A LAND CAPABILITY STUDY OF THE FORMER SHIRE OF KYNETON

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Further Information

This report has been prepared to assist broad scale planning in the former Shire of Kyneton. The information in the report has been derived from air photo interpretation and a limited number of representative field sites. The scale of mapping adopted has necessitated some generalisations from the site information collected. While the ratings indicate the likely performance of the various types of land for a specific use, site specific information may be required for on-site planning. The precision of mapped boundaries is affected by the scale of the map. Any enlargement of the map will distort information and is unlikely to improve its accuracy.

Baxter, N.M. (Nathalie Marie), 1968-
A Land Capability Study of the Former Shire of Kyneton

Bibliography
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1. Land capability for agriculture - Victoria - Macedon, Mount, Region. 2. Land use, Rural - Victoria - Macedon, Mount, Region - Planning. 3. Landscape assessment - Victoria - Macedon, Mount, Region - Planning. 4. Regional planning - Victoria - Macedon, Mount, Region. 5. Macedon, Mount, Region (Vic.). I. Boyle, G (Grant). II. Victoria. Land Protection Branch. III. Centre for Land Protection Research. IV. Title. (Series: Technical Report (Centre for Land Protection Research (Vic.); no. 28)

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PREFACE

The Department of Conservation and Natural Resources has been involved in formal land capability assessment studies since the early 1970s. The Land Capability Section of the (then) Soil Conservation Authority established the framework for the conduct of formal land capability studies upon which this more recent work is based. This framework included rating tables for some thirty activities. Ratings for various activities were presented as thematic maps, or combined into ratings for various land uses, depending upon the needs and abilities of the client.

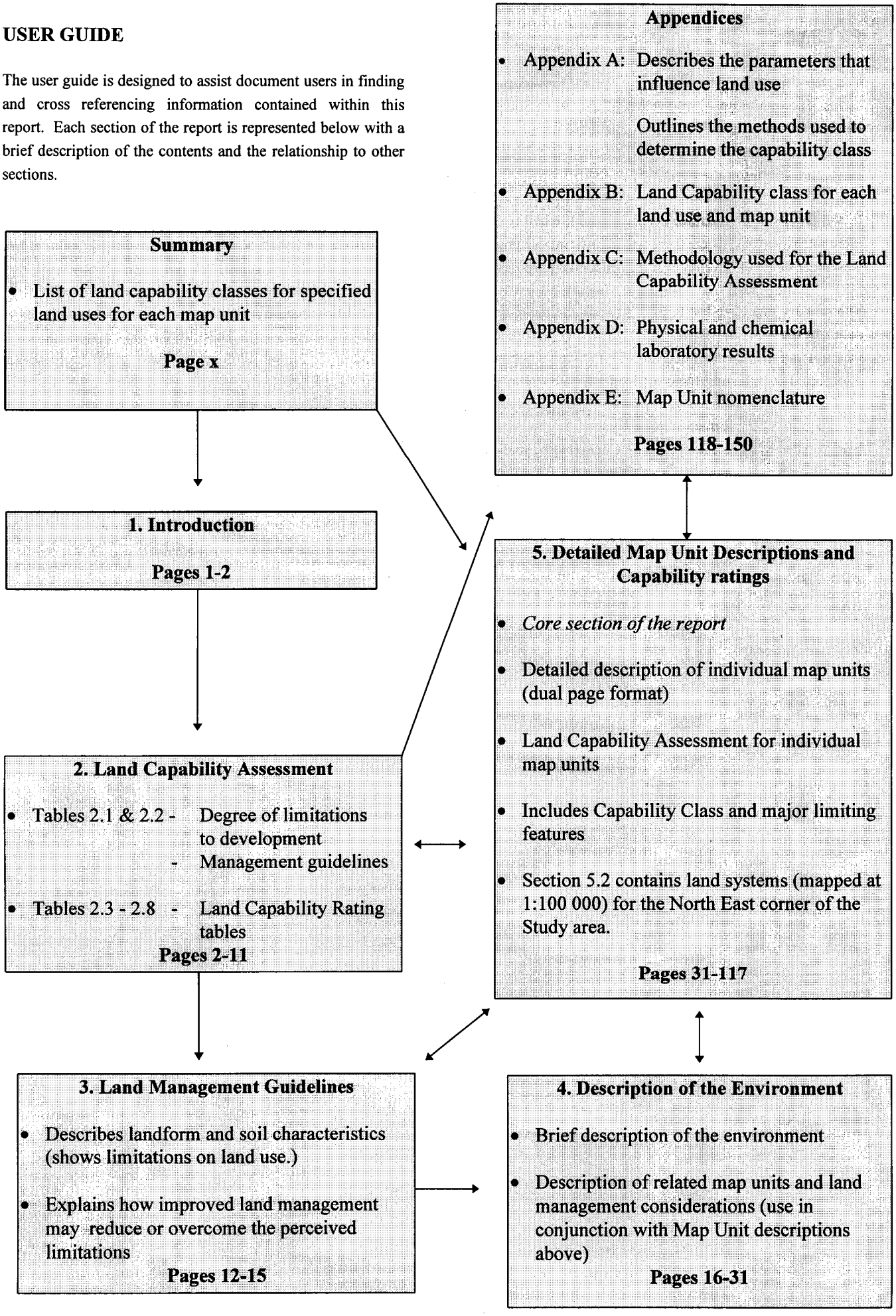
It was proposes to undertake detailed Land Capability Studies in municipalities with significant pressures for change in land use to more intensive uses, where there was significant existing or potential land degradation issues, or where better quality agricultural land was under threat of development for residential purposes.

The primary objective has been to provide the municipality with detailed land resource information, consisting of base data on the nature of the land, and assessment of the likely performance of the land under various activities. This information can underpin many land use and management decisions by the municipal authority, both now and in the future. In doing so, many of the problems and unexpected costs incurred through inappropriate land use can be avoided.

The majority of the former Shire of Kyneton is now part of the Macedon Ranges Shire Council. It is one of three former Shires in the amalgamated Macedon Ranges Shire Council to be studied in the current series of investigations.

USER GUIDE

The user guide is designed to assist document users in finding and cross referencing information contained within this report. Each section of the report is represented below with a brief description of the contents and the relationship to other sections.



EXAMPLE: This hypothetical example is designed to assist users understand the interrelationship between the different sections in the report and the use of the accompanying maps.

Scenario: Determining the feasibility of further development at the Kyneton Airfield, requiring secondary roads, and septic tanks.

Step 1: Locate the airfield site on the Base Map and establish the map unit (Qb lf)

Step 2: Refer to Table ii, in the Summary for a general idea of the capability of this map unit to support the specified land uses AND / OR use the Land Capability Assessment for Secondary Roads, and Land Capability Assessment for Effluent Disposal maps. Locate the site and refer to the legend which will provide the rating and the limiting features.

Step 3: Refer to the core section of the report - 5. Detailed Map Unit Descriptions - and find the relevant map unit (Qb10. This will give a detailed description of the soil and landscape features of this map unit. Due to the broad scale of the maps, the first thing to do is to determine whether the detailed soil and landscape features are infact similar to what is found on the site of interest. If not, the site may be similar to another map unit description or it may be an anomaly and therefore an individual study of the site may need to be carried out.

If the site is similar, the Land Capability Assessment table will give the rating for the land uses in question. For this example the Land Capability Ratings are:

Effluent Disposal: Rating 3-Limiting feature: Drainage

Secondary Roads: Rating 4 - Limiting features: proportion of stones and boulders, linear shrinkage.

Step 4: To assist in understand the definition of Class 3 and Class 4, refer to table 2.2 for the degree of limitations Class 3 and 4 have for development, and the management guidelines needed to overcome the constraints.

Step 5: Section 3. Land Management Guidelines will explain the limitations specified in step 3 (i.e. drainage for effluent disposal and proportion of stones and boulders and linear shrinkage for secondary roads) and whether they can be reduced or overcome by an improved level of management.

Step 6: If the limitations can be overcome, referring to Appendix B will show if there are any other limitations which need to be overcome to allow the development to take place without causing degradation to land and water quality.

NOTE: Understanding the whole study area is important in making planning decisions as development may be capable of occurring on the site of interest but the off-site effects may be considerable. Therefore, reading section 4. Description of the Environment, particularly 4.4 Map Unit Group Descriptions will provide background information on the general area.

The process of how and when to use the various sections of the report is largely up to the user. There may be times when the user may need to refer to different sections of the report, particularly a new user to ensure that they have a full understanding of the Land Capability Assessment process. For example, understanding the process of determining the Land Capability Assessment Ratings is very important, therefore the user will need to refer to Section 2. Land Capability Assessment and Appendix A to establish how the ratings were determined.

SUMMARY

The former Shire of Kyneton is now incorporated in the Macedon Ranges Shire Council, excluding the Trentham area which now forms part of the Hepburn Shire Council. The former Shire covers an area of around 750 km^2 and is located approximately 85 km north west of Melbourne.

The former Shire has seen significant population increase in the last few decades due to its easy commuting distance to Melbourne and Bendigo by way of the Calder Highway and the Melbourne-Bendigo railway line. The Kyneton township has seen the most population growth, although development has also occurred around the smaller townships in the Shire such as Tylden, Trentham and Carlsruhe.

The majority of the former Shire falls into the Eppalock Special Water Supply Catchment Area. The water supply for Kyneton, Castlemaine, Bendigo, Melton, Trentham and Woodend is serviced from the study area, therefore maintenance of high quality water in the three reservoirs, Upper Coliban, Lauriston and Malmsbury, is essential. The land use must be compatible with the maintenance of high quality water supply.

It is well established that indiscriminate development of land for residential and small lot development may result in extensive land and water degradation, loss of good agricultural land and unnecessarily high development and maintenance costs. Much of the former Shire consists of Quaternary basalt and volcanics, Ordovician sediments and Devonian granite. The sedimentary and granite steep to moderate hills are particularly susceptible to all forms of water erosion, particularly sheet and gully erosion, and can contribute significantly to salt loads in the catchment. Inappropriate development of these areas for rural residential purposes can result in environmental degradation due to complications with roading, building foundations and effluent disposal.

The former Shire of Kyneton requested that the north east corner of the former Shire, which is predominantly granite, be mapped at a scale of 1:100 000. The area is divided into land systems based primarily on geology, landform and soil type. Land capability ratings for rural residential development have been determined, although it must be stressed that if more intensive use of the land is contemplated, additional site specific information would be required.

The areas recognised as having higher agricultural value are the red volcanic plains in the south of the Shire and the non-cracking basalt gentle slopes. The basalt plains occur around the growing township of Kyneton, and therefore has considerable pressure for conversion to rural residential.

A land capability study provides a planning tool to assist the Shire in the development of a detailed planning scheme that will facilitate the planning of future land use through a systematic and rational examination of management requirements, and consequences of a range of alternative land uses. Revision of the planning scheme, based on sound land resources information, is required to direct development away from areas not well suited to certain uses, and to maintain a balance between competing land uses and the better quality agricultural land, in the interest of the whole community.

Table 1.1 Summary of land capability classes

Note: Please refer to Section 5 (Detailed Map Unit Descriptions and Capability Ratings) for further information.

MAP UNIT		LAND CAPABILITY RATING				
Symbol	**Description**	**Agriculture**	**Effluent Disposal**	**Farm Dams**	**Secondary Roads**	**Rural Residential**
Qa1	Quaternary alluvium, Coliban floodplain	5	5	5	5	5
Qa2	Quaternary alluvium, Campaspe floodplain	5	4	5	4	5
Qb1a	Quaternary basalt, non cracking, rocky scarp	5	4	5	5	5
Qblc	Quaternary basalt, non-cracking, moderately steep slope	4	4	5	4	5
Qb1d	Quaternary basalt, non cracking, moderate slope	4	3	5	4	5
Qb1e	Quaternary basalt, non cracking, gentle crest	3	3	4	3	4
Qblf	Quaternary basalt, non cracking, gentle slope	3-4	3	4	4	4
Qb1g	Quaternary basalt, non cracking, very gentle slope	3-4	3	4	4	4
Qb2b(i)	Quaternary basalt, cracking, steep slope	5	5	5	4	
Qb2c(i)	Quaternary basalt, cracking, moderately steep slope	4	4	5	4	5
Qb2d(i)	Quaternary basalt, cracking, moderate slope	4	3	5	4	5
Qb2e(i)	Quaternary basalt, cracking, gentle crest	4-3	4	4	4	4
Qb2f(i)	Quaternary basalt cracking, gentle slope	4	5	4	4	5
Qb2g(i)	Quaternary basalt, cracking, very gentle slope	4	5	4	4	5
Qb2h(i)	Quaternary basalt, cracking, drainage depression	4	5	4	4	5
Qb2I	Quaternary basalt, cracking, former lake bed	5	5	5	5	5
Qb2e(ii)	Quaternary basalt. cracking, gentle crest	3	4	4	4	4
Qb2f(ii)	Quaternary basalt, cracking, gentle slope	3	4	4	4	4
Qb2g(ii)	Quaternary basalt, cracking, very gentle slope	3	4	4	4	4
Qvb	Quaternary volcanic, very gentle slope	5	5	5	5	5
Qvc	Quaternary volcanic, moderate steep slope	4	4	5	4	5
Qvd	Quaternary volcanic, moderate slope	4	3	5	4	5
Qve	Quaternary volcanic, crest	3	2	5	4	5
Qvf	Quaternary volcanic, gentle slope	3	2	5	4	5
Qvg	Quaternary volcanic, very gentle slope	3	2	5	4	5
Qvh	Quaternary volcanic, drainage depression	3	3	4	3	4
Osa	Ordovician sedimentary, steep crest	5	2	5	4	5
Osb	Ordovician sediments, steep slope	5	5	5	5	5
Osc(i)	Ordovician sediments, moderately steep slope, deep	4	4	5	4	5

MAP UNIT		LAND CAPABILITY RATING				
Symbol	**Description**	**Agriculture**	**Effluent Disposal**	**Farm Dams**	**Secondary Roads**	**Rural Residential**
Osc(ii)	Ordovician sediments, moderately steep slope, shallow	5	5	5	4	5
Osd(i)	Ordovician sediments, moderate slope, deep	4	4-3	4	4	4
Osd(ii)	Ordovician sediments, moderate slope, shallow	5	5	5	4	5
Ose	Ordovician sediments, gentle crest	4	3	5	4	5
Osf	Ordovician sediments, gentle slope	4	4	4	3	4
Osg	Ordovician sediments, very gentle slope	3	3	4	3	4
Osh	Ordovician sediments, drainage depression	4	4	4	4	4

1 INTRODUCTION

1.1 Overview

Land varies considerably in its basic characteristics and its response to the demands made upon it. Such demands include the production of food, fibre, water, and development for residential, industrial and recreational purposes.

Planners need to match the requirement of land use with the capability of the land to sustain that use and avoid land degradation. Prior knowledge of soil and land limitations can prevent unnecessary and costly mistakes. Information obtained through land capability assessments can provide the necessary data to assist local government with planning decisions and the preparation of planning strategies for the future.

Planning schemes developed and implemented by local government provide an effective means of managing changes in land use. A planning scheme may prohibit or place conditions on land use not well suited to a land type.

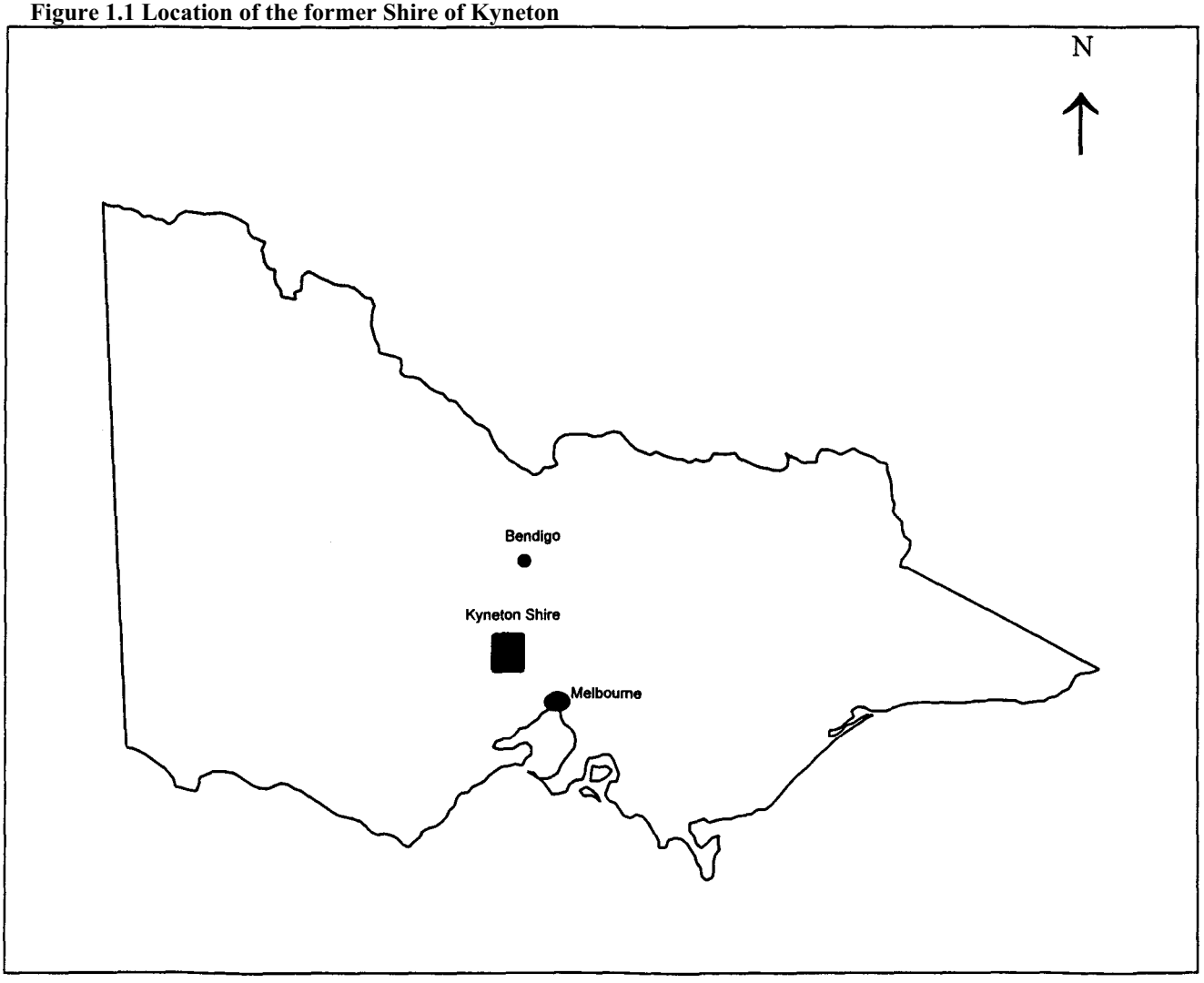
This report provides land resource information for broad-scale planning within the former Shire of Kyneton. It does not provide recommendations for land use and no allowance has been made for social or economic considerations which may influence planning proposals. It is primarily an examination of potential consequences and levels of management required for a range of land uses.

