leven estuary at Ulverstone.

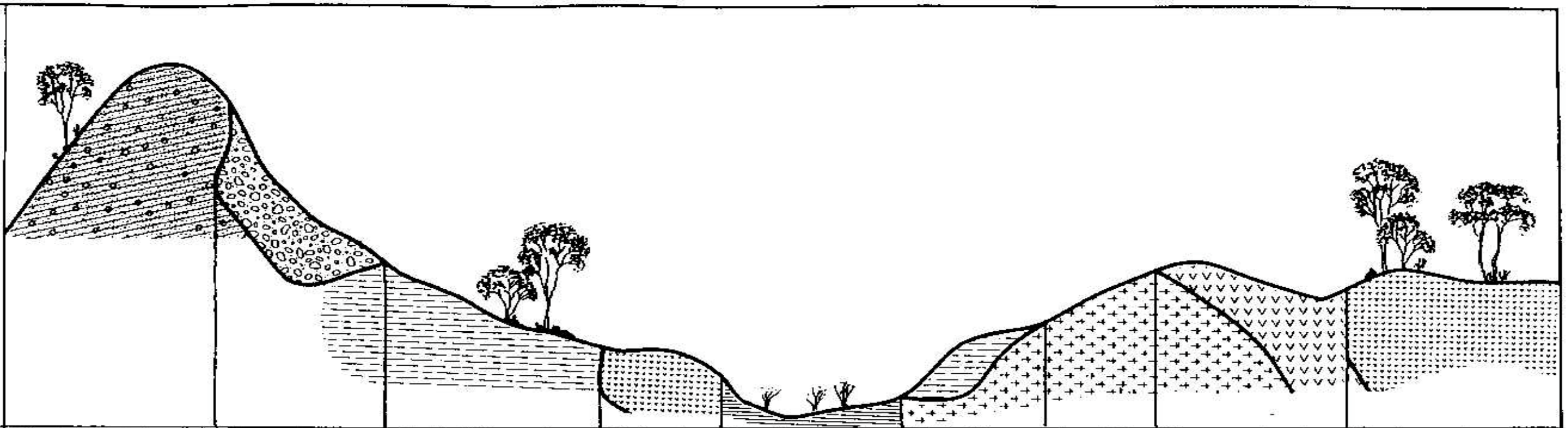
Heavy rainfall in the upper catchments of many of these rivers can result in “nuisance” flooding at almost any time of year while more regular flooding occurs as a result of short, sharp summer storms or with prolonged winter rains. For the most part these floods rarely last more than a couple of days and, due to the often narrow valley floor, affect only limited areas. There are flood gauging stations on the Mersey river at Kimberley and Latrobe and on Redwater Creek at Railton.

Stylised cross sections through the survey area are presented as Figs. 11, 12 and 13. While providing an insight to the landforms of the survey area the diagrams also indicate the relationships between geology, soils, landforms and land capability.



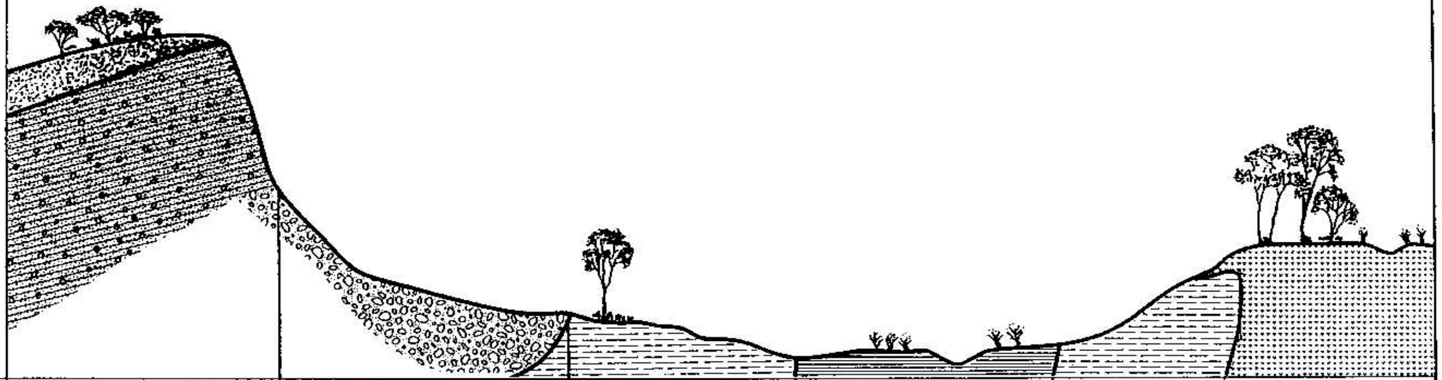
Typical Landform	Moderately steep hills and valley sides.	Gently undulating to rolling low rises.	Moderately steep to rolling hills	Low lying basaltic colluvial fans and alluvial floodplain and terraces	Moderately steep to gently undulating ridge tops and associated valley sides	Steep escarpments	Coastal margins and dune fields
Geology	Permian mudstones and related sediments	Permian mudstones, and related sediments	Jurassic dolerite	Tertiary basalt colluvium, Quaternary alluvium and marsh deposits	Tertiary basalt and sediments (Wesley Vale sands)	Tertiary basalt, basaltic talus, and slump complexes	Quaternary alluvium and windblown sands
Soil Type	Chromosols, and grey dermosols	Hydrosols in wet areas, grey and red dermosols, brown kurosols and some podosols	Brown chromosols and dermosols with gravels or boulders	Brown dermosols and aquic vertisols in drainage depressions. Stony ferrosols on basalt colluvium	Red ferrosols on basalts and kurosols and dermosols on Wesley Vale sediments; occasional podosols	Red ferrosols	Vertisols on alluvium: podosols and Rudosols elsewhere
Slope Range	0-56%	0-32%	12-32%	0-5%	0-18%	32->56%	<5%
Drainage Status	Moderately well to imperfect	Imperfect to moderately well; occasionally poor in drainage lines	Moderately well	Imperfect to poor	Well	Moderately well to well	Imperfect to well drained on sand and beach cobbles
Permeability	Slow to mod	Slow to mod	Mod	Slow	Mod - high	Mod	Slow -rapid
Erosion risk	Moderate to high	Mod to high	Mod	Low	Low on basalt, mod-high on Wesley Vale Sediments.	High mass movement risk; moderate rill and gully	Low on alluvium, mod - high wind erosion risk on dunes
Main Limitations	Dispersive subsoil, shallow topsoils on steeper slopes; landslip and gully erosion	Poor drainage in low lying areas; soil structure decline; landslip and gully erosion on steeper slopes	Stony soil	Flooding, compaction, poor drainage, short working window	Water erosion especially under irrigation; wind erosion on sandy soils	Erosion risk - landslips, water erosion; irregular topography	Drainage, wind erosion
Land Capability Classes	5,6,E	4,5,6	4	4,5	1,2,3	4,5,6	4 & 5 on alluvial soil, 7 on dunes