A previous study covering the former Shire of Kyneton, by M.S Lorimer and N.R Schoknecht entitled *A Study of the Land in the Campaspe River Catchment* has provided background information for this study

1.2 Location

The former Shire of Kyneton covers an area of around 750 km^2 and is located approximately 85 km north of Melbourne. (Figure 1.1)

Figure 1.1 Location of the former Shire of Kyneton



1.3 Purpose of study

The former Shire of Kyneton is predominantly rural but is experiencing increasing pressure from urban expansion. The relatively low cost of land, easy commuting distance to Melbourne and the rural environment makes the area attractive for residential development. Land that was once agricultural or forested is being converted into rural residential lots, particularly on the fringes of the townships of Kyneton, Tylden, Malmsbury and Trentham.

In planning for the future use of land in the Shire, there is a need to preserve the qualities that make this area attractive, both economically and aesthetically, whilst also accommodating population growth. It is important to preserve better agricultural land and farming because of its significant input into the economy of the region.

To ensure a sound base for future planning strategies, the former Shire of Kyneton requested a land capability study by the Department of Conservation and Natural Resources.

1.4 Objectives

Major Objective:

To provide land resource information to the former Shire of Kyneton that will facilitate the planning of future land use through a systematic and rational examination of management requirements, and consequences of a range of alternative land uses.

More specifically:

1. To map and describe, at a scale of 1: 25 000, the freehold land of the former Shire of Kyneton which is under the most pressure for conversion to rural residential development. Mapping and description will involve identifying dominant land types (including soil types and topography), climatic zones and other land characteristics relevant to the assessment of the capability of the land.

To prepare land capability analyses based on standardised rating tables for:

- agriculture
- effluent disposal (septic tanks)
- farm (earthen) dams
- secondary roads
- rural residential development

3. To map and describe the north east corner of the former Shire as land systems at a scale of 1:100 000.
4. To prepare and provide a vegetation map of the Shire displaying tree cover.
5. To provide the Shire with a digital copy of the land capability information gathered.
6. To assist the Macedon Ranges Shire Council in the incorporation of this land resource information into its planning strategies.

2 LAND CAPABILITY ASSESSMENT

2.1 Philosophy and principles

Land capability assessment is a rational and systematic method of determining the ability of land to sustain a specific use and level of management, without causing significant long-term degradation.

The objectives of land capability assessments are:

i) to assist land managers and land use planners to identify areas of land with physical constraints for a range of nominated land uses;

ii) to identify management requirements that will ensure a particular land use can be sustained without causing significant on-site or off-site degradation to land or water quality.

To achieve these objectives, it is necessary to know the natural characteristics of the land, and understand the effects that a proposed land use may have on the land and the water derived from it.

Land capability assessments analyse basic landform and soils information to determine the ability of the land to sustain a desired land use. A strength of the methodology lies in its association with land systems since the results can be extrapolated, with care, to similar land components and land systems in other areas (Refer to 4.2).

The ratings provided by a land capability assessment are not intended to restrict development of land, but rather to identify the principal constraints of that land for a specified land use. It is a matter for the land manager or land use planner to decide if the cost of overcoming the constraints is justified Where particularly severe physical constraints exist, the planning authority has the option of excluding that land from that use, or permitting the use only under strict conditions. The placement of conditions on development permits is quite a Proper exercise of planning responsibility.

2.2 Land resource mapping - methodology and constraints

The main objective of land resource mapping is to identify areas of land that are uniform with respect to the characteristics that affect land use. These areas of land will have a similar land use capability for a nominated use and are likely to respond in a similar way to management. By identifying areas of land with a limited range of variability, the resultant map provides the basis for land capability assessment (for specific methodologies, refer Appendix C).

Mapping an area of land can be a complex task as many differences arise due to interactions between climate, geology and topography. While it is possible to measure and determine some of the land characteristics such as slope, rock outcrop, and soil type, other characteristics such as site drainage, and permeability of water are less easily determined.

The following procedure has been adopted for this study:

i) The geological boundaries are obtained from existing maps and verified in the field at the appropriate mapping scale.

ii) The broad landform pattern and the landform elements are identified from air-photos using a binocular stereoscope. The map units are derived from this information.

iii) Extensive field verification of map units ensure that map units are consistent with respect to parent material, slope, position in the landscape, soil type, drainage and native vegetation.

iv) A representative site for each map unit is selected, to record general landform and site information. The incidence of any land degradation in each map unit is also recorded.

v) A soil pit or large exposure of the soil profile is prepared at each selected site. Detailed soil profile information is recorded. Colour photographs are taken and soil samples collected for physical and chemical analyses (see Appendix D and the corresponding tables for each Land Unit in Section 4.2 for details).

vi) The permeability to water of the soil profile is measured when the soils arc near field capacity (see Appendix C).

vii) The map unit boundaries are entered into a Geographic Information System where the data is combined with base-map information on roads, contours and streams to produce a final base map of the study area with appropriate headings and legend.

viii) Land capability ratings for those land uses relevant to the study are derived from the climatic, land and soil data available for each map unit based on standardised rating tables. Separate land capability assessment maps are prepared for the specified land uses.

ix) A report is prepared to provide accompanying land resource information and methodology for the land capability maps.

2.3 Assessment Procedure

A land capability rating table lists key land characteristics such as slope, site drainage or soil depth, which may affect the ability of the land to support a specified land use. These land characteristics are quantified and graded into classes for the land use being assessed. Each map unit within the study area is given a capability class according to the tables shown in Section 2.4.

It is the most limiting factor that determines the Capability Class for the map unit. This is related to the degree of limitation for that land use and the general level of management that will be required to minimise degradation.

A Capability Class of one represents essentially no physical limitations to the proposed land use whilst a Class of five indicates a very low capability to sustain the land use. Limitations in Class five generally exceed the current level of management skills and technology available. Severe deterioration of the environment is likely to occur if development is attempted. A Class of two, three or four will require increasing levels of management to sustain the particular land use, otherwise the environment will deteriorate.

Separate class descriptions are prepared for agriculture (Table 2.1) and other land uses (Table 2.2). Due to the scale of mapping adopted (1:25 000), the inherent variability within some landscapes may result in the presence of small unrepresentative areas within map units. In some cases, these areas will have a capability class exceeding that of the overall map unit. An opportunity may therefore exist to utilise land with less constraints for the chosen development.

2.4 Land Capability Rating Tables

Each land capability rating table (refer Tables 2.3, 2.4, 2.5, 2.6, 2.7, 2.8) contains criteria which will strongly influence the ability of the land to sustain the desired land use. The limitations distinguishing each land capability class from one to five are also presented for comparison.

There has been no attempt to rank the criteria in order of importance. The objective of having classes is to identify the kind of limitation and its severity. It is recognised that criteria may interact, but an underlying objective of this study is to provide the information in a useable form, rather than have a convoluted series of alternative pathways that would be too complex for the intended user to follow. Where there are known interactions between different criteria, it is the responsibility of the planner or land manager to assess the importance of the limiting factor(s) and to determine the need for management or additional financial input to overcome the limitation.

Theoretically a single diagnostic land quality could be found and used to rate land performance, but there is the risk of such a feature masking the true parameters that affect the land use, thus preventing a change to a more appropriate land use or level of management. Land use and land management practices will continue to change and if the community is concerned about long-term sustainability of specific land uses, then the limitations of the soil, the various processes of land degradation, and the possibility of off-site effects, must be recognised. Once a limitation to land use is identified, steps can be taken to overcome or minimise the long-term effect of land degradation that would result if the land use was continued.

Table 2.1 Land capability classes for agriculture.

CLASS	CAPABILITY	DEGREE OF LIMITATION
Class 1	Very good	Can sustain a wide range of uses including an intensive cropping regime. Very high levels of production possible with standard management levels.
Class 2	Good	Moderate limitations to agricultural productivity, overcome by readily available management practices.
Class 3	Fair	Can sustain agricultural uses with low to moderate levels of land disturbance such as broadacre cultivation in rotation with improved pastures. Moderate to high levels of production possible with specialist management practices such as minimum tillage.
Class 4	Poor	Low capacity to resist land disturbance such as cultivation. Moderate production levels possible with specialist management such as improved pasture establishment with minimum tillage techniques. Recommended for low disturbance agriculture such as grazing or perennial horticulture.
Class 5	Very poor	Very low capability to resist land disturbance. Areas of low productive capacity. Minimal grazing levels or non-agricultural uses recommended.

Note: Land is assessed for agricultural production on the basis of climate, topography, and the inherent characteristics of the soil.

Climate differs from topography and soil features in that it is a regional parameter rather than site specific. The capability table identifies the versatility and potential productivity of an area for a range of agricultural uses, and highlights the necessary level of management required to sustain the land use.

These agricultural ratings are for comparative purposes only and should not be used as a basis for detailed property planning.

Table 2.2 Land capability classes for effluent disposal, farm dams, secondary roads and building foundations.

CLASS	CAPABILITY	DEGREE OF LIMITATION TO DEVELOPMENT	GENERAL DESCRIPTIONS AND MANAGEMENT GUIDELINES
Class 1	Very good	The limitation of long term instability, engineering difficulties or erosion hazards do not occur or they are very slight.	Areas with high capability for the proposed use. Standard designs and installation techniques, normal site preparation and management should be satisfactory to minimize the impact on the environment.
Class 2	Good	Slight limitations are present in the form of engineering difficulties and/or erosion hazard.	Areas capable of being used for the proposed use. Careful planning and the use of standard specifications for site preparation, construction and follow up management are necessary to minimise the impact of the development on the environment.
Class 3	Fair	Moderate engineering difficulties and/or moderately high erosion hazard exist during construction.	Areas with a fair capability for the proposed use. Specialised designs and techniques are required to minimise the impact of the development on the environment.
Class 4	Poor	Considerable engineering difficulties during development and/or a high erosion hazard exists during and after construction.	Areas with poor capability for the proposed use. Extensively modified design and installation techniques, exceptionally careful site preparation and management are necessary to minimise the impact of the development on the environment.
Class 5	Very poor	Long term severe instability, erosion hazards or engineering difficulties which cannot be practically overcome with current technology.	Performance of the land for the proposed use is likely to be unsatisfactory. Severe deterioration of the environment will occur if development is attempted in these areas.

Table 2.3 Land capability assessment for agriculture.

PARAMETERS INFLUENCING AGRICULTURAL PRODUCTION		LAND CAPABILITY RATINGS				
		Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
C: Climate	Length of growing season (months)	12 - 11	10 - 8	7 - 5	4 - 2	< 2
T: Topography	Slope (%)	< 1	1 - 3	4 - 10	11 - 32	> 32
S: **Soil**	Condition of topsoil'	25 - 21	20 - 16	15 - 11	10 - 6	5 - 1
	Depth of topsoil (mm)	> 300	300 - 160	150 - 110	100 - 50	< 50
	Depth to rock/hardpan (m)	> 2.0	2.0 - 1.5	1.5 - 1.0	1.0 - 0.5	< 0.5
	Depth to seasonal watertable (m)	> 5.0	5.0 - 2.0	2.0 - 1.5	1.5 - 1.0	< 1.0
	Total amount of water (mm) available to plants *	> 200	200 - 151	150 - 101	100 - 51	50 - 0
	Index of permeability/rainfall *	Very high	High	Moderate	Low	Very low
	Dispersibility of top soil (Emerson)'	E6, E7, E8	E3(1), E3(2), E4, E5	E3(3), E3(4)	E2	E1
	Gravel/stone/boulder content (v/v %) *	0	1 - 10	11 - 25	26 - 50	> 50
	Electrical conductivity(us/cm) *	< 300	300 - 600	600 - 1400	1400 - 3500	> 3500
	Susceptibility to sheet/rill erosion *	Very low	Low	Moderate	High	Very high
	Susceptibility to gully erosion *	Very low	Low	Moderate	High	Very high
	Susceptibility to wind erosion *	Very low	Low	Moderate	High	Very high

Note: The potential agricultural productivity land of is generally classified by the CTS criteria (Climate, Topography and Soil)

* See Appendix A

Table 2.4 Land capability assessment for on-site effluent disposal.

PARAMETERS INFLUENCING EFFLUENT DISPOSAL	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%) *	< 3	3 - 10	11 - 20	21 - 32	> 32
Flooding risk *	Nil	Low	Moderate	High	Very high
Drainage *	Rapidly drained	Well drained	Moderately drained	Imperfectly drained	Poorly/very poorly drained
Depth to seasonal watertable (m)	> 2.0	2.0 - 1.5	1.5 - 1.0	1.0 - 0.5	< 0.5
Depth to hard rock/impermeable layer (m)	> 1.5	1.0 - 1.5	1.0 - 0.75	0.75 - 0.5	< 0.5
Number of months/year when average daily rainfall > Ksat *	0	1	2	3	> 3
Permeability (K_{sat} mm/day) *	> 500 **	500 - 100	100 - 50	50 - 10	< 10

Note: Areas capable of absorbing effluent from a standard anaerobic, all-waste, septic tank connected to a single family dwelling (approximate output of 1000 litres per day).

10 mm/day is equivalent to disposing of 1000 1/day along a 0.5 x 200 m trench

* See Appendix A

** Permeabilities > 1000 mm/day could pollute groundwater

Table 2.5 Land capability assessment for earthen dams.

PARAMETERS INFLUENCING THE CONSTRUCTION OF EARTHEN DAMS	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%) *	3 - 7	0 - 3	7-10	10 - 20	>20
Linear shrinkage (%) *	0 - 5	6 - 12	13 - 17	18 - 22	> 22
Suitability of subsoil *	Very high	High	Moderate	Low	Very low
Depth to seasonal watertable (m)	> 5		5 - 2		< 2
Depth to hard rock (m)	> 5	5 - 3	3 - 2	2 - 1	< **1**
Permeability (K_{sat} mm/day) *	< 1	1 - 10	11 - 100	101 - 1000	> 1000
Dispersibility of subsoil (Emerson)	E3(2), E3(3)	E3(1), E3(4)	E2(1), E2(2), E5(A), E5(B)	E2(3), E2(4), E5(C), E5(D)	El, E6, E7, E8
Susceptibility to slope failure	Very low	Low	Moderate	High	Very high

Note: This table should only be considered for small farm dams to 1000 m^3 in capacity, that have a top water level less than 3 m above the original ground surface at the upstream side of the wall.

Rock outcrop, depth of topsoil and flooding risk were also considered but have not been included for reasons given in Appendix A.

* See Appendix A

Table 2.6 Land capability assessment for secondary roads.

PARAMETERS INFLUENCING SECONDARY ROADS	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%)	0 - 1	2 - 5	6-10	11 - 30	>30
Drainage *	Rapidly	Well	Moderately	Imperfectly	Poorly
Depth of seasonal watertable (m)	> 5	5 - 2	2 - 1	1 - 0.5	< 0.5
Proportion of stones and boulders (v/v %) *	0	1 - 10	11 - 20	21 - 50	> 50
Depth to hard rock (m)	> 1.5	1.5 - 0.75	0.75 - 0.51	0.5 - 0.25	< 0.25
Susceptibility to slope failure *	Very low	Low	Moderate	High	Very high
Linear shrinkage (%) *	< 6	7 - 12	13 - 17	18 - 22	> 22
Bearing capacity (kPa) *	> 50	-	< 50	-	-
Flooding risk*	Nil	Low	Moderate	High	Very high
Dispersibility of subsoil Emerson (> 4% slope) *	E6, E7, E8	E4, E5, E3(1), E3(2)	E3(3), E3(4)	E2	E I
Unified Soil Group	GW, GC, SC	SM, SW, GM	SP, CL, CH, MH, GP	ML	Pt, OH, OL

Note: Areas capable of being used for the construction of earthen roads for light vehicles without sealed surfaces or concrete drainage and kerbing.

* See Appendix A

Table 2.7 Land capability assessment for building foundations.

PARAMETERS INFLUENCING BUILDING FOUNDATIONS	LAND CAPABILITY RATINGS				
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Slope (%) i) Slab ii) Stumps/footings	 0 - 1 0 – 5	 2 - 5 6 – 10	 6-10 11 – 30	 11 - 30 30 – 45	 >30 > 45
Drainage *	Rapidly drained	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Depth to seasonal watertable (m) •	> 5	5 - 2	2 - 1	1 - 0.5	< 0.5
Proportion of stones and boulders (v/v %)	0	1 - 10	11 - 20	21 - 50	> 50
Depth to hardrock (m)	> 1.5	1.5 - 0.75	0.75 - 0.51	0.5 - 0.25	< 0.25
Susceptibility to slope failure *	Very low	Low	Moderate	High	Very high
Linear shrinkage (%) * i) Slab ii) Stumps/footings	<12 < 6	13 - 17 7 – 12	18 - 22 13 – 17	22 - 30 18 – 22	>30 >22
Flood risk	Nil	Low	Moderate	Moderate/high	High

Note: Areas capable of being used for the construction of buildings of one or two stories. It is assumed that any excavation will be less than 1.5 m and can be completed by a tractor-backhoe or equipment of similar capacity. Two methods of construction are considered:

i) Concrete slab - 100 mm thick and reinforced

ii) Stumps or strip footings

* See Appendix A

Table 2.8 Land capability assessment for rural residential and rural farmlet development

Rural residential development (0.4 ha 2.0 ha)		Rural farmlet (> 5.0 ha)	
Building foundations	No change to capability class	Building foundations	No change to capability class
Secondary roads	No change to capability class	Secondary roads	No change to capability class
Effluent disposal	No change to capability class	Effluent disposal	***Improve by one rating class*** if major limitation is due to permeability, drainage and depth to hardrock No change to rating class if another criteria is the major limitation present
Earthen dams	No change to capability class	Earthen dams	***Improve rating by one class.*** No change where slope, rapid permeability, risk of slope failure and dispersibility are the major limitations present

Rural residential development involves a range of land uses; building foundations, earthen dams, effluent disposal and secondary roads. There is a need to consider the capability of each individual land use in assessing the overall capability of a map unit to sustain rural residential development. More intensive use of the land will require an improved level of management to reduce the likelihood of land degradation.

The land and soil within certain map units can vary substantially in the former Shire of Kyneton. This variation within a map unit is more likely to occur with large size allotments. It is recognised that in areas greater than 5 ha, detailed site inspection can highlight areas with a higher capability to support a given land use. For example, dam construction may *be* restricted by shallow soil depth on a small allotment (less than 2 ha), however on a larger allotment a minor drainage line may be found to contain sufficient soil depth to enable a dam to be constructed.

Allotments larger than 5 ha may also have a number of different map units, therefore there may be a range of slope and soil types. This allows greater flexibility in siting the land uses associated with the development.

Larger allotments also allow for greater flexibility in management and design, while an allotment of 1/4 - 1 hectare will place absolute limits on options for development.

In assessing the overall capability for rural residential development the capability of each individual land use has been combined to arrive at a final rating class.

For the purpose of this study, rural residential development has been defined as block sizes between 0.4 - 2.0 ha. The ratings for blocks greater than 5.0 ha are not depicted on the maps and in the report, although the table below gives an indication of the capability of the map units if they are larger than 5.0 ha, where there may be more variety in map units and therefore slope and soil types.

3. LAND MANAGEMENT GUIDELINES

3.1 Management of land characteristics that influence land use

The criterions used in land capability rating tables have been selected because of the limitations they impose on the use of the land for certain land uses. This section explains why these features are important and how an improved level of management can reduce or even overcome the limitation. Some of the information has been extracted from Rowe *et* al. (1980) and Charman and Murphy (1991).

3.1.1 Soil texture

Relevant Land Use(s)

Agriculture

Earthen dams

Soil texture is largely determined by the proportions of different-sized particles (sand, silt and clay) which make up the soil. Top soils with well-graded textures have a relatively even distribution of particle sizes from clay through to sand, and tend to be better able to support agricultural and pastoral activities than either very sandy or very clayey soils. They are better able to withstand cultivation and compaction and are more resistant to soil erosion.

Soil texture is closely related to available water-holding capacity which is important for plant growth. The fine sandy loam - silty clay loam soils can hold more available water than sands or clays, and so can maintain plant growth for longer periods after wetting.

Texture is also an important determinant in soil infiltration and internal drainage, with sandier soils tending to have greater infiltration rates and better internal drainage. The higher infiltration rates of sandier soils may, however, lead to significant leaching of nutrients and organic matter.

Soil texture can determine the intensity of agricultural practices on the land. For instance silty soils are inherently unstable under cultivation as structure can be easily destroyed. Whereas soils with loam to clay loam soils with high organic matter contents are more stable under cultivation.

The red volcanic soils are generally the most stable soils in the former Shire of Kyneton due to the organic loam to clay loam texture of the topsoil. They can therefore cope with more intensive agricultural practices than the soils on the other geologies.

On the other hand, the granitic soils with coarse or sandy textures are generally very unstable and easily eroded, and will need the protection of a vegetative cover over the dry season.

Some of the limitations imposed by soil texture can be reduced
or overcome by special treatments such as the addition of stabilising chemicals and incorporating organic matter. Sandy textured soils can be improved by retaining organic matter which will improve the nutrient status and increase the water holding capacity of the soil. Retaining organic matter of clay soils will improve the workability of the soil by increasing biological activity that can improve the structure of the clay.

The texture of the subsoil is an important constituent for earthen dam construction, although it also takes into account the physical characteristics of the soil such as the plasticity index, the liquid limit and the dispersion characteristics of the soil.

3.1.2 Boulders and rock outcrop

Relevant Land Use(s)

Agriculture

Secondary Roads

Building Foundations

Boulders and rock outcrop provide physical obstacles to excavation for roads and building foundations, cultivation and plant growth, and so inhibit these land uses. It may be possible to remove isolated rock outcrops by blasting, but for extensive uses, such as cropping and grazing, boulders and rock outcrop are a permanent limitation. Additional costs may be involved with the increased management required to maintain pasture growth or reduce storm water run-off from rocky areas.

3.1.3 Depth to hard rock

Relevant Land Use(s)

Agriculture

Effluent Disposal

Earthen Dams

Secondary Roads

Building Foundations

The presence of shallow hard rock (<0.5 m) causes problems for engineering and agricultural land uses. Shallow hard rock may need to be excavated for engineering activities such as road works, building foundations and other shallow excavation work. Shallow hard rock may be overcome with heavy machinery and blasting. Agricultural land use including cropping and farm dams are permanently restricted where shallow hard rock is present.

Very shallow soils are inherently more susceptible to erosion and require the protection of a permanent undisturbed cover of vegetation.

3.1.4 Depth of topsoil

Relevant Land Use(s)

Agriculture

Construction

Topsoil is not favoured as a construction material because it has a low bearing capacity due to the high organic matter content, permeability and the generally light texture of the soil. The greater the depth of topsoil, the greater the cost of removing and stockpiling it. Many excavation permits now require the topsoil to be re-spread on construction sites to facilitate revegetation and this can be done successfully provided the compacted surface is broken up prior to the top soil being returned.

A deep topsoil is preferable for agriculture as it is generally the area of maximum biological activity, and is therefore usually the most productive area for plant growth.

Appropriate farming practices such as direct drilling and minimum tillage will retain the organic matter and sustain the amount of biological activity.

3.1.5 Depth to seasonal, perched or permanent watertable

Relevant Land Use(s)

Agriculture

Effluent Disposal

Earthen Dams

Secondary Roads

Building Foundations

The presence of a watertable close to the surface causes problems for both agricultural and engineering land uses. Saturated soils have a low bearing capacity so, for uses dependent on a stable foundation (e.g. building foundations, roads), a high watertable is undesirable.

High watertables restrict the percolation of additional water from rainfall, irrigation or the effluent from septic tanks through the soil profile, whereas a fluctuating watertable is likely to cause leaching of the more mobile plant nutrients, or the concentration of iron compounds which immobilise nutrients such as phosphorus. Poor aeration in the zone of saturation will restrict root growth. Trafficability can be adversely affected, and in the case of effluent disposal, public health aspects may be of concern. High watertables may also restrict the depth of excavation for farm dams and quarries, even shallow excavations for sand and gravel deposits.

Watertables can be lowered by pumping or constructing artificial drains, however if the water is saline, disposal options are limited.

3.1.6 Dispersible clays

Relevant Land Use(s)

Agriculture

Earthen Dams

Secondary Roads

Dispersion is the spontaneous separation of the clay fraction of a soil in water. Slaking is the breakdown of an aggregate into smaller aggregates. Dispersion and slaking are important characteristics of a soil because of their influence on the stability of the soil structure. Soils with a high degree of slaking or dispersion have a high erosion potential and any activity that exposes the topsoil or subsoil

to rainfall or running water increases the risk of erosion.

Dispersible topsoils usually have poor physical characteristics, such as surface crusting, cloddiness, poor aeration and low emergence of plant seedlings. Maintenance of an effective pasture cover or litter layer reduces raindrop splash, dispersion and the associated surface sealing of topsoils.

Dispersible subsoils predispose a site to tunnel or gully erosion. The risk may be minimised by careful pasture management such as ensuring that the slopes and drainage depressions are well vegetated with plant species that have deep root systems and high water requirements.

Road batters may be subject to slumping and erosion, with subsequent turbidity of run-off water and sedimentation in nearby water storages. As the dispersibility of the subsoil increases, so does the need to reduce batter slopes and establish a protective vegetative cover on the exposed soil.

Earthen dams constructed in soils which are too dispersive will have a high percentage of clay particles in suspension and therefore the water quality will be poor.

Highly dispersive soils can be treated with gypsum and will respond well to reduced tillage and stubble retention.

3.1.7 Flooding

Relevant Land Use(s)
Effluent Disposal
Secondary Roads
Building Foundations

Flooding can be a problem on land with very low gradients and within confined drainage ways. Precise data is difficult to obtain on the frequency of flood events and the classes have been determined by observations of land form, catchment geometry and soil types which reflect recent sediment deposition.

A distinction should be made between fast flowing flood waters (flash floods) and flooding caused by a rise in water levels with little flow (inundation). The type and severity of impact caused by these two forms of flooding differ and therefore different types of management may be required to reduce the hazard.

Floods are a threat to human safety, causing damage to property and livestock. Thus, flood-prone land should not be used for intensive development, but should be retained for land use such as grazing, where stock can be moved to higher ground in times of increased hazard.

In some areas the problem may be overcome by building levee banks or retarding basins, however there may be severe environmental problems caused by this form of management. Some modification of flooding characteristics may be possible by special management aimed at delaying surface run-off. When dealing with large catchments, the problem is a long-term hazard and a permanent limitation.

3.1.8 Organic matter

Relevant Land Use(s)
Roads
Earthen Dams
Agriculture

Where soil materials are to be used as road fill or for earthen dams, the presence of organic matter reduces soil quality for these purposes. Soils containing even moderate amounts of organic matter are more compressible and less stable than inorganic soils. The presence of organic material in sand for concrete is also undesirable.

When used as a medium for plant growth, a high level of organic matter is most desirable as it improves soil structure and chemical fertility. Soils high in organic matter are good for intensive cropping, however cultivation promotes rapid oxidation of organic matter and the condition of the topsoil will deteriorate if the organic matter is not replaced. Organic matter levels can be increased by growing productive crops and pastures and maintaining plant residues.

3.1.9 Permeability

Relevant Land Use(s)
Agriculture
Effluent Disposal
Earthen Dam

Soils of low water permeability have poor drainage through some or all of the profile. On sloping land, lateral flow may occur above an impervious layer thereby draining the water away from the site, but on relatively flat areas such soils can become waterlogged and inhibit plant growth or become too boggy for the use of agricultural machinery at certain times of the year.

Low permeability in soils also reduces the efficiency of effluent disposal systems. This limitation can be overcome if sufficient area is available to increase the length of an absorption trench or utilise plants to transpire water from the effluent disposal area.

Extremely permeable soils may have excessive leaching of plant nutrients or may not be able to retain moisture for plant growth. Such soils may drain too rapidly to purify the effluent from septic tanks, thereby increasing the risk of polluting groundwaters or nearby streams.

For earthen dams, low permeability in the floor, the sides and the walls of the dam is most desirable. A dam constructed in highly permeable soils may need the addition of a dispersive agent such as sodium tripolyphosphate, or a liner or membrane to seal the dam.

3.1.10 Plasticity index

Relevant Land Use(s)
Earthen Dams
Secondary Roads
Agriculture

The plasticity index is a measure of the range of moisture content over which the soil is in the plastic state. A soil is most easily worked or is most readily deformed when in the plastic state. A low index indicates that the range is narrow, which is desirable where the stability of the material is important, such as in a road subgrade. However where the soil is to be cultivated, a higher plasticity index is desirable to enable working over a wider range of moisture contents.

3.1.11 Linear shrinkage (shrink-swell potential)

Relevant Land Use(s)
Earthen Dams
Secondary Roads
Building Foundations

This relates to the capacity of clayey soil material to change in volume with changes in moisture content, and is dependant on the quantity and nature of the clay minerals present. The shrink-swell characteristics of a soil influence the capability of land for uses such as roads or buildings which require a stable substrate. Buildings and roads shift or crack in soils which undergo large changes in volume during periodic wetting and drying. Construction on soils with a high shrink-swell potential requires special techniques such as laying deeper than usual foundations for roads or using a reinforced concrete slab rather than stumps or strip footings for buildings.

3.1.12 Site drainage

Relevant Land Use(s)
Effluent Disposal
Secondary Roads
Building Foundations

Site drainage is influenced by soil type, soil permeability, steepness of slope, slope shape, rainfall and position in the landscape. For most land uses it is important that water flows freely from the site, since poor site drainage can result in the land becoming waterlogged and boggy, inhibiting plant growth, damaging roads and buildings through subsidence, and reducing the capacity of the area to dispose of effluent. Special works or higher levels of management may be necessary to overcome poor site drainage and this will add to the cost of development and production.

3.1.13 Slope

Relevant Land Use(s)
Agriculture
Effluent Disposal
Earthen Dams
Secondary Roads
Building Foundations

As the angle and length of slope increases so too does the erosion hazard. The loss of adequate ground cover during the construction of dams, roads and buildings, or on land

that is cultivated or overgrazed, increases the risk of erosion. Steeper slopes are more difficult and costly to use for agricultural, forestry or road-making activities, and impose limitations on the type of machinery which can be used.

Certain soil types become unstable in wet conditions. As the slope increases, the risk of mass movement also increases, particularly if large quantities of water are contained in the soil profile. Instability can occur on natural slopes, under trees or pasture, road batters and earthen dam banks.

Effluent from septic tanks contains high levels of nutrients and bacterial organisms. If the absorption beds are situated on sloping land, then during wet periods when the soil profile may be saturated (from excessive rainfall and/or run-off from upslope), there is an increased risk of effluent being washed into the streams and water storages further down the catchment. This may result in adverse consequences for water quality and aquatic ecosystems.

3.1.14 Soil reaction

Relevant Land Use(s)

Agriculture

The pH of the soil is a measure of its acidity or alkalinity. Most plants have a pH range in which optimum growth can be expected. Soil acidification occurs as nitrates that were fixed by pasture legumes are leached from the soil, and by the addition of acids in superphosphate. With the long-term use of superphosphate and nitrogen fixing legumes, and the constant removal of grain, hay and/or animal products from the land, the topsoils in many areas have become more acid (pH < 5.5 in H_20) and the potential for aluminium toxicity has increased. Acid soils and aluminium toxicity can result in a decline in plant vigour and growth.

3.1.15 Stone and gravel

Relevant Land Use(s)

Agriculture

Secondary Roads

Building Foundations

The stone and gravel content in a soil can restrict land use and plant growth in the following ways:

i) reducing the available water content and nutrient supply in the profile to plants;

ii) increasing the wear and tear on cultivating and excavating machinery;

iii) increasing the cost of harvesting root and tuber crops,

e.g. potatoes.

Little can be done to overcome this limitation, other than the continual removal of stones from an area as they appear on the land surface.

4 DESCRIPTION OF THE ENVIRONMENT

4.1 Overview

4.1.1 Geology and Physiography

The majority of the former Shire of Kyneton consists of undulating basalt plains which can be divided into three separate land types, based mainly on soil drainage. The soils on the basalt adjoining the Campaspe River are generally very dark in colour and crack in summer and are imperfectly drained during the winter and spring months. The majority of the basalt soils closer to Kyneton are more freely draining, are lighter in colour and have a more developed soil profile. South of Tylden, and particularly around Trentham, red strongly structured and very well drained volcanic soils occur.

In the western part of the Shire, rolling to undulating hills of Ordovician sedimentary geology occurs. The slope of the hills can be either short and simple, commonly when they are highly dissected with drainage lines, or long and terraced. Pockets of weathered basalt can occur throughout the sedimentary geology, particularly at the break of slope where the majority of the basalt flow has eroded over time.

The major creeks and rivers commonly have quite small floodplains, which experience seasonal inundation, caused mainly by throughflow from the surrounding hills.

The north east corner of the Shire is mostly granitic, although small areas of basalt and metamorphosed sediments occur throughout the granitic landscape.

4.1.2 Climate

The former Shire of Kyneton experiences its most effective rainfall for plant growth during winter. The average annual rainfall is around 750 mm, with the southern parts of the Shire, around Trentham, receiving over 1 000 mm.

The average summer temperature averages 17˚C, and the winter months have a mean temperature of 6˚C. The winter temperatures and the high number of frost days (refer to Table 4.1) indicate that the most effective growth period in the Shire is during the warmer months.

Table 4.1 Number of days of frost occurrence per month in the former Shire of Kyneton

Temp	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
°C	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2	<0; <2.2
Max days	0; 0	0; 0	1; 4	4; 10	9; 15	11; 19	11; 21	8; 19	10; 19	3; 9	3; 5	0; 4
Min days	0; 0	0; 0	0; 0	0; 1	0; 3	2; 6	5; 10	2; 9	1; 5	0; 0	0; 1	0; 0
Ave days	0; 0	0; 0	0; 1	0; 5	5; 9	7; 13	8; 14	5; 13	4; 11	1; 5	1; 3	0; 2

Source: Foley, J.C. (1945); Commonwealth Bureau of Meteorology, 1982

4.2 Land systems

A land system is an area of land, distinct from the surrounding terrain that has a specific climate range, parent material and landform pattern. These features are expressed as a recurring sequence of land components. Land system mapping is generally at a scale of 1:100 000 or 1:250 000 and is appropriate for large scale planning exercises, such as regional planning. Refer to Section 5.2 for Land Systems descriptions for the north east corner of the study area.

Land units or components are distinguished by recurring slope, soil, aspect and vegetation patterns. Land units are therefore subject to similar forms of land degradation. A map unit may be the same as a land unit, however a larger mapping scale allows land components to be divided into further distinct areas based on more specific soil and topographical characteristics. The hierarchy of the Land System concept has been maintained in this study.

In Table 4.2, the close relationships between the map units in the two previous studies (Rowan (1990) and Lorimer & Schoknecht (1987)) and this study can be seen. Where clear relationships do not occur, the 1:25 000 land capability study has invariably been able to identify more accurately the dominant soil.

Table 4.2 Land systems comparisons

(i) Land Systems of Victoria (Rowan, 1990) 1:250 000	(ii) A Study of the Land in the Campaspe River Catchment (Lorimer & Schoknecht ,1987) 1:100 000		(iii) Map Units in the former Shire of Kyneton (This study) 1:25 000		
land system	land system	major soil	map units	soil major	minor
7.1 Pvf7$_7$	Kyneton	Db2.1, Db2.2, Dy3.1, Dy3.2; minor Dy3.21,Gn3.94	Qblf, Qblg	Dd2.1, Dd1.1, Gn3.21, Gn3.91/2	
		Gn3.11, Gn3.12, Gn3.14, Gn4.12, Gn4.14, Gn3.22, Gn3.24; minor Um	Qbla	Dy2.12/1	Um6, Uf6
		Uf6.32; minor Ug5.1	Qb2b(i), Qb2c(i), Qb2d(i), Qb2f(i) Qb2g(i), Qb2f(ii) ,	Ug5 Gn3.51 Gn3.51 Ug5.14 Ug5.14 Gn3.92, Dy3.12	Ug5 Ug5
			Qb2g(ii)	Gn3.92, Dy3.12	
		Ug5.1, Ug6	Qb2h(i)	Ug5.14	
		Gn3.95, Gn3.96, Dd3.13; minor Uc5.11	Qa2	Gn3.06, Dy3.21	Ug5.14
7.1 Pvf$_8$	Trentham East	Gn3.14, Gn3.12, Gn3.11	Qvf, Qvg	Gn3.11, Dr2.11	
		Gn3.42; minor Uf6.32	Qvh	Dr2.12, Dd1.12	
		Urn, Gn4.1, Gn3.1	Qve	Gn3.11 Dr2.11	
7.1 Pvf71 $_i$	Glenvue	Dr2.21, Dr2.11	Qvg, Qvf	Gn3.11 Dr2.11	
		Gn3.74, Gn3.04, Gn4.51	Qvh	Dr2.12 Dd1.12	

(i) Land Systems of Victoria (Rowan, 1990) 1:250 000	(ii) A Study of the Land in the Campaspe River Catchment (Lorimer & Schoknecht ,1987) 1:100 000		(iii) Map Units in the former Shire of Kyneton (This study) 1:25 000		
land system	**land system**	**major soil**	**map units**	**soil major**	**minor**
2.1 Gs7,	Wombat	Gn4.11, Gn3.74; minor Gn4.81, Gn4.31, Um2.21	Osa, Osb, Osc(i) Osc(ii) Osd(i) Osd(ii)	Dy2.11, Gn3.74 Gn4.31 Dy3.01/4 Gn4.51 Dy3.01/4 Gn4.51	 Dy3 Dy3
		Gn3.74, Gn3.84, Dy3.41; minor Dy2.21	Ose, Osf, Osg	Gn3.84 Gn3.74 Gn3.8 Gn3.84, Gn3.91	 Dy3.41 Dy3.21 Dy3
		Gn3.91, Gn4.71, Gn4.31	Osh	Dy2.11, Gn4.51, Dy3.11	

4.3 Special Water Supply Catchment Areas

The former Shire falls into four River Basins. The majority of the Shire is in the Campaspe River Basin, with the extremities of the Shire falling into the Werribee, Maribynong and Goulburn River Basins. The former Shire also falls into four water supply catchments which were proclaimed under the Soil Conservation and Land Utilisation Act 1958. These have been subsequently transferred to the Catchment and Land Protection Act 1994. The previously designated Proclaimed Water Supply Catchments are now called Special Water Supply Catchment Areas. The majority of the Shire occurs in the Eppalock Special Water Supply Catchment Area, with the other catchments being the Eppalock (Kyneton), Lake Merrimu (Lerderderg River), Mollisons Creek (Pyalong). (See Figure 4.1).