Figure 11. Stylised cross-section north-west from Latrobe to Northdown Beach



Typical Landform	Mountains and steep hills with steep river valleys	Steep rocky hillslopes and valley sides	Moderately steep to rolling hill country	Moderately steep to rolling hills with steep river valleys	Low lying river flood plains and river terraces	Moderately steep to rolling hill country	Steep hills and valley sides	Steep to moderately sloping hills	Level to gently undulating plateaux
Geology	Ordovician conglomerate	Ordovician conglomerate and talus	Cambrian mudstones	Cambrian volcanics	Quaternary alluvium	Mudstones and sandstone	Cambrian Chert	Cambrian Spilites	Tertiary basalt
Soil Type	Aeric and Semiaquic podosols	Aeric and Semiaquic podosols with gravels and stones	Dermosols	Red ferrosols	Brown dermosols	Dermosols	Semiaquic podosols and brown dermosols	Brown dermosols and red ferrosols	Red ferrosols
Slope Range	>56%	32-56%	<32%	<32%	<5%	<32%	>32%	<32%	<12%
Drainage Status	Moderately well to well	Moderately well to well	Moderately well	Well	Imperfect to moderately well	Moderately well	Moderately well to well	Well	Well
Permeability	Mod	Mod	Mod	Mod	Slow- mod	Mod	Mod	Mod	Mod-high
Erosion risk	High	High	Mod	Mod	Low-mod	Mod	High	Low-mod	Low
Main Limitations	Erosion, low fertility, irregular topography	Stones, irregular topography, erosion	Soil structure decline, variable topsoil depth	Soil structure decline, stony and shallow topsoils	Poor drainage, flooding, short working window	Soil structure decline, variable topsoil depths	Erosion, low fertility, irregular topography	Soil structure decline, erosion, irregular topography	Erosion, climate
Land Capability Classes	6,E	5,6,E	4,5	4,5	4,5,6	4,5	5,6	3,4	1,2

Figure 12. Stylised cross-section east from the Dial Range to North Motton.



Typical Landform	Higher mountains, cliffs and scree slopes.	Mountain slopes and foothills	Rolling to undulating hills and lower footslopes.	Flood plain, river terraces	Steep hill slopes at margins of ridges and minor plateaux	Minor plateaux, undulating ridge crests.
Geology	Ordovician sandstone and conglomerate	Talus from overlying Ordovician rocks	Cambrian sandstone, siltstone, mudstone, greywacke	Quaternary alluvium	Cambrian greywacke, Tertiary basaltic colluvium	Tertiary basalt and Cambrian spilites
Soil Type	Rock outcrop, skeletal soils, and podosols.	Podosols and skeletal soils.	Dermosols	Vertisols and brown dermosols	Dermosols	Red ferrosols (krasnozems)
Slope Range	>56%	<56%	<32%	<5%	32-56%	<18%
Drainage Status	Well	Moderately well	Moderately well	Imperfect to poor	Moderately well	Well to moderately well.
Permeability	High	High	Mod	Slow	Mod	Mod - high
Erosion risk	Mod high - high	Mod high - high	Mod	Low - mod	Mod - high	Low - mod
Main Limitations	Very shallow soils, rockiness slope, climate, irregular topography.	Stony, shallow soil, slope, erosion risk, irregular topography	Soil structural degradation, shallow soils on steeper slopes, erosion risk.	Waterlogging, flood risk, stream bank erosion	Erosion risk - landslips, gully erosion, shallow, stony topsoils.	Climate, erosion on steeper slopes, soil structure decline.
Land Capability Classes	5,6,7,E	5,6,E	4,5,E	4,5	4,5,6	3,4

Figure 13. Stylised cross-section north-west from Mount Roland to the West Kentish area.

5.5 Soils

Existing soil survey information relating to the Forth survey area is confined to that undertaken by Forestry Tasmania (Hill *et al 1995*). While this mapping has been limited to areas of State Forest (ie Exclusion areas for land capability mapping purposes) it has nevertheless provided a very useful source of reference during the course of the survey. In identifying capability boundaries in areas adjacent to State Forests reference has been made to the appropriate soil information and many assumptions on the nature of the various soil types have been made on the basis of information provided in the soil reports. It is beyond the scope of this survey to determine the relationships between different soil types but, particularly during work on the transects (areas identified for more detailed investigation at the beginning of the survey), some relationships have been identified and are discussed where they are relevant to land capability mapping.

Soils derived from basaltic parent materials are the most obvious in the area due to the strong red colour of the soil material. The red colour is due to the high free iron content of these soils which is normally above 5%. Under the new Australian Soil Classification system (Isbell, 1996) the high iron content means that these soils are classified as Ferrosols but they are generally locally known as krasnozems or just red soils.