These catchments provide water supply to the towns of Kyneton, Castlemaine, Bendigo, Melton, Trentham, Woodend and other small townships within the Shire. Careful planning of land use in these areas is essential if future resource use conflicts are to be minimised.

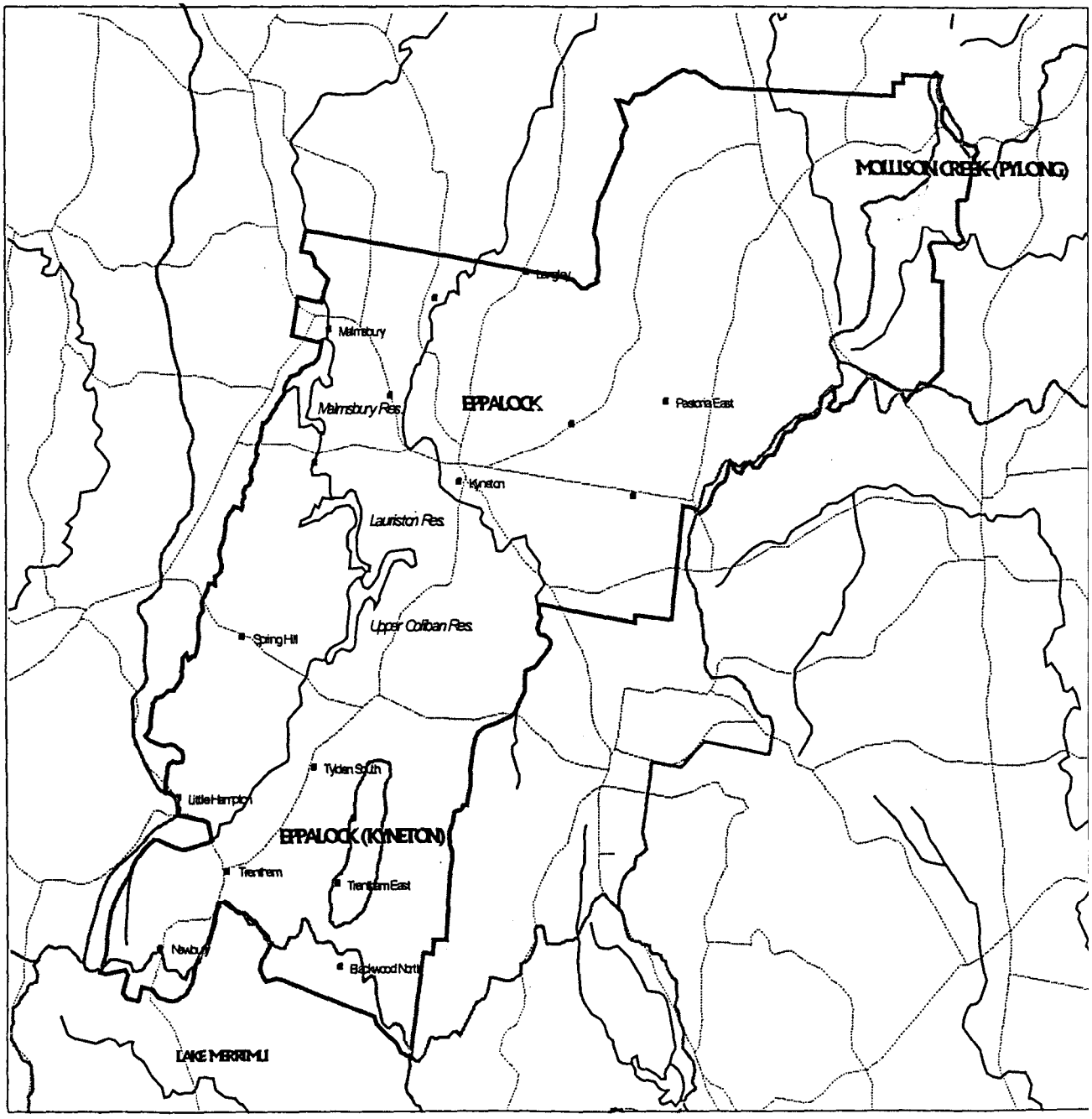


Figure 41: Special Water Supply Catchment Areas within tie former Shire of Kyneton

4.4 Map Unit Group Descriptions

4.4.1 Quaternary alluvial map units (Qa)

There are two major river systems running through the Shire, the Coliban River and the Campaspe River.

Floodplains associated with these river systems are generally quite small in size and are subject to frequent bank stream flow. Both alluvial floodplains are subject to inundation during the winter months due to the presence of a seasonal watertable.

The Malmsbury, Lauriston and Upper Coliban Reservoirs have been built on the Coliban River. This has lead to changes in the flooding regime of the Coliban floodplains.

Sedimentation from the sedimentary hills which the Coliban River and its tributaries mainly run through in the Shire has lead to a strong sedimentary influence on the soils formed on the Coliban floodplain (Qal).

Although the soils are variable, the common soil type is a yellow, mottled duplex soil (Chromosol), with gradational variants also occurring.

The Campaspe River mainly flows through basalt, therefore the soils of the Campaspe floodplain (Qa2) are strongly influenced by this geology. As is common with the alluvial lithology, the soils are variable. They are commonly dark duplex soils with a clay loam topsoil and a clay subsoil, although black cracking clays (Vertosols) also occur, particularly around the Malmsbury area.

Both floodplains tend to have quite dispersive subsoils, therefore are susceptible to stream bank and gully erosion.

Vegetation, such as Narrow-leaved Peppermint and understorey species, such as Blackwood and Golden Wattle, grow along the stream banks and assist in stabilisation.

As the floodplains are prone to seasonal inundation, the land use is restricted to grazing.

Land management considerations

Shallow watertables

Quality of groundwater

The shallow watertables which lead to seasonal inundation are the major limiting features of both the Campaspe and the Coliban floodplains.

The shallowness of the watertables during winter and spring would cause flooding and inundation and therefore failure of septic tank trenches. There is also a risk of effluent entering and polluting local creeks and rivers, due to the moderate permeability of local soil types. An alternative form of effluent disposal should be sought if development is to occur in these areas. The siting of houses and access roads on the flood plains and dams will also be affected by the perched watertable.

Quality of groundwater is a major consideration if development is to occur on the sedimentary hills surrounding the Coliban floodplain and the basalt plains surrounding the Campaspe River floodplain. The well drained sedimentary soils and cracking basalt soils could pose a problem with the effective disposal of effluent. There is a high throughflow effect with these soils which could allow effluent to enter and pollute the groundwater and river system. Further tests may need to be conducted if development is to occur on the hills surrounding the floodplains to ascertain the effect it may have on the quality of groundwater.

4.4.2 Quaternary basalt non-cracking soils map units (Qb1)

The main eruption point of the Quaternary basalt flow originated from Green Hill, just outside the northern boundary of the Shire. The flow was generally quite shallow and overlies sedimentary material.

The landscape is generally gently undulating, with some moderate to steep slopes leading to the major drainage lines. Lower slopes adjacent to flood plains and drainage depressions may become waterlogged in the winter months.

Without extensive surveying, it is difficult to distinguish between the non cracking soils (Qbl) and the cracking soils (Qb2). Care must be taken when working with these land units, particularly on the lower slopes, and slopes associated with drainage depressions or drainage lines (where cracking soils are common), to determine which soil type exists.

The soils are generally duplex (Chromosols), although gradational (Dermosols) profiles can also occur. As a consequence of the shallow basalt flow and subsequent

erosional processes, the soils are quite shallow, although the weathered basalt can be relatively deep. The percentage of stone and rock throughout the profiles, particularly on the crests, can be quite high, although this can vary throughout the Shire.

Rocky scarps above gently undulating rocky slopes are a common land form characteristic of this landscape.

The landscape is generally moderately well drained, although during excessively wet winters, drainage can be impaired. In better drained areas, a red variant can occur.

The incidence of land degradation is relatively low, with some minor gully erosion occurring in some drainage depressions and very gentle slopes. Minor sheet erosion also occurs on some moderate to steep slopes.

Small isolated stands of native vegetation occur on the basalt. The majority of the area has been cleared for agricultural purposes. Manna Gums are generally found on the wetter, poorly drained sites, with Candlebarks, Black Wattle and Silver Wattle also occurring particularly on road sides.

Land management considerations

Shallow depth of soil (shallow basalt flow)
High percentage of stone and rock outcrop
High linear shrinkage (lower slopes)

The non-cracking soils of the basalt have some soil and landscape characteristics which limit the potential use of the land.

The major limitations are the soil depth and *the* percentage of basaltic stones and boulders throughout the soil profile and on the land surface. The high linear shrinkage of the subsoil on the lower reaches of the landscape is also a limitation for earthen dams, secondary roads and building foundations, particularly stumps.

Earthen dams are not prevalent throughout this land system due to the shallow, stony soil and low runoff rate.

Some dams in the study area have been constructed in weathered sedimentary rock, as the basalt flow was generally quite shallow. In some cases liners to seal the dams may need to be used as the clay percentage could be quite low.

The basalt soils are generally highly fertile, although land use is restricted mainly to grazing due largely to the high percentage of rock outcrop. Extensive clearing of the rocks has occurred in some areas.

4.4.3 Quaternary basalt seasonally cracking soils map units (Qb2)

The main eruption point of the Quaternary basalt is the same as the previous map units section.

These land units are associated with the Campaspe River or drainage lines. They are common around the Malmsbury area, with some occurrences around Kyneton.

The landscape generally consists of gentle simple slopes leading directly from the crest to the depression, not highly dissected with drainage lines. Runoff is generally quite low due to large cracks formed when the soil dries. The first winter rains quickly percolate through the soil profile, gradually wetting up the profile and closing the cracks. Once the subsoil reaches saturation, it often becomes impermeable to water. Seeps can occur on the lower slopes where water has flowed above the impermeable layer.

As a result of the soil forming large cracks when it is dry, episodic recharge occurs during summer rainfall events and at the beginning of winter before the cracks have sealed.

The lower sections of the landscape associated with the Campaspe River and other drainage lines are prone to water logging during the winter months.

Rock outcrops are scattered throughout the gentle and very gentle slopes. Narrow rocky scarps give way to moderate to steep slopes leading to the drainage lines, with rock outcrop occurring to varying degrees.

Two main soil types occur on these map units, black cracking clays (Vertosols) and clay loam self mulching topsoils and cracking clay subsoils (Chromosols). Both soil types have hardsetting clay subsoils with minor soft carbonate nodules in the B2 horizon. These two soil types have been described separately in the map unit descriptions, delineating the Vertosols as Qb2 (i) and the Chromosols as Qb2 (ii). Due to the small size of the map units and the scale of the maps, both soil types are delineated as the same map unit (Qb2) on the map. The land capability assessments depicted on the maps are

derived from the Qb2 (i) map unit as this is deemed to be the more common soil type, although the ratings for the Qb2 (ii) map units have also been established and are indicated on the legend of the maps and in more detail in the report. More detailed investigation is required if working with this map unit to establish which soil type is present in a specific area.

Generally, the Vertosols tend to occur in direct association with the drainage lines. The Chromosols commonly occur higher in the landscape than the Vertosols.

The strong self mulching topsoil of the Chromosols is very friable. When disturbed by vehicle or stock traffic this soil is easily eroded. When this occurs the subsoil is revealed and the characteristic cracking appears on the surface. Minor incidence of gilgai (hummocks and/or hollows) also occur on the self mulching Chromosols and the Vertosols, particularly on the lower slopes.

The steeper slopes formed by the downcutting of streams tend to have more gradational soils (Dermosols) and less obvious cracks in the heavy clay subsoil.

Included in these land units are former lake beds originating from the Campaspe River. This map unit is seasonally waterlogged (Hydrosols), but exhibit the familiar cracking characteristics in the subsoil when dry.

The original vegetation was quite sparse. Some remnant Swamp Gums and Manna Gums remain and are mostly found in the drainage depressions.

Limited land degradation occurs throughout this landscape, although there are incidences of gully erosion and erosion of the self mulching topsoil on the Chromosols. Compaction of the soil can also occur.

Land management considerations

Cracking characteristics of the subsoil when dry (high linear shrinkage)
Impermeable clay subsoil when wet (poor drainage)
High percentage of rock outcrop

The major limitations of the land within these map units are the cracking characteristics of the subsoil when dry, and the impermeable clay subsoil when wet.

Significant problems with septic tanks may occur if residential development takes place on these land units due to the clays becoming very impermeable when saturated which may cause the septic tank trenches to fail.

Dam construction is limited on the cracking clays due to their inability to retain water in the summer months, and low runoff from the gentle slopes.

The high linear shrinkage allows significant movement of the subsoil and will cause problems with access roads and building foundations as they require a stable substrate.

Although the basalt soil is inherently high in nutrients, the land use on these map units is restricted mainly to grazing due to the heavy clay subsoil, poor drainage, and high percentage of rock outcrop.

The Vertosols have a very shallow self mulching topsoil, with a clear transition to the clay subsoil that is very hard setting when dry. Plant roots have difficulty penetrating deep into the profile. Much of the moisture is held within the clay and remains mostly inaccessible to plant roots.

The land use on the former lake beds is restricted to grazing due to seasonal inundation. High linear shrinkage and the very slow permeability of the soil once saturated also limits the land use of these areas.

4.4.4 Quaternary volcanic map units (Qv)

The Quaternary volcanics occur in the southern part of the Shire, around Tylden and Trentham. Although the lithology is still basalt, these map units are described as volcanic to differentiate them from the basalt in the rest of the study area. The soils are different due to higher rainfall and different source of the flow.

The volcanic flow was not particularly deep in some parts of the Shire as weathered sedimentary material can occur at depths of less than 2 metres, particularly on the lower slopes and drainage depressions.

The landscape mainly consists of gently undulating slopes, dissected with minor drainage depressions. Moderate to steep slopes occur as the downcutting slopes to the major drainage lines. The volcanic and sedimentary lithologies are commonly separated by main waterways, although the junction can also occur part way down a slope where the volcanic material has been eroded over time.

The soils are generally quite similar throughout the landscape, commonly occurring as red, well structured gradational soils (Ferrosols, Dermosols) or as whole coloured duplex profiles (Chromosols). The red volcanic soils are inherently high in ferric oxide.

The percentage of rock outcrop on the land units is variable, and some areas have been cleared of rock. Stones and rocks can occur throughout the soil profile, particularly on the crests.

The soils are physically very fertile because of the free flowing drainage, strong structure and clay subsoil. These characteristics also allows a very high water holding capacity available for plants. The free drainage of these soils has lead to leaching of nutrients through the profile and therefore the nutrient status is moderate.

Due to the very favourable attributes of the soil, the agricultural use on these land units is quite varied, consisting of cropping, particularly potatoes, perennial pasture, summer fodder crops and grazing of sheep and cattle.

The high agricultural potential of this area has led to extensive clearing of native vegetation. Stands of native vegetation remain on the roadsides and crown land reserves, such as Trentham Falls Reserve. The vegetation commonly consists of Manna Gum, Messmate and Narrow-leaved Peppermint, with Blackwood and Black Wattle occurring as the dominant understorey species.

Red volcanic soils are susceptible to sheet erosion, particularly on moderate to steep slopes. Gully erosion can also occur on the very gentle slopes and drainage depressions.

Land management considerations

High permeability (dam construction)
Low dispersibility (dam construction)
Shallow basalt flow (dam construction, building foundations, secondary roads)
High linear shrinkage (farm dams, secondary roads, building foundations)
Pollution of groundwater (from effluent)

The red volcanic soils are the most productive agricultural soils in the former Shire. They are quite diverse in their agricultural use due to the favourable physical characteristics of the soil.

The siting of earthen dams needs careful consideration on these map units as permeability rates can be excessive and the dispersibility of the soil is generally quite low. As with the basalt (Qb) map units, the volcanic flow was quite shallow in parts and some dams have been constructed into weathered sedimentary material. Using liners or a dispersion agent in dams which have either shallow soils or highly permeable subsoils may overcome some of these constraints.

The subsoil generally has a high linear shrinkage, particularly on the lower slopes. This may cause problems with access roads and buildings as they require a stable substrate.

The use of septic tanks as a form of effluent disposal, may cause problems with water quality, as the very permeable soils may not allow for the retention of nutrients, and therefore may cause pollution of the watertable. An alternative form of effluent disposal may need to be sought to preserve the water quality in the Shire.

As these map units are the most agriculturally productive areas in the former Shire this must be taken into account when considering rural residential development.

4.4.5 Ordovician sedimentary map units (Os)

The Ordovician sediments in the former Shire are composed of steeply dipping and tightly folded marine sandstones and shales.

The landscape mainly consists of undulating to rolling low hills. Most of the steep hills have been left forested and now form part of the Wombat State Forest, which has been excluded from the study area. Steep slopes also occur down cutting to the major drainage lines and reservoirs.

The majority of the soils on the sedimentary lithology throughout the Shire are gradational, with a bleached A2 horizon and a mottled clay subsoil, (Dermosols). Many of the profiles tend towards a duplex soil classification, except they commonly have a transitional horizon between the topsoil and the subsoil.

Gradational soils are commonly found in areas of relatively high rainfall. The depth of soil is variable in most units, although there can be quite a deep weathered rock zone beneath the soil before reaching the fractured bedrock. Stone and gravel is common throughout most profiles.

The moderate to moderately steep slopes have two major soil types; shallow, poorly structured gradational soils (Kandosols Osc(ii), Osd(ii)), and deep gradational soils with a bleached A2 horizon and a mottled clay subsoil (Dermosols Osc(i), Osd(i)).

The shallow soil variant often occurs when the landscape is dissected with numerous drainage depressions, often leading to major drainage lines or the reservoirs. The slopes are generally moderately steep, long simple slopes and have a high runoff rate.

The slopes where the deeper more developed variant has formed are commonly undulating and slightly terraced, which has allowed more water to enter the profile than runs off down slope and thereby increases the soil forming processes.

Due to limitations of scale, the two soil types have not been differentiated in the mapping process, and have been mapped generally as Osc or Osd, although they have been described independently in the report. The land capability assessments depicted on the map are those pertaining to the Os (i) map units, as this is the most common soil type. The limiting features of both soil types are outlined in the map legend and report. Care must be taken when working with these land units to determine which soil type predominates in the area of interest. The shallow variant may have deeper pockets of soil occurring throughout the slope.