Hill *et al* identify a range of Ferrosols on basalt depending on the nature of the parent material. Several of these soils equate to similar soils described by Loveday and Farquhar (1958) and Stephens (1937) on the adjacent Burnie and Table Cape soil map to the west. Some differences between the soil types relate to subtle differences in soil hue which Loveday and Farquhar have suggested may be related to rainfall and profile drainage. Generally speaking, the redder soils occur nearer the coast and in slightly drier areas and colours become progressively browner with increasing annual rainfall and distance from the coast. Browner coloured soils also occur in less well drained areas and the colour may be almost black where the soil lies wet for long periods.

The Ferrosols comprise the best agricultural soils found in Tasmania and form the standard against which other soils are evaluated. Typically, the soils are reasonably fertile, well drained, have good aeration and permeability and a stable, strong soil structure. In the natural state topsoil organic matter is high but declines rapidly in regularly cultivated soils. These soils are not immune to degradation and excessive tillage and trafficking when the soil is at field capacity can rapidly result in a decline in structural stability leading to increased erosion risk and decreased productivity.

While no attempts have been made at direct correlation with Ferrosols identified from previous surveys it is likely that those Ferrosols occurring from sea level to about 70 m elevation will correlate with the Burnie Clay Loam. These soils are likely to be the reddest profiles seen and are almost entirely stone free. Loveday and Farquhar suggest that they are limited to areas where rainfall is below 1140 mm. Inland, with increased

Photo 4. Ferrosols, developed from basalt, create a complex pattern with soils developed from Wesley Vale sediments in some areas of the survey (GR E456925, N5439150).

Photo 5. Wind erosion is a significant hazard on loose sandy soils if a vegetation cover is not maintained (GR E458000, N5432750).

elevation and rainfall, the Ferrosols of the Forth survey area become progressively browner and more stony. Ferrosols in the 1340-1140 rainfall zone may equate with the Lapoinya soils while further south soils similar to the Yolla (1340-1780 mm rainfall range) and Oonah soils (> 1600mm rainfall) occur. The latter two soils can be particularly stony with the amount of stone increasing with depth.

Hill *et al* have described the Lebrina soil as occurring under damp sclerophyll forest. This soil has many similarities with the Lapoinya soil described by Loveday.

Landslips and talus deposits are to be found throughout all the basalt areas and variants of previously described soils can be found in association with these areas. Profiles developed on basaltic talus are generally similar to the parent soils but often have a higher stone content. Soils on landslip areas typically show evidence of impeded drainage and are mottled at relatively shallow depth.

A range of soils occur on the Permian sediments reflecting the variable lithology of these parent materials. On the Kelcey Tier Mudstone the soils are imperfectly to moderately well drained clays with low permeability and a weak to massive structure. Similar soils have previously been defined as Roebuck soils and are identified elsewhere on Permian Basal Beds and Mersey Coal Measures. Also found on the Basal Beds and the Coal Measures are a range of duplex soils with bleached A2 horizons. Many examples of these soils are to be found around Latrobe and similar profiles have been defined as China soils by Hill. A range of Podosols are also relatively common on the Tertiary Sediments. These soils have a dark A1 horizon overlying a bleached A2 sandy layer over weakly cemented Bh and Bhs horizons. The A2 horizon is often greater than 50 cm thick and the entire profile is typically moderately acid and of low fertility. The often sandy nature of the upper layers of these soils can make them highly susceptible to erosion.

Podosols have also developed on Ordovician and Cambrian quartzites and conglomerates particularly around Buster Road and west of Mt. Riana in the Dial Range. However these parent materials can also give rise to shallow, coarse sandy or stony soils of very limited agricultural potential. Such soils have been identified along the Forth river valley, east of Abbotsham and North of Quailes Hill near Wilmot.