The agricultural land use on the sedimentary landscape is predominantly grazing, with some areas, particularly on the lower slopes sown to perennial pasture. Nutrient status is low which is expected in high rainfall areas where there is significant leaching of the nutrients.

Gully erosion and salinity is the major land degradation of concern on the very gentle slopes and drainage depressions. Minor incidence of sheet and rill erosion occurs on the moderate to steep slopes.

Pockets of native vegetation occurs throughout the former Shire, particularly near the Wombat State Forest, and are commonly found on the steeper slopes and crests which have shallower soils and therefore are less productive agriculturally. Messmate, Manna Gum and Narrow-leaved Peppermints are the common tree species, although Candlebark occurs in the south of the former Shire where the rainfall is slightly higher. Silver Wattle, Black Wattle and Blackwood are the dominant understorey species.

Land management considerations

Shallow soils
Stone and gravel throughout the profile
Salinity and gully erosion
Recharge to groundwater table

The shallow soils and the presence of stone and gravel throughout the soil profile limits the diversity of land use on this lithology.

The soil depth and the percentage of stones vary throughout the landscape. Rural residential development can occur if well developed soils can be found in an area large enough to support all the required land uses.

The drainage depressions, and to a lesser extent, the lower slopes of the sedimentary landscape are prone to salinity and gully erosion. Careful management of these areas is required to control and minimise further degradation.

Infiltration of water through the steeper slopes and crests contribute to the rising groundwater levels which cause salinity. Therefore careful management of these areas also have to be employed.

Effluent disposal methods which are not going to increase and pollute the watertable level need to be investigated.

Plate 1 Map unit: Qa1
Yellow duplex
Grey Chromosol

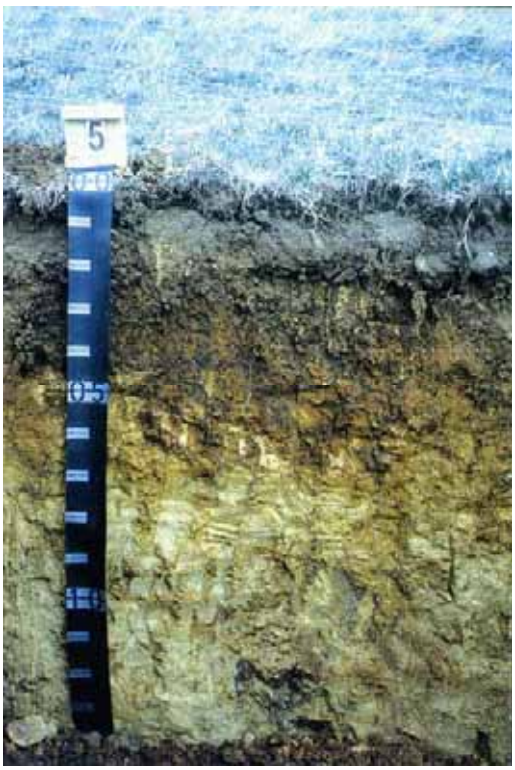


Plate 2 Map unit: Qb1c
Dark duplex
Black Chromosol

Plate 3: Map unit: Ob1g
Dark duplex
Brown Chromosol

Plate 4 Map unit: Qb2f(i)
Black cracking uniform clay
Black Vertosol

Plate 5 Map unit: Qb21
Yellow duplex
Oxyquic Hydrosol

Plate 6 Map unit: Qb2f (ii)
Gradational
Black Chromosol

Plate 7: Map unit: Qvg
Gradational
Red Ferrosol

Plate 8 Map unit: Qvh
Red Duplex
Red Chromosol

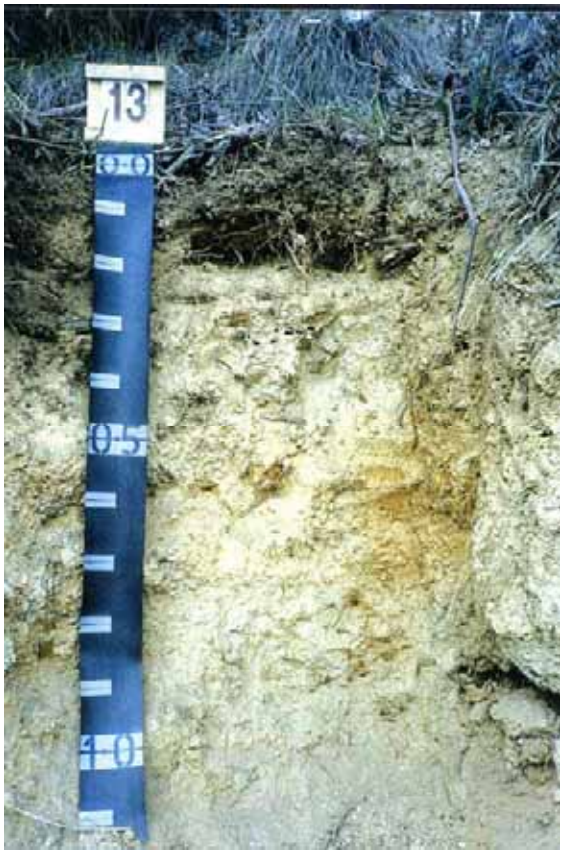


Plate 9 Map unit: Osd (i)
Gradational
Brown Dermosol

Plate 10 Map unit: Osd (ii)
Gradational
Brown Kandosol

Plate 11: Map unit: Ose
Gradational
Brown Dermosol

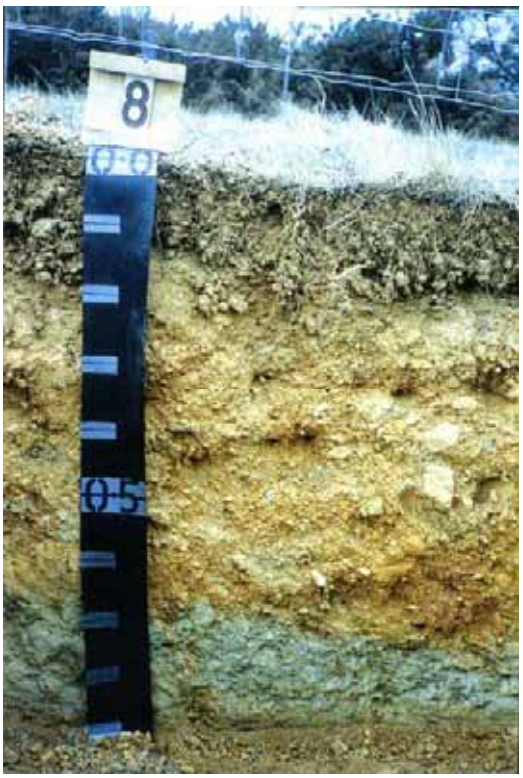


Plate 12 Map unit: Qsf
Gradational
Red Dermosol

Plate 13 Map unit: Osh
Yellow Duplex
Grey Kurosol

5 MAP UNIT AND LAND SYSTEMS DESCRIPTIONS

5.1 Detailed Map Unit Descriptions and Capability Ratings

Thirty-six map units have be identified in the study area. Each map unit is described in a 2 page format in terms of geology, topography, dominant soil type and general site characteristics. It includes a table of land capability assessments for those land uses considered important by the former Shire of Kyneton, and estimates of susceptibility to erosion and recharge. The land capability assessment table also identifies the major limiting feature(s) for each land use.

The classes for the land capability ratings range from 1-5 with one being very good and 5 being very poor. (Refer to Tables 2.1 and 2.2 for more detailed explanations).

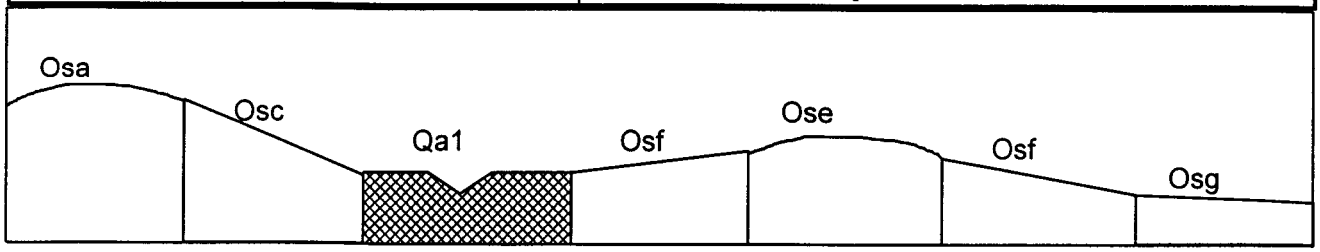
The potential agricultural productivity of land is generally classified by the CTS criteria (Climate, Topography and Soil) e.g. The 'ideal' prime agricultural areas would be denoted by $C_1T_1S_1$ compared with another area that had, for example, a 5-7 month growing season, slopes of 3% and a depth to rock/hardpan of only 0.7 m, denoted by $C_3T_2S_4$. (Refer to Table 2.3). The overall Land Capability Class of this latter land would be 4; with soil factors being the major limiting features.

Maps depicting the map units and the land capability assessments for the nominated land uses have been produced. Some areas with the same geology and topography have been described as two separate map units due to the different soil types and site characteristics. It is very difficult to accurately locate them on the accompanying map due to restrictions of scale, therefore they have been represented on the map as the same map unit. Detailed descriptions of the soil type and separate land capability assessments are provided in the report and in the legend of the map although the ratings depicted on the land capability assessment maps are those relating to the dominant soil type which is delineated as (i).

Note: As observations only go to a maximum of 2.0 m, the depth to hardrock and to seasonal watertable have been generalised.

The pH recorded in the profile descriptions is field pH. The pH record in the interpretation of laboratory analyse are pH ($CaC1_2$) or pH (H_2O) as indicated.

MAP UNIT SYMBOL: **Qa1** Area: 369 ha	MAP UNIT: **Quaternary alluvium, Coliban floodplain**



A. GENERAL DESCRIPTION

These floodplains occur on the Coliban River and its tributaries. The flooding risk is low and if flooding occurs it is possibly only very infrequent and very slow moving, therefore flood risk is not a large threat to residential development or agriculture if it designed for correctly. The main limitation of the floodplains is that they experience seasonal inundation from local runon and overland flow. There is also the occurrence of a perched watertable during winter and spring. Development on the hills surrounding the floodplains has to take into account the fact that through-flow is occurring from these hills and that effluent may accumulate on the floodplains and therefore cause pollution of the groundwater. Although the floodplains are seasonally waterlogged, the permeability is moderate, as the water may be infiltrating through the clay and seeping into the creeks. The soils are strongly influenced by the sedimentary hills that the Coliban River and its tributaries run through. They are commonly duplex, with a loam to clay loam topsoil and a fine sandy clay to medium clay subsoil, although gradational variants can occur when the topsoil is a heavier texture.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	0.5 m
Parent Material Lithology:	Alluvium	**Flooding Risk:**	Low
Landform Pattern:	Floodplain	**Drainage:**	Imperfectly drained
Landform Element:	Plain	**Rock Outcrop:**	0%
Slope a) common:	2%	**Depth to Hard Rock:**	>2.0 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:		Low	
Major Native Vegetation Species:		Blackwood, Golden Wattle, *Juncus sp.*	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Very low	Low	High	High
Incidence	Very low	Low	Very low	Nil	Moderate	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K10

A1 0-23 cm Very dark grey (10YR3/1) loam with fine sand, strong subangular blocky structure, peds 10 - 20 mm, rough fabric, firm consistence, very few fine subrounded sedimentary pebbles, pH 5.5. Clear transition to:

B21 23-45 cm Greyish brown (10YR5/2) fine sandy clay, bleached (10YR7/2), weak subangular blocky structure, peds 20-50 mm, rough fabric, firm consistence, very few small subrounded sedimentary pebbles, pH 6.0. Gradual transition to:

B22 45-100 cm Brown (10YR5/3) fine sandy clay, bleached (10YR7/3), medium distinct yellow and brown mottles are common, moderate subangular blocky structure, peds 20-50 mm, rough fabric, firm consistence, very few small subrounded sedimentary pebbles, pH 6.0. Gradual transition to:

B23 100-110 cm Light brownish grey (10YR6/2) fine sandy clay, many medium distinct yellow and brown mottles, weak subangular blocky structure, peds 20-50 mm, rough fabric, firm consistence, very few small subrounded sedimentary pebbles, pH 6. Diffuse transition to:

B24 110-150 cm^{+} Light brownish grey (10YR6/2) fine sandy clay, many very coarse distinct orange and brown mottles, weak subangular blocky structure, peds 50-100 mm, rough fabric, firm consistence, very few small subrounded sedimentary pebbles, pH 8.5.

CLASSIFICATION

Factual Key:	Dy3.13 (major), Gn3.4, Gn4.4 (minor)
Australian Soil Classification:	Mottled-Sodic, Eutrophic, Grey CHROMOSOL; medium, non-gravelly, loamy, clayey / very deep
Unified Soil Group:	ML

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	1	VL	L	S	S	T	H	VL
B1	4.6	1	VL	L	D	D	T	M	L
B21	4.6	8	VL	L	D	D	S	VL	L
B22	5.5	7	VL	L	D	D	S	VL	H
B23	6.8	16	VL	L	D	D	S	VL	H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results **Strongly Acidic

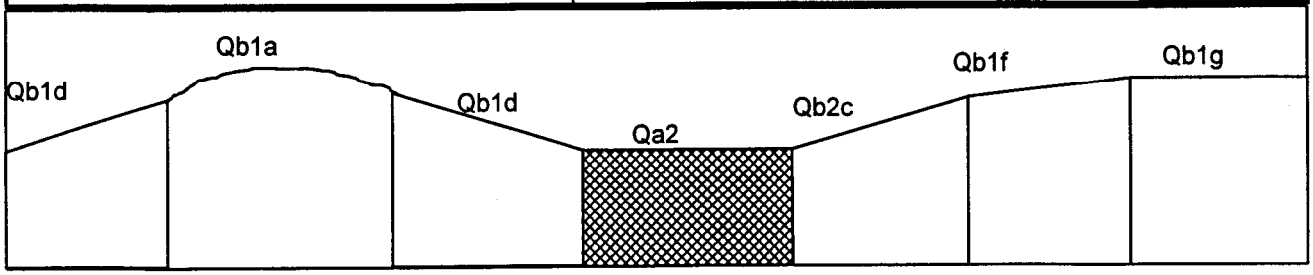
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average range 100 - 270 mm/day)
Available Water Capacity:	Very high (267 mm H_20)
Linear Shrinkage (B horizon):	Linear (10%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_5$	Depth to seasonal watertable
Effluent Disposal (septic tanks)	5	Depth to seasonal watertable
Farm Dams	5	Depth to seasonal watertable
Secondary Roads	5	Depth to seasonal watertable
Rural Residential Development	5	Secondary roads, building foundations, farm dams, effluent disposal

MAP UNIT SYMBOL: **Qa2** Area: 385 ha	MAP UNIT: **Quaternary alluvium, Campaspe floodplain**



A. GENERAL DESCRIPTION

These floodplains occur on the Campaspe River and its tributaries. The flooding risk is low and if flooding occurs it is possibly only very infrequent and very slow moving, therefore flood risk is not a large threat to residential development or agriculture if it designed for correctly. The main limitation of the Campaspe floodplains is that they experience seasonal inundation from local runon and overland flow. There is also the occurrence of a perched watertable during winter and spring. Development on the hills surrounding the floodplains has to take into account the fact that through-flow is occurring from these hills and that effluent may accumulate on the floodplains and therefore cause pollution of the groundwater. The soils are strongly influenced by the basalt landscape that the Campaspe River and its tributaries run through. They are commonly dark duplex, with a clay loam topsoil and clay subsoil, although cracking uniform clay variants also occur.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	0.5 -1.0 m
Parent Material Lithology:	Alluvial	**Flooding Risk:**	Low
Landform Pattern:	Floodplain	**Drainage Risk:**	Imperfectly drained
Landform Element:	Plain	**Rock Outcrop:**	0%
Slope a) common:	1%	**Depth to Hard Rock:**	>3.0 m
Slope b) range:	0-1%		
Potential Recharge to Groundwater:		Low	
Major Native Vegetation Species:		Narrow-leaved Peppermint	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Low-mod	Very low	Low	Low-mod	Moderate
Incidence	Nil	Low	Nil	Nil	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A 0-15 cm Very dark grey (7.5YR3/0) clay loam, strong subangular blocky structure, peds 2-5 mm (self mulching), smooth fabric, pH 7.0. Gradual transition to;

B1 15-55 cm Very dark grey (7.5YR3/0) medium clay, strong prismatic structure, breaking down to angular blocky peds, smooth fabric, pH 6.5. Clear transition to:

B2 55-100^{+} cm Very dark grey (7.5YR3/0) heavy clay, strong prismatic structure, breaking down to angular blocky peds, smooth fabric, pH 8.5.

CLASSIFICATION

Factual Key:	Dd1.13, Ug5.14
Australian Soil Classification:	
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_2O)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	7.0	NA	NA	NA	NA	NA	NA	NA	NA
B1	6.5	NA	NA	NA	NA	NA	NA	NA	NA
B2	8.5	NA	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

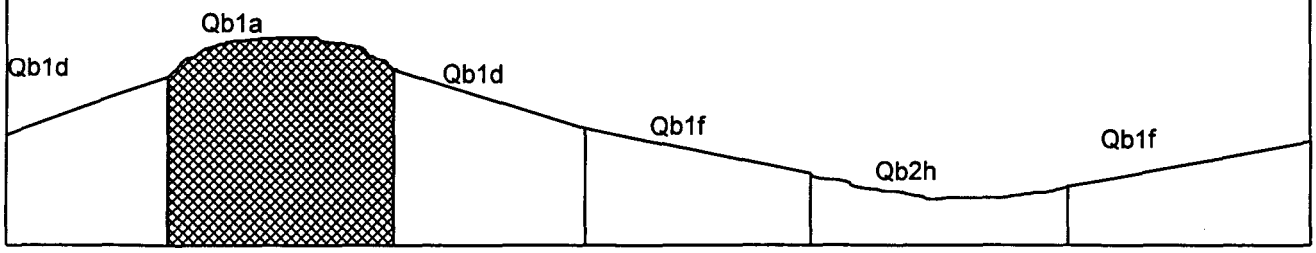
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow to slow (estimate)
Available Water Capacity:	Very high (210 mm H_20)
Linear Shrinkage (B horizon):	High (estimate)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_5$	Depth to seasonal watertable
Effluent Disposal (septic tanks)	4	Drainage, depth to seasonal watertable, permeability
Farm Dams	5	Depth to seasonal watertable
Secondary Roads	4	Drainage, depth to seasonal watertable, linear shrinkage
Rural Residential Development	5	Farm dams, Building foundations

MAP UNIT SYMBOL: **Qb1a** Area: 88 ha	MAP UNIT: **Quaternary basalt, non cracking, rocky scarp**



A. GENERAL DESCRIPTION

The rocky scarps in the basalt are generally of low relief, and can be quite narrow. Due to restrictions of scale, they could not all be mapped, and some of the scarps may have cracking characteristics, or have a lower rock outcrop percentage, therefore care must be taken when working with this map unit. The textures are variable, ranging from uniform sandy clay barns (Dermosols), through to duplex soils (Chromosols) with loam to clay loam topsoils and clay subsoils.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava plain	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	40%
Slope a) common:	3%	**Depth to Hard Rock:**	0.5m
Slope b) range:	1-5%		
Potential Recharge to Groundwater:		High	
Major Native Vegetation Species:		Yellow Box, Manna Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Very low	Mod-high
Incidence	Low	Very low	Very low	Very low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A11 0-12 cm — Dark brown (7.5YR4/2) loam to clay loam with fine sand, moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, many small and large subangular and subrounded basaltic pebbles, pH 6.0. Clear transition to:

A12 12-22 cm — Dark reddish brown (5YR3/2) heavy loam to clay loam with fine sand, moderate subangular blocky structure, rough fabric, weak consistence, many small and large, subangular basaltic pebbles, pH 6.0. Gradual transition to:

B2 22-33 cm — Dark brown (7.5YR4/2) light clay to heavy clay, fine sandy, moderate subangular blocky structure, peds 10-20 mm, weak consistence, small, medium and large angular and subangular basaltic pebbles are abundant, pH 6.5. Gradual transition to:

BC 33-52 cm — Partially weathered basaltic rock, pH 6.5. Gradual transition to:

R 52 + cm — Basaltic rock

CLASSIFICATION

Factual Key:	Dy2.12/1, (minor) Um6, Uf6,
Australian Soil Classification:	Haplic, ?, Grey CHROMOSOL; medium, moderately gravelly, clay loamy / clayey, shallow
Unified Soil Group:	Not available

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	6.0	20-50	NA	NA	NA	NA	NA	NA	NA
A12	6.0	20-50	NA	NA	NA	NA	NA	NA	NA
B2	6.5	50-90	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

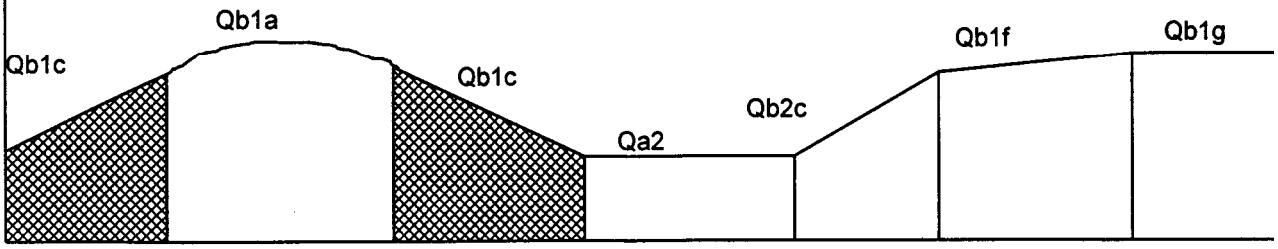
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very rapid (estimate)
Available Water Capacity:	Very low (31-35 mm H_20)
Linear Shrinkage (B horizon):	Not available

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_5$	Available water capacity
Effluent Disposal (septic tanks)	4	Depth to impermeable layer
Farm Dams	5	Suitability of subsoil, depth to hardrock, permeability
Secondary Roads	5	Proportion of stones and boulders
Rural Residential Development	5	Farm dams, secondary roads

MAP UNIT SYMBOL: **Qb1c** Area: 95 ha	MAP UNIT: **Quaternary basalt, non cracking, moderately steep slope**



A. GENERAL DESCRIPTION

This map unit commonly has very short slopes, mainly leading to drainage lines or depressions. This slope class in the Quaternary basalt consists of two soil types, black cracking clays (Qb2c(i)) and non cracking duplex soils (Qb1c). It is difficult to distinguish between the two soil types due to the small size of this map unit, therefore care must be taken when working on this slope class, as both soil types may be present.

The soils on this map unit are variable, commonly occurring as red or dark, whole coloured duplex soils (Chromosols), although gradational profiles and uniform clays (Dermosols) can occur. There is commonly a high percentage of rock or stone throughout the profile.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava plain	**Drainage:**	Well drained
Landform Element	Hill slope	**Rock Outcrop:**	10-20%
Slope a) common:	29%	**Depth to Hard Rock:**	>1.0 - 1.5 m
Slope b) range:	21-32%		
Potential Recharge to Groundwater.		High	
Major Native Vegetation Species:		Manna Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Mod-low	Low	Low	Mod-high
Incidence	Low	Low	Low	Low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K5

A 0-19 cm Dark brown (7.5YR4/2) loam to fine sandy clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, very few small and large angular and subrounded basaltic pebbles, pH 6.0. Clear transition to:

B2 19-35 cm Dark brown (7.5YR3/2) fine sandy clay to light clay, moderate subangular structure, peds 10-20 mm, smooth fabric, very firm consistence, a few medium angular and subrounded basaltic pebbles, pH 6.0. Gradual transition to:

B3 35 - 62 cm Reddish brown (5YR4/4) fine sandy clay, moderate subangular blocky structure, peds 10-20mm rough fabric, firm consistence, small subrounded basaltic pebbles are common, pH 6.0. Gradual transition to:

BC 62-80 cm Partially weathered basaltic rock. Gradual transition to:

C 80-150 cm Weathered basaltic rock

CLASSIFICATION

Factual Key:	Dd1.11 (major), Dr2.11, Gn3.1, Um6 (minor)
Australian Soil Classification:	Haplic, Eutrophic, Black CHROMOSOL; medium, gravelly, loamy / clayey, moderate.
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	5.4	14	VL	H	S	S	S	H	VL
B2	5.6	42	VL	H	S	S	S	L	VL
B3	5.7	25	VL	VH	S	S	S	L	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available see Appendix D for analytical results ** Strongly Acidic

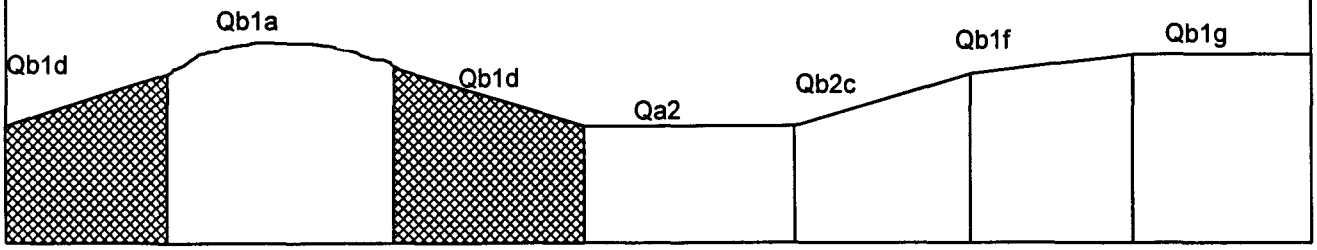
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (estimate)
Available Water Capacity:	Low (67 mm H_20)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope, suitability of subsoil, low dispersibility of subsoil
Secondary Roads	4	Slope, proportion of stones and boulders
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qb1d** Area: 188 ha	MAP UNIT: **Quaternary basalt, non cracking, moderate slope**



A. GENERAL DESCRIPTION

This map unit commonly has very short slopes, mainly leading to drainage depressions or creeks. This slope class in the Quaternary basalt consists of two main soil types, black cracking clays (Vertosols) (Qb2d(i)) and non cracking duplex or gradational soils (Chromosols) (Qb1d). The lower slopes of this map unit may have black cracking clays when associated with the drainage depressions. Due to restrictions of scale, it is difficult to distinguish between the Qb2d(i) map unit and the Qb1d map unit. This must be taken into account when working on this map unit.

The soils on this map unit are commonly duplex (Chromosols) or gradational soils (Dermosols), with a loam to clay loam topsoil and a clayey subsoil.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	10-20 %
Slope a) common:	13%	**Depth to Hard Rock:**	>1.5m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:		High	
Major Native Vegetation Species:		Manna Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Mod-low	Low	Low	Mod-high
Incidence	Low	Low	Low	Low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K5

A 0-19 cm — Dark brown (7.5YR4/2) loam to fine sandy clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, very few small and large angular and subrounded basaltic pebbles, pH 6.0. Clear transition to:

B2 19-35 cm — Dark brown (7.5YR3/2) fine sandy clay to light clay, moderate subangular structure, peds 10-20 mm, smooth fabric, very firm consistence angular and subrounded basaltic pebbles, pH 6.0. Gradual transition to:

B3 35 - 62 cm — Reddish brown (5YR4/4) fine sandy clay, moderate subangular blocky structure, peds 10-20 mm rough fabric, firm consistence, small subrounded basaltic pebbles are common, pH 6.0. Gradual transition to:

BC 62-80 cm Partially weathered basaltic rock. Gradual transition to:

C 80-150 cm Weathered basaltic rock

CLASSIFICATION

Factual Key:	Dd1.11, Gn3.91/2 (major), Gn4.51/2 (minor)
Australian Soil Classification:	Haplic, Eutrophic, Black CHROMOSOL; medium, gravelly, loamy / clayey, moderate.
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	5.4	14	VL	H	S	S	S	H	VL
B2	5.6	42	VL	H	S	S	S	L	VL
B3	5.7	25	VL	VH	S	S	S	L	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

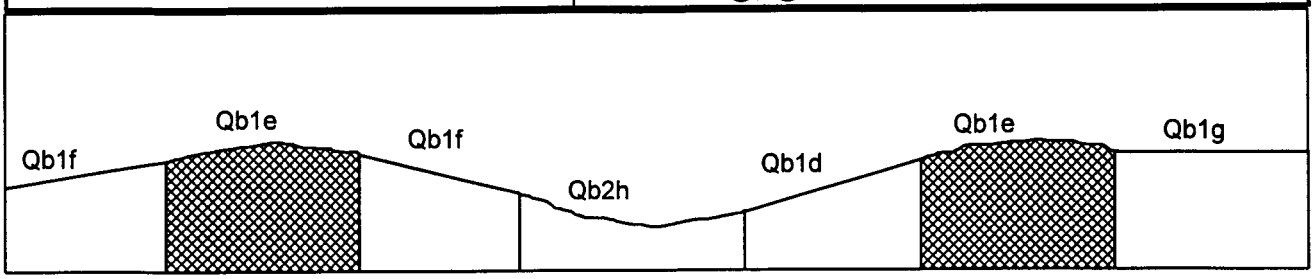
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (estimate)
Available Water Capacity:	Low (67 mm H_2O)
Linear Shrinkage (B horizon):	Low (12%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	3	Slope
Farm Dams	5	Suitability of subsoil, low dispersibility of subsoil
Secondary Roads	4	Slope, proportion of stones and boulders
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qb1e** Area: 315 ha	MAP UNIT: **Quaternary basalt, non cracking, gentle crest**



A. GENERAL DESCRIPTION

This map unit comprises the broader basaltic crests, which have a developed soil profile. Floaters throughout the soil profile are common. Due to restrictions of scale, some areas with a higher rock outcrop percentage may have been mapped as this map unit, therefore care should be taken when dealing with this map unit. The soils are commonly • gradational (Dermosols) with silty clay loams topsoils and mottled clay subsoils.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Moderately well drained
Landform Element:	Crest	**Rock Outcrop:**	2-20%
Slope a) common:	1-5%	**Depth to Hard Rock:**	>1.0m
Slope b) range:	2%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Low	Very low	Very low	Moderate
Incidence	Low	Very low	Low	Very low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A11 0-7 cm — Dark brown (7.5YR3/2) clay loam to silty clay loam, moderate subangular blocky structure, rough fabric, a few basaltic gravel fragments, pH6.0. Clear transition to:

A12 7-24 cm — Dark brown (7.5YR3/2) silty clay loam, moderate to strong subangular blocky structure, rough fabric, a few basaltic gravel fragments, pH 6.0. Clear transition to:

B21 24-40 — Dark brown (7.5YR3/4) to reddish brown (5YR4/3) silty clay, mottles are common, moderate to strong blocky structure, smooth fabric, basaltic gravel and stone fragments are common, pH 6.0. Clear transition to:

B22 40-100 cm — Brown (10YR4/3) to reddish brown (10YR4/4) light clay to medium clay, mottles are common, moderate to strong subangular blocky structure, basaltic gravel and stone fragments are common, pH 6.0.

CLASSIFICATION

Factual Key:	Gn3.11 (major) Gn3.22, Dd 1.11 (minor)
Australian Soil Classification:	Mottled, ?, brown DERMOSOL; medium, slightly gravelly, silty / clayey, deep. Confidence level 4
Unified Soil Group:	Not available

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	6.0	2-10	NA	NA	NA	NA	NA	NA	NA
A12	6.0	2-10	NA	NA	NA	NA	NA	NA	NA
B21	6.0	10-20	NA	NA	NA	NA	NA	NA	NA
B22	6.0	10-20	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

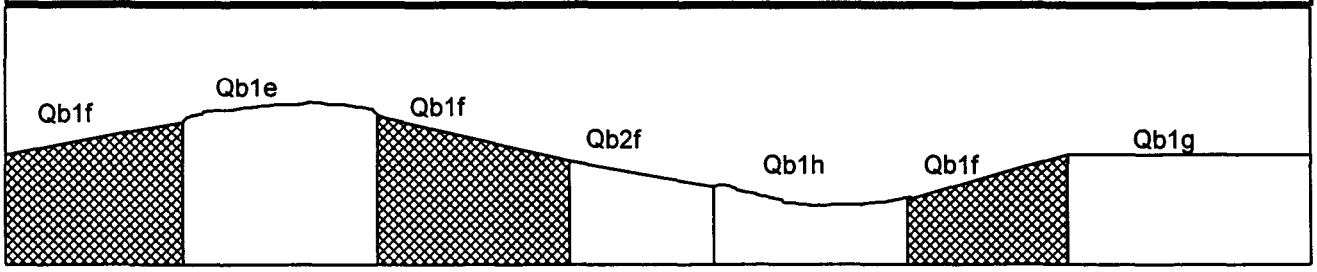
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate-rapid (estimate)
Available Water Capacity:	Moderate (117 mm H_20)
Linear Shrinkage (B horizon):	Not available

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Length of growing season, gravel, stone and boulder content, susceptibility to sheet erosion, available water capacity
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Depth to hardrock, permeability
Secondary Roads	3	Drainage, proportion of stones and boulders
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Qb1f** Area: 7363 ha	MAP UNIT: **Quaternary basalt, non cracking, gentle slope**



A. GENERAL DESCRIPTION

This map unit consists of the basalt gentle slopes which do not crack. It comprises a large area of the former Shire and is often dissected with drainage depressions. The colour of the subsoil varies, ranging from dark, yellow and occasionally red duplex soils (Chromosols) to gradational soils (Dermosols), when a transitional horizon is present. Mottles are common, although not always present. Rock outcrop, stone and gravel content occurs to varying degrees. Care must be taken when working with this map unit as cracking soils may be present.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	2-20% (variable)
Slope a) common:	6 %	**Depth to Hard Rock:**	>1.0 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Candlebark, Black Wattle, Silver Wattle	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Moderate	Very low	Low	Moderate
Incidence	Low	Low	Low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE Description: Site K4

A1 0-20 cm — Very dark grey (10YR3/1) to dark brown (7.5YR3/2) clay loam to silty clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, a few basaltic fragments, pH 6.0. Clear transition to:

BI/B21 20-40 cm — Dark brown (7.5YR4/3) light clay, mottles are common, moderate subangular blocky structure, peds 5-10 mm, smooth fabric, basaltic fragments are common to abundant, pH 6.0. Clear transition to:

B22 40-60 cm — Dark brown (10YR4/3) light clay to medium clay, mottles are common, moderate to strong subangular blocky structure, peds 5-10 mm, smooth fabric, basaltic fragments are common, pH 6.0. Clear transition to:

B23 60-90 cm — Brown (10YR5/3) light medium clay to heavy clay, mottles are common, moderate to strong subangular blocky structure, peds 10-20 mm, smooth fabric, basaltic fragments are common, pH 6.5. Clear transition to:

B3 90-100 cm Dark greyish brown (2.5Y4/2) medium to heavy clay, mottles are common, moderate subangular blocky structure, peds 5-10 mm, smooth fabric basaltic fragments are common, pH 6.0.