Many soils developed on the Tertiary and Quaternary sediments show evidence of sodicity and slake readily while others are dispersive indicating a strong susceptibility to structural degradation if not carefully managed.

Hill has defined Gawler soils occurring on Cambrian Spilites and other intermediate volcanic materials. These soils have properties similar to those developed on Tertiary basalt and are also classified as Ferrosols. However, they appear to be less robust than Ferrosols on Tertiary basalt and consequently are more at risk of erosion.

5.6 Vegetation

The vegetation of the Forth survey area is broadly described in the map and accompanying legend by Kirkpatrick and Dickinson (1984). Much of the agricultural land is simply defined as “Cleared” land. *Eucalyptus obliqua* wet forest is identified on the Dial Range, around Castra, Lake Barrington, Bonney’s Tier, Pine Hill

Plantation and along the mountain slopes at the southern edge of the survey area. Sclerophyll forest and inland grassy forest is identified at The Badgers, north of Sheffield, with localised stands of *E. Obliqua* tall forest around Castra. In addition, there are extensive areas of forest regrowth and plantation forest of various types, mainly within Exclusion areas.

5.7 Land Use

Land use throughout the area varies between intensive vegetable production on the red ferrosol soils, derived from basaltic parent materials, and other better quality land on alluvial sediments closer to the coast, to intensive dairy country and rough grazing in more upland areas or on poorer quality land. There are extensive areas of private forestry in the region particularly on the poorer soils and upland areas in the central and southern parts of the survey area.

Prime agricultural land (Classes 1-3) can be found on soils derived from basalt in the northern and central parts of the area. Under irrigation this land can support a wide range of vegetable crops including onions, carrots, potatoes, peas, beans and sweetcorn, 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.

As altitude and rainfall increase with distance from the coast, climate becomes an increasing limitation to agricultural production, and vegetable production eventually gives way to dairying. As well, the quality of the Ferrosols deteriorates away from the coast, with increasing amounts of stone being found in many soils making them less suited to intensive vegetable production.

The extent and distribution of vegetable production in the area is, to some extent, also controlled by *traditional* agricultural practices. For example, while the land around Weegena has some reasonable red Ferrosols it is traditionally a dairy area and there is only limited vegetable production. The vegetable processing companies can also significantly influence the distribution of crops through their allocation of contracts to growers. Contracts for early Kennebec potatoes, for example, are rarely given around Sunnyside because, it is suggested, these companies consider the area is too high and the climate therefore unsuitable, a fact contested by some local farmers. As well, these companies can dictate various management practices which must be followed in the production of contracted crops. In some cases these practices are less than ideal and do not meet best environmental practices. For example, lack of storage facilities can mean that potatoes may remain in the ground until well into June or even July before being harvested. By this time early winter rains may cause soil moisture conditions to be at a level where there is a higher risk of damage to soil structure by machinery during harvest than might otherwise be the case in late April or May.

Around Spreyton there are extensive areas of apple orchards most of which are developed on Permian Sediments or Quaternary alluvial deposits. Much of this land has been classified as Class 4 although it is well suited to apple production. The reader is reminded of the difference between land suitability and land capability (see page 13) and that the Tasmanian Land Capability Classification System evaluates land for broadacre agricultural activities only.

Extensive areas of State Forest occur in southern parts of the survey area and also along higher ridges of conglomerate and quartzite on the Badger and Dial Ranges. Private forest development also occurs throughout the area, most notably the North Forest Product's developments at Youngman's Road, north of Railton.

Other non-agricultural activities tend to be located on land excluded from the land capability survey. These include a number of large quarries for gravel or other construction materials, at Nowhere Else and north-east of Wilmot for example, and a large limestone quarry at Railton. Lake Barrington is a man made lake open for a range of recreational activities and there are a number of small areas allocated to HEC or classified as State or Conservation Reserves.

Other minor land uses include viticulture, lavender and other herbs, emu, ostrich and dear farming. A small area of hops is grown at Gunns Plains, at the western margin of the survey area.