CLASSIFICATION

Factual Key: Dd2.1, Dd1.1, Gn3.21, Gn3.91/2
Australian Soil Classification: Mottled, Eutrophic, Brown CHROMOSOL; medium, gravelly, clay loamy / clayey, deep.
Unified Soil Group: MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.5	19	VL	M	S	S	T	H	VL
B21	5.0	20-70	VL	M	D	S	S	M	VL
B22	5.5	27	VL	M	D	D	S	VL	L
B23	5.7	17	VL	M	D	D	S	VL	L
B3	5.8	38	VL	M	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

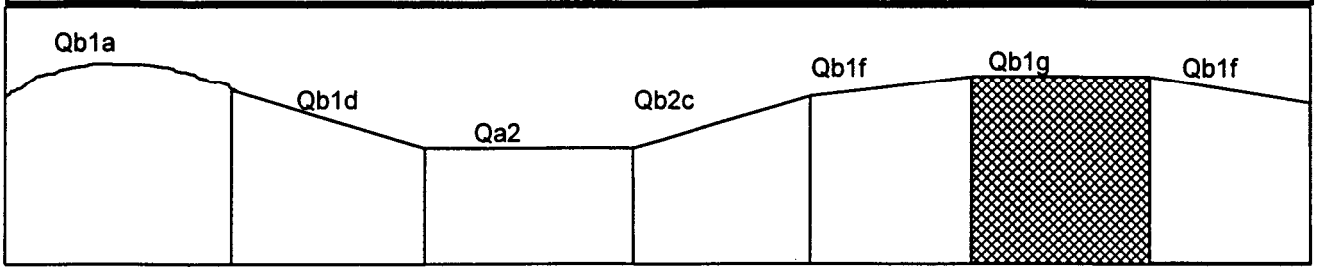
SOIL PROFILE CHARACTERISTICS:

Permeability: Moderate (average 130 mm/day, range 75-245 mm/day)
Available Water Capacity: Moderate (142 mm H_20)
Linear Shrinkage (B horizon): High (19%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_{3-4}$	Stone and gravel content
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Linear Shrinkage, suitability of subsoil, depth to hardrock, permeability
Secondary Roads	4	Proportion of stones and boulders, linear shrinkage
Rural Residential Development	4	Farm dams, Secondary roads, building foundations

MAP UNIT SYMBOL: **Qb1g** Area: 3605 ha	MAP UNIT: **Quaternary basalt, non cracking, very gentle slope**



A. GENERAL DESCRIPTION

The very gentle slopes of the Quaternary basalt often grade down to gentle slopes (4-10%). The soils of the non cracking very gentle slopes range from duplex (Chromosols) to gradational profiles (Dermosols), with a clay loam topsoil to a clay subsoil. A transitional horizon between the topsoil and subsoils is often present, which makes the profile gradational. Mottles may be present. The percentage of rock, stone and gravel is variable. Care must be taken when working on this map unit as cracking soils may be present.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating rises	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	2-20% (Variable)
Slope a) common:	2 %	**Depth to Hard Rock:**	>1.7 m
Slope b) range:	1-3 %		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Candlebark, Black Wattle, Silver Wattle	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Moderate	Very low	Low	Mod-high
Incidence	Low	Low	Low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K4

A1 0-20 cm Dark greyish brown (2.5Y4/2) loam to silty clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, pH 5.5. Clear transition to:

B1 20-40 cm Dark greyish brown (10YR4/2) coarse sandy clay to silty clay, weak to moderate subangular blocky structure, peds 5-10 mm, rough fabric, firm consistence, small to medium subrounded basaltic pebbles are common to abundant, pH 6.0. Clear transition to:

B21 40-75 cm Brown (10YR4/3) light clay, many fine, faint red and orange mottles, strong subangular blocky structure, peds 5-10 mm, smooth structure, small rounded and subrounded basaltic pebbles are common, pH 6.0. Clear transition to:

B22 75-95 cm Dark yellowish brown (10YR4/6) medium clay to heavy clay, moderate to strong subangular blocky structure, peds 10-20 mm, smooth fabric, firm consistence, large angular and rounded basaltic pebbles are common, pH 6.0. Diffuse transition to:

B3 95-130 cm Dark greyish brown (2.5Y4/2) medium to heavy clay, moderate subangular blocky structure, peds 5-10 mm, smooth fabric, very firm consistence, many large angular basaltic pebbles, pH 6.0. Diffuse transition to:

BC 130-170 cm Partially weathered basaltic rock

CLASSIFICATION

Factual Key:	Db2.11, Gn3.91/2 (major), Uf6.22/3 (minor)
Australian Soil Classification:	Mottled, Eutrophic, Brown CHROMOSOL; medium, gravelly, clay loamy / clayey, deep.
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.5	19	VL	M	S	S	T	H	VL
B1	5.0	20-70	VL	M	D	S	S	M	VL
B21	5.5	27	VL	M	D	D	S	VL	L
B22	5.7	17	VL	M	D	D	S	VL	L
B3	5.8	38	VL	M	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

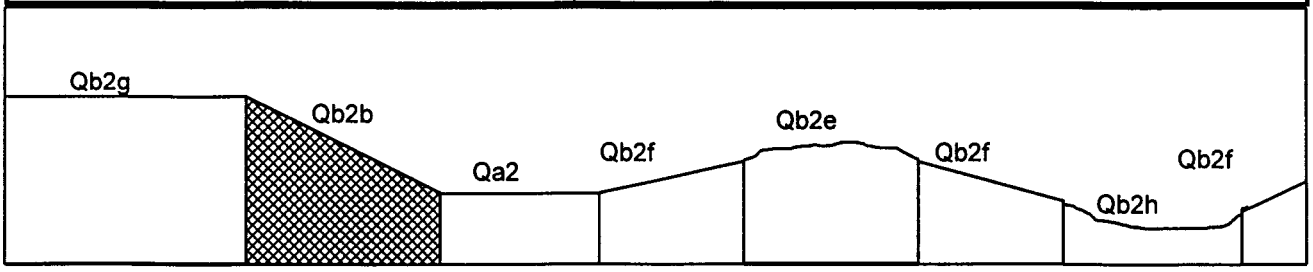
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 130 mm/day, 5-245 mm/day)
Available Water Capacity:	Moderate (132-141 mm H_20)
Linear Shrinkage (B horizon):	High (19%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_{3-4}$	Stone and gravel content
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Linear shrinkage, suitability of subsoil, permeability
Secondary Roads	4	Proportion of stones and boulders, linear shrinkage
Rural Residential Development	4	Building foundations, farm dams, secondary roads

MAP UNIT SYMBOL: **Qb2b(i)** Area: 38 ha (Qb2b)	MAP UNIT: **Quaternary basalt, cracking, steep slope**



A. GENERAL DESCRIPTION

This unit only comprises a small area of the former Shire. It is commonly found as down sloping land to the Campaspe River. Rock outcrop can be common. The soils are commonly uniform clays, which have a high water holding capacity. They are commonly cracking. The colour of the soil varies from very dark greyish brown to reddish brown. As there are two soil types present on the Quaternary basalt, this map unit is mapped generally as Qb2b.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Steep rises	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	10-20%
Slope a) common:	34%	**Depth Hard Rock:**	>0.8 m
Slope b) range:	>33		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very high	Low	Very low	High	Very Low	Low
Incidence	Low	Low	Very low	Low-mod	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A	0-10 cm	Dark brown (7.5YR4/2) silty clay light clay, moderate subangular blocky structure, smooth fabric, pH 6.0. Gradual transition to:
B2	10-35 cm	Dark brown (7.5YR4/2) light medium to heavy clay, strong subangular blocky structure, smooth fabric, pH 6.0. Gradual transition to:
B3	35-75^{+} cm	Susceptibllity.5YR4/2) medium clay, strong subangular blocky structure, smooth fabric, basaltic fragments are common.

CLASSIFICATION

Factual Key:	Ug5
Australian Soil Classification:	Haplic, ?, Grey DERMOSOL; medium, slightly gravelly, clayey / clayey, moderate / deep. Confidence level 4
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	6.0	NA	NA	NA	NA	NA	NA	NA	NA
B2	6.0	NA	NA	NA	NA	NA	NA	NA	NA
B3	NA	10-20	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

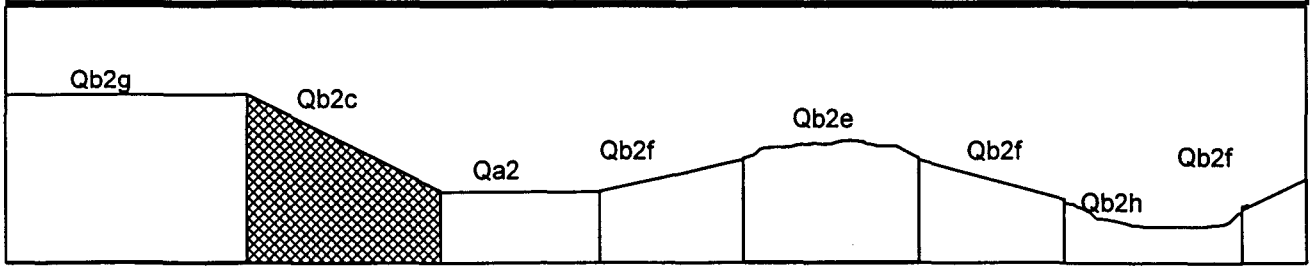
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate to slow (estimate)
Available Water Capacity:	Moderate (104-110 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_5S_5$	Slope, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope, suitability of subsoil
Secondary Roads	4	Susceptibility to slope failure, linear shrinkage
Rural Residential Development	5	Effluent disposal, farm dams, building foundations (slab)

MAP UNIT SYMBOL: **Qb2c(i)** Area: 145 ha (Qb2c)	MAP UNIT: **Quaternary basalt, cracking, moderately steep slope**



A. GENERAL DESCRIPTION

This map unit mainly consists of slopes leading to the Campaspe River and associated drainage lines. The soils are commonly gradational, with a clay loam topsoil and a clay subsoil. Depth of soil and the percentage of rock out crop is variable. As there are two soil types present on the Quaternary basalt, this map unit is mapped generally as Qb2c.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	10-20 %
Slope a) common:	25%	**Depth to Hard Rock:**	>0.6 m
Slope b) range:	21-32%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Mod-low	Moderate	Very low	Mod-high
Incidence	Low	Very low	Low	Low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A1	0-5 cm	Very dark brown (10YR2/2) loam to clay loam, moderate to strong subangular blocky structure, rough fabric, pH 7. Clear transition to:
B1	5-20 cm	Very dark brown (10YR2/2) clay loam to light clay, strong subangular blocky structure, smooth fabric, basaltic gravel fragments are common, pH 6.5. Clear transition to:
B2	20-60 cm	Black (10YR2/1) to dark brown (7.5YR4/2) coarse sandy clay to heavy clay, strong subangular blocky structure, smooth fabric, basaltic gravel fragments are common, pH 6.5. Gradual transition to:
BC	60 cm^{+}	Partially weathered basaltic rock

CLASSIFICATION

Factual Key:	Gn3.51(major), Ug5 (minor)
Australian Soil Classification:	Haplic, ?, Grey / black DERMOSOL; thin, non-gravelly, clay loamy / clayey, moderate. Confidence level 4
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_2O)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
Al	7.0	<2.0	NA	NA	NA	NA	NA	NA	NA
B1	6.5	10-20	NA	NA	NA	NA	NA	NA	NA
B2	6.5	10-20	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

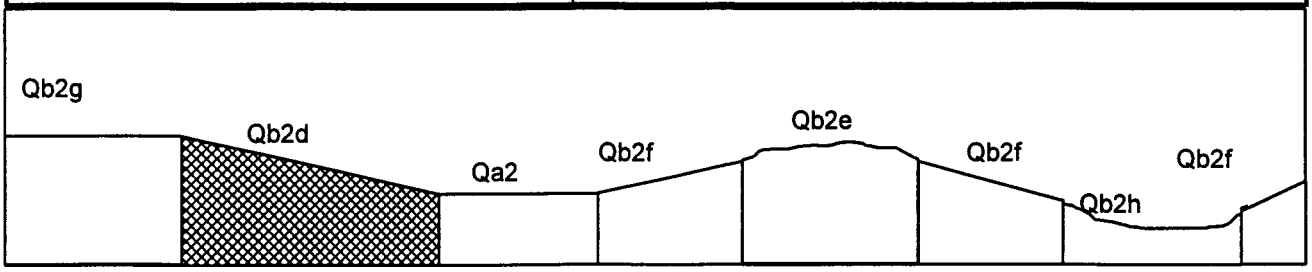
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate to slow (estimate)
Available Water Capacity:	Low (90 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, depth of topsoil, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope, suitability of subsoil
Secondary Roads	4	Slope, linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qb2d(i)** Area: 331 ha (Qb2d)	MAP UNIT: **Quaternary basalt, cracking, moderate slope**



A. GENERAL DESCRIPTION

This map unit mainly consists of slopes leading to the Campaspe River and associated drainage lines. The soils are commonly gradational, with a loam to clay loam topsoil and a clay subsoil, generally with a transitional horizon between the topsoil and the subsoil. Rock outcrop and the cracking characteristics of the subsoil occurs to varying degrees. As there are two soil types present on the Quaternary basalt, this map unit is mapped generally as Qb2d.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	10-20%
Slope a) common:	15%	**Depth to Hard Rock:**	>0.6 m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Mod-low	Moderate	Very low	High-mod
Incidence	Low	Low	Low	Low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A	0-5 cm	Very dark brown (10YR2/2) loam to clay loam, moderate to strong subangular blocky structure, rough fabric, pH 7.0. Clear transition to:
B1	5-20 cm	Very dark brown (10YR2/2) clay loam to light clay, strong subangular blocky structure, smooth fabric, basaltic gravel fragments are common pH 6.5. Clear transition to:
B2	20-60 cm	Black (10YR2/1) to dark brown (7.5YR4/2) coarse sandy clay to heavy clay, strong subangular blocky structure, smooth fabric, basaltic gravel fragments are common, pH 6.5. Gradual transition to:
BC	60^{+} cm	Partially weathered basaltic rock

CLASSIFICATION

Factual Key:	Gn3.51 (major), Ug5 (minor)
Australian Soil Classification:	Haplic, ?, Black DERMOSOL; thin, non-gravelly, clay loamy / clayey, moderate. Confidence level 4
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_2O)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	7.0	<2.0	NA	NA	NA	NA	NA	NA	NA
B1	6.5	10-20	NA	NA	NA	NA	NA	NA	NA
B2	6.5	10-20	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

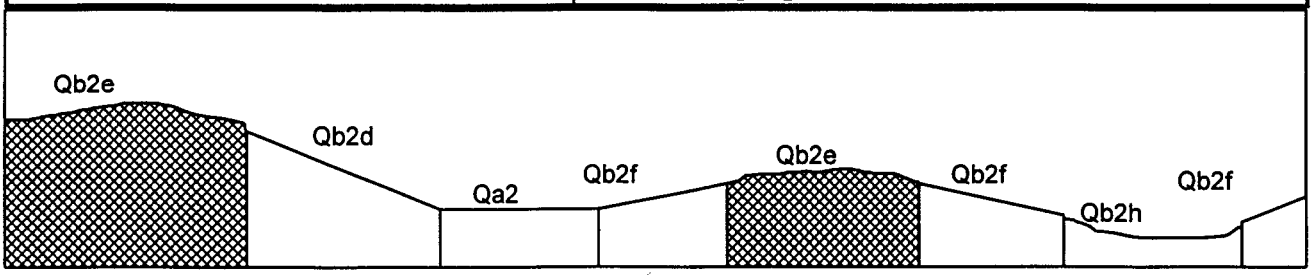
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate to slow (estimate)
Available Water Capacity:	Low (75-89 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, depth of topsoil, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	3	Slope, drainage, permeability
Farm Dams	5	Suitability of subsoil
Secondary Roads	4	Slope, linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qb2e(i)** Area: 37 ha (Qb2e)	MAP UNIT: **Quaternary basalt, cracking, gentle crest**



A. GENERAL DESCRIPTION

The cracking crests exist in association with the slopes consisting of cracking clays leading to the drainage depressions in the Malmsbury area. Rock outcrop is common. The crests are often very narrow and of low relief, therefore they are difficult to map accurately due to restrictions of scale, and when mapped they may be exaggerated in size. The topsoil can be self mulching and can range from a clay loam to a light clay. Colours range from brown to black. Mottles tend to be absent when the soils are a darker colour. Care must be taken when working with this map unit, as it is hard to distinguish between the non-cracking soils (Qb1e) and the self-mulching variant of this map unit (Qb2e(ii)). As there are two soil types present on this map unit, for the purpose of mapping they have been mapped generally are Qb2e. The land capability assessments depicted on the map are those pertaining to this soil type as it is dominant in the former Shire.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Imperfectly drained
Landform Element:	Crest	**Rock Outcrop:**	20-30 % (variable)
Slope a) common:	2%	**Depth to Hard Rock:**	>0.7m
Slope b) range:	0-5 %		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Low	Mod-low
Incidence	Low	Very low	Very low	Very low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A 0-10 cm — Very dark grayish brown (10YR3/2) clay loam to light clay, strong subangular blocky structure, peds 2-5 mm, (self mulching), rough fabric, a few basaltic gravel fragments, pH 5.5. Gradual transition to:

B1 10-20 cm — Dark greyish brown (10YR4/2) light medium clay, strong prismatic and columnar structure breaking down to subangular blocky structure, smooth fabric, pH 6.0. Clear transition to:

B21 20-55 cm — Brown (10YR4/3) heavy clay, strong prismatic and columnar structure breaking down to subangular blocky structure, smooth fabric, mottles are common, pH 6.5. Clear transition to:

B22 55-65^{+} cm — Brown (10YR5/3) heavy clay, strong prismatic and columnar structure, breaking down to subangular blocky structure, smooth fabric, many mottles, pH 7.0.

CLASSIFICATION

Factual Key:	Db2.12 (major) Ug6.13 (minor)
Australian Soil Classification:	Mottled, ?, Black DERMOSOL; medium, non-gravelly, clay loamy / clayey, moderate / deep
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
Al	5.5	0	VL	VH	D	D	S	H	VL
B1	6.0	10	VL	VH	D	D	S	M	VL
B21	6.5	2	VL	VH	D	S	S	L	VL
B22	7.0	2	VL	VH	D	S	S	L	VL

VL: Very Low L: Low H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

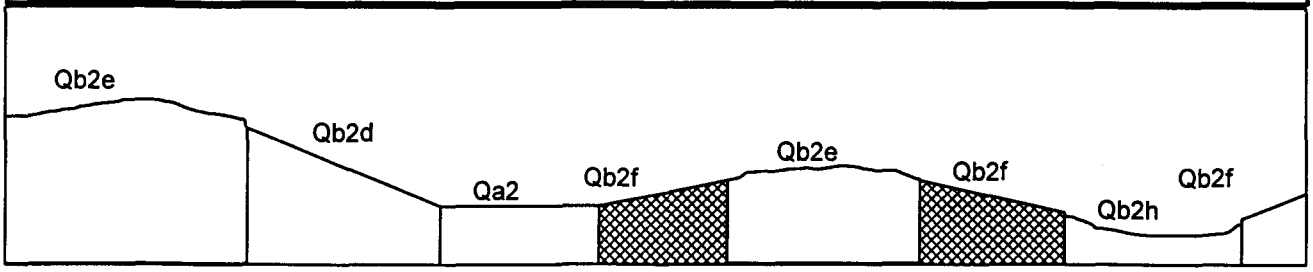
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow to slow (estimate)
Available Water Capacity:	Moderate (104-110 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_4$	Boulder content (variable)
Effluent Disposal (septic tanks)	4	Permeability, drainage
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, proportion of stones and boulders, linear shrinkage
Rural Residential Development	4	Effluent disposal, farm dams, secondary roads, building foundations

MAP UNIT SYMBOL: **Qb2f(i)** Area: 655 ha (Qb2f)	MAP UNIT: **Quaternary basalt, cracking, gentle slope**



A. GENERAL DESCRIPTION

This map unit commonly occurs in association with drainage depressions around the Malmsbury area. The soils have clayey subsoils, commonly with a thin self-mulching topsoil. Large cracks are common on the surface due to the high linear shrinkage of the subsoil. Although the soils are very fertile, the high clay percentage in the subsoil impedes root access, and limits agricultural production to grazing. Therefore, although impenetrable subsoils is not a parameter in the Land Capability Ratings Table for agriculture, in this instance it is the major limitation along with the shallow topsoil. As there are two soil types present on this map unit, for the purpose of mapping they have been mapped generally as Qb2f. The land capability assessments depicted on the map are those pertaining to this soil type as it is dominant in the former Shire.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Undulating rises	**Drainage:**	Imperfectly drained
Landform Element:	Hill slope	**Rock Outcrop:**	10 -20 %
Slope a) common:	5%	**Depth to Hard Rock:**	>1.4 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Low	Low
Incidence	Low	Very low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K2

A1 0-10 cm — Black (2.5 YR2.5/0) medium clay, strong, subangular blocky structure, self-mulching, peds 5-10 mm, smooth fabric, strong consistence, pH 6.0. Clear transition to:

B21 10-30 cm — Black (2.5YR3/0) medium to heavy clay, strong prismatic and columnar structure, peds 200 -500 mm, breaking down to subangular blocky structure, smooth fabric, strong consistence, pH 6.5. Gradual transition to:

B22 30-90 cm — Black (2.5YR2.5/0) medium to heavy clay, strong prismatic and columnar structure, peds 200 -500 mm, breaking down to angular blocky structure, smooth fabric, strong consistence, few carbonate nodules, pH 7.0. Gradual transition to:

B3	90-120 cm	Grey (10YR5/1) light clay, strong subangular blocky structure, peds 200-500 mm, rough fabric, very firm consistence, many fine subangular basaltic gravel fragments, pH 8.5. Gradual transition to:
C	120-140^{+} cm	Weathered basaltic rock

CLASSIFICATION

Factual Key:	Ug5.14
Australian Soil Classification:	Haplic, Self-mulching, Black VERTOSOL; Non-gravelly, medium fine / medium fine, deep.
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.7	0	VL	VH	D	D	S	H	VL
B21	6.5	10	VL	VH	D	D	S	M	VL
B22	5.4	2	VL	VH	D	S	S	H	
B3	7.4	30	VL	VH	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

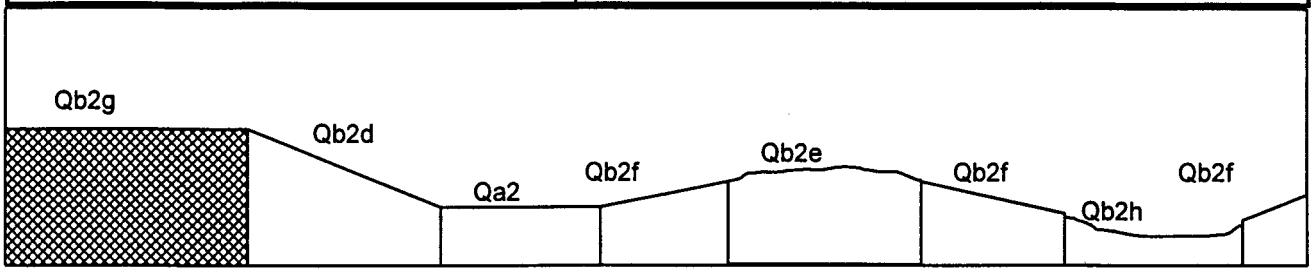
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow (estimate)
Available Water Capacity:	Moderate (142 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_3S_4$	Impenetrable subsoil, depth of topsoil
Effluent Disposal (septic tanks)	5	No. of months/year when average daily rainfall>Ksat, permeability
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, linear shrinkage
Rural Residential Development	5	Effluent disposal

MAP UNIT SYMBOL: **Qb2g(i)** Area: 663 ha (Qb2g)	MAP UNIT: **Quaternary basalt, cracking, very gentle slope**



A. GENERAL DESCRIPTION

This map unit commonly occurs in association with the major drainage depressions and creeks in the basalt landscape around Malmsbury. Black cracking clays (Vertosols) predominate. The soil is intrinsically highly fertile, but the high clay percentage in the subsoil restricts agricultural land use to grazing, as it is difficult for roots to penetrate the subsoil. Although impenetrable clay subsoil is not a parameter in the Land Capability Ratings Tables for agriculture, in this instance it is the major limitation along with the shallow topsoil. Rock outcrop occurs to varying degrees. As there are two soil types present on this map unit, for the purpose of mapping they have been mapped generally are Qb2g. The land capability assessments depicted on the map are those pertaining to this soil type as it is dominant in the former Shire.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Low
Landform Pattern:	Lava plain	**Drainage:**	Imperfectly drained
Landform Element:	Hill slope	**Rock Outcrop:**	2-10%
Slope a) common:	3%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Low	Low
Incidence	Low	Very low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K2

A1 0-10 cm — Black (2.5 YR2.5/0) medium clay, strong subangular blocky structure, self-mulching, peds 5-10 mm, smooth fabric, strong consistence, pH 6.0. Clear transition to:

B21 10-30 cm — Black (2.5YR2.3/0) medium to heavy clay, strong prismatic and columnar structure, peds 200-500 mm, breaking down to subangular blocky structure, smooth fabric, strong consistence, pH 6.5. Gradual transition to:

B22 30-90 cm — Black (2.5YR2.5/0) medium to heavy clay, strong prismatic and columnar structure, peds 200 - 500 mm, breaking down to angular blocky structure, smooth fabric, strong consistence, very few carbonate nodules, pH 7.0. Gradual transition to:

B3	90-120 cm	Grey (10YR5/1) light clay, strong subangular blocky structure, peds 200-500 mm, rough fabric, very firm consistence, many fine subangular basaltic gravel fragments, pH 8.5. Gradual transition to:
C	120-140^{+} cm	Weathered basaltic rock

CLASSIFICATION

Factual Key:	Ug5.14
Australian Soil Classification:	Haplic, Self-mulching, Black VERTOSOL; Non-gravelly, medium fine / medium fine, deep.
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.7	0	VL	VH	D	D	S	H	VL
B21	6.5	10	VL	VH	D	D	S	M	VL
B22	5.4	2	VL	VH	D	S	S	H	L
B3	7.4	30	VL	VH	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

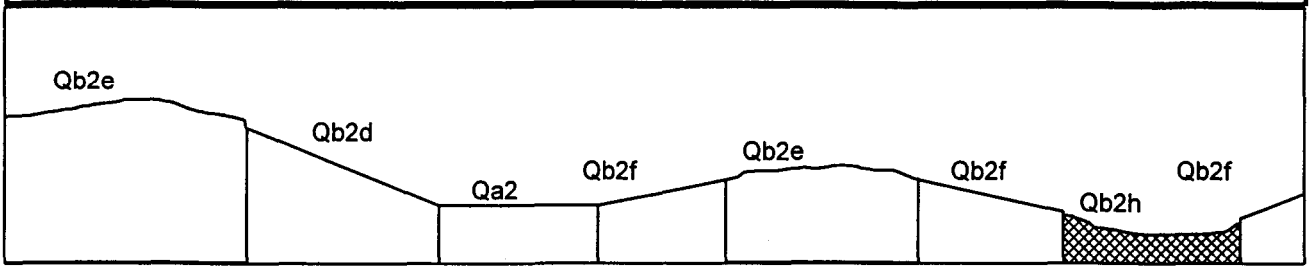
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow (estimate)
Available Water Capacity:	Moderate (144 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_4$	Impenetrable subsoil, depth of topsoil
Effluent Disposal (septic tanks)	5	No. of months/year when average daily rainfall > Ksat, permeability
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, linear shrinkage
Rural Residential Development	5	Effluent disposal

MAP UNIT SYMBOL: **Qb2h(i)** Area: 922 ha (Qb2h)	MAP UNIT: **Quaternary basalt, cracking, drainage depression**



A. GENERAL DESCRIPTION

The soils of the drainage depressions in the basalt are commonly black cracking clays (Vertosols). There is often a shallow self mulching topsoil and a clayey subsoil composed of large prismatic or columnar peds, and have large cracks during summer. The high clay percentage in the subsoil, makes it difficult for plant roots to penetrate the subsoil, therefore although this is not a perimeter in the Land Capability Ratings Table for agriculture, this combined with the shallow subsoil is the major limitation for agricultural productions. There are few drainage depressions dissecting the cracking basalt soils, due to low runoff and high infiltration rates during the first winter rains. Consequently, there are few dams throughout this landscape.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>1.4 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	High
Landform Pattern:	Lava plain	**Drainage:**	Imperfectly drained
Landform Element:	Drainage depression	**Rock Outcrop:**	>2%
Slope a) common:	3%	**Depth to Hard Rock:**	>1.5m
Slope b) range:	1-5%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Low	Low
Incidence	Low	Low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K2

A1 0-10 cm — Black (2.5 YR2.5/0) medium clay, strong, subangular blocky structure, self-mulching, peds 5-10 mm, smooth fabric, strong consistence, pH 6.0. Clear transition to:

B21 10-30 cm — Black (2.5YR2.3/0) medium to heavy clay, strong prismatic and columnar structure, peds 200-500 mm, breaking down to subangular blocky structure, smooth fabric, strong consistence, pH 6.5. Gradual transition to:

B22 30-90 cm — Black (2.5YR2.5/0) medium to heavy clay, strong prismatic and columnar structure, peds 200-500 mm, breaking down to angular blocky structure, smooth fabric, strong consistence, very few carbonate nodules, pH 7.0. Gradual transition to:

B3 90-120 cm Grey (10YR5/1) light clay, strong subangular blocky structure, peds 200-500 mm, rough fabric, very firm consistence, pH 8.5. Gradual transition to:

C 120-140^{+} cm Weathered basaltic rock

CLASSIFICATION

Factual Key: Ug5.14
Australian Soil Classification: Haplic, Self-mulching, Black VERTOSOL; Non-gravelly, medium fine / medium fine, deep.
Unified Soil Group: CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
Al	5.7	0	VL	VH	D	D	S	H	VL
B21	6.5	10	VL	VH	D	D	S	M	VL
B22	5.4	2	VL	VH	D	S	S	H	L
B3	7.4	30	VL	VH	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

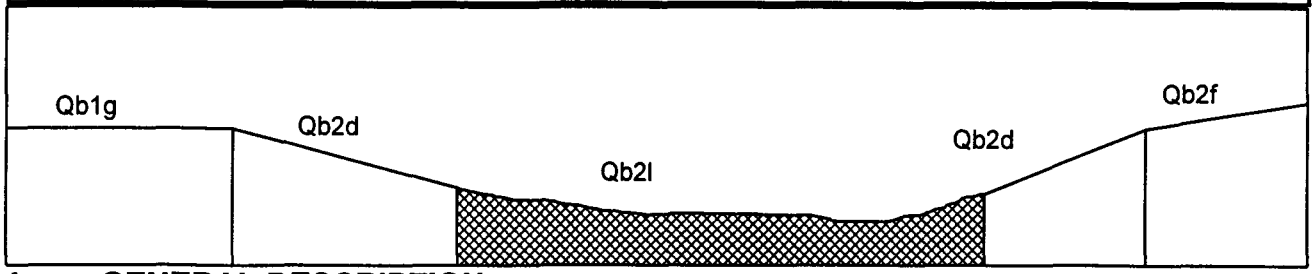
SOIL PROFILE CHARACTERISTICS:

Permeability: Very slow (estimate)
Available Water Capacity: Moderate (144 mm H_20)
Linear Shrinkage (B horizon): High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_4$	Impenetrable subsoil, depth of topsoil
Effluent Disposal (septic tanks)	5	No. of months/year when average daily rainfall > Ksat, permeability
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, linear shrinkage, flood risk
Rural Residential Development	5	Effluent disposal, building foundations

MAP UNIT SYMBOL: **Qb2l** Area: 136 ha	MAP UNIT: **Quaternary basaltic, cracking, former lake bed**



C . GENERAL DESCRIPTION

This map unit consists of old dry lake beds, originating from the Campaspe River, found predominantly around Malmsbury. The depressions are seasonally waterlogged, and the soils are seasonally cracking and are depositional. The major limitation is the shallow depth of the watertable, which can be less than 50 cm of the surface during the winter months.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>50 cm
Parent Material Lithology:	Basaltic colluvial/alluvial	**Flooding Risk:**	High
Landform Pattern:	Lava Plain	**Drainage:**	Imperfectly drained
Landform Element:	Drainage depression	**Rock Outcrop:**	0%
Slope a) common:	1%	**Depth to Hard Rock:**	>1.7 m
Slope b) range:	0-1%		
Potential Recharge to Groundwater:		Low	
Major Native Vegetation Species:		*Juncus sp*	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Very low	Low	Mod-low	High
Incidence	Very low	Low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site 3

A1	0-16 cm	Very dark greyish brown (10YR3/2) loam, moderate to strong subangular blocky structure, self-mulching, peds, 2-5 mm, rough fabric, firm consistence, pH 6.0. Clear transition to:
B1	16-47 cm	Dark grey (10YR4/1) light clay, moderate to strong subangular blocky structure, peds, 200-500 mm, smooth fabric, strong consistence, pH 6.0. Gradual transition to:
B21	47-115 cm	Dark grey (10YR4/1) medium clay, strong prismatic and columnar structure, breaking down to subangular blocky structure, peds 200-500 m smooth fabric, strong consistence, pH 7.0. Clear transition to:
B22	115-145 cm	Brown (10YR5/3) heavy clay, many coarse faint yellow mottles, moderate subangular blocky structure, peds 50-100 mm, smooth fabric, very firm consistence, a few calcareous nodules, pH 8.5. Gradual transition to:
BC	145-170^{+}cm	Partially weathered basaltic rock, pH 8.5.

CLASSIFICATION

Factual Key:	Dy 3.13
Australian Soil Classification:	Vertic/sodic, Chromsolic, Oxyaquic HYDROSOL; Medium, non-gravelly, loamy / clayey, deep.
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.8	0	VL	M	S	S	S	H	VL
B1	5.1	6	VL	H	D	D	S	L	VL
B21	5.9	5	VL	H	D	D	S	L	M
B22	7.3	16	M	VH	D	D	S	VL	H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

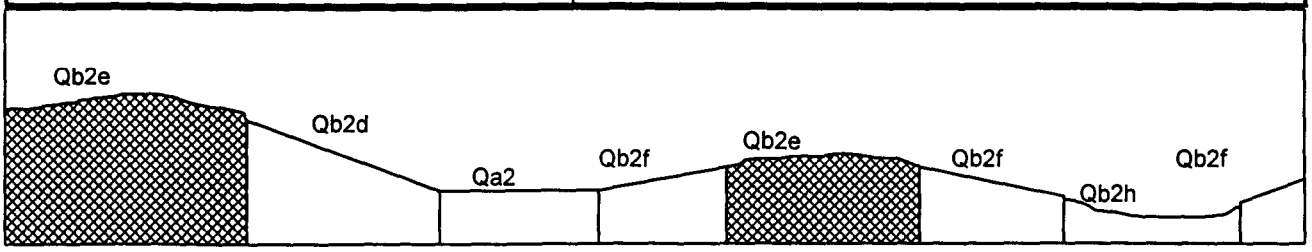
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow (estimate)
Available Water Capacity:	High (194 mm H_20)
Linear Shrinkage (B horizon):	High (18%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_2T_2S_5$	Depth to seasonal watertable
Effluent Disposal (septic tanks)	5	No. of months/year when average daily rainfall > Ksat, depth to seasonal watertable, permeability
Farm Dams	5	Depth to seasonal watertable
Secondary Roads	5	Depth to seasonal watertable
Rural Residential Development	5	Effluent disposal, building foundations, farm dams, secondary roads

MAP UNIT SYMBOL:**Qb2e(ii)** Area: 37 ha (Qb2e)	MAP UNIT: **Quaternary basalt, cracking, gentle crest**



A. GENERAL DESCRIPTION

Two soil types can be found on this map unit. Most of the soils have obvious cracking (Vertosols) (Qb2e(i)), although there are some which have the cracking characteristics in the subsoil, but have a self mulching topsoil (Chromosols) as described in this map unit description. Once this very friable topsoil is disturbed, it is very easily eroded, and therefore cracks occur on the surface. As this soil is very hard to distinguish throughout the area, some areas which may have this soil type could have been mapped as Qb1e. For the purpose of mapping, this soil type has been mapped generally a Qb2e, and the land capability assessments depicted on the maps have been based on the Qb2e(i) soil type, as it predominates in the former Shire. The land capability ratings for this soil type are written in the legend, although more detailed information can be found the report. This soil type commonly occurs around the Malmsbury area in association with drainage depressions and black cracking clays (Vertosols). The soils are initially very well drained, as rainfall easily percolates through the strongly structured topsoil, and seep through the cracks in the subsoil before they have closed. Once the subsoil has had sufficient water to swell the clay, the drainage becomes very poor. Once the clay subsoil is saturated, an impermeable layer is formed. During exceptionally wet winters, water may flow above the impermeable clay and form seeps down the slope.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava plain	**Drainage:**	Imperfectly drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	0-3%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	2%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Low	Moderate
Incidence	Low	Very low	Very low	Very low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K1

A11 0-10 cm — Very dark brown (10YR2/2) to dark brown (7.5YR 3/2) clay loam, self mulching, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, very few small, subangular basaltic pebbles, pH 6.0. Clear transition to:

AI2 10-20 cm — Very dark brown (10YR2/2) to dark brown (7.5YR3/2) clay loam, self mulching, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, a few, medium subangular basaltic pebbles, pH 6.0. Clear transition to:

B1 20-45 cm — Very dark greyish brown (10YR3/2) light gray strong subangular blocky structure, peds 2-5 mm, smooth fabric, firm consistence, small to medium angular and subangular basaltic pebbles are common, pH 6.5. Gradual transition to:

B21 45-70 cm — Very dark greyish brown (10YR3/2) light medium to medium clay, very few fine faint red mottles, strong prismatic and columnar structure, peds >500 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, very few medium subangular basaltic pebbles and carbonate nodules, pH 7.25. Gradual transition to:

B22 70-80 cm — Dark greyish brown (2.5Y412) light medium to heavy clay, very few fine faint red and yellow mottles, strong prismatic and columnar structure, peds 20-50 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, medium subangular basaltic pebbles are common, very few carbonate nodules, pH 8.5. Clear transition to:

B23 80-100 cm — Greyish brown (2.5Y5/2) medium to heavy clay, medium, distinct orange and gleyed mottles are common, strong prismatic and columnar structure, peds 20-50 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, very few fine subangular basaltic pebbles and carbonate nodules, pH 8.5. Gradual transition to:

BC 100-150^{+} cm — Partially weathered basaltic rock.

CLASSIFICATION

Factual Key:	Dy 3.12, Gn3.92
Australian Soil Classification:	Melanic-Vertic, Hypocalcic, Black CHROMOSOL; medium, slightly gravelly, clay loamy / clayey, deep.
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.7	4	VL	M	D	S	S	H	VL
A12	5.0	15	VL	M	D	D	S	H	L
B1	5.8	6	VL	H	D	D	S	M	L
B21	6.8	9	VL	VH	D	D	S	L	L
B22	7.1	8	VL	VH	D	D	S	L	L
B23	7.1	2	VL	VH	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

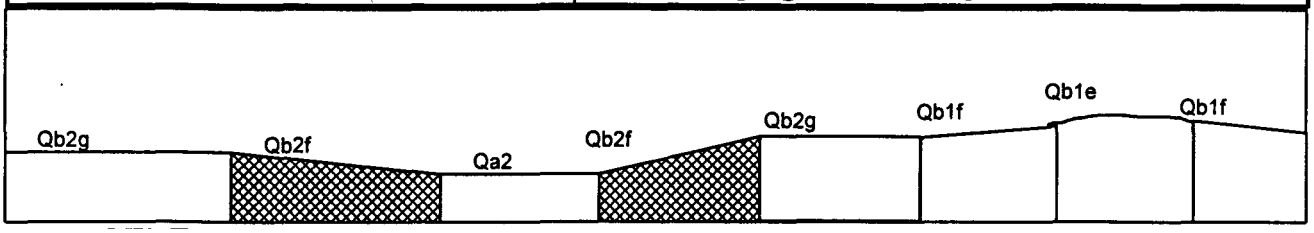
SOIL PROFILE CHARACTERISTICS:

Permeability:	Very slow to slow (average 10 mm/day; range 0-30 mm/day)
Available Water Capacity:	Moderate (142 mm H_2O)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Growing season, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	4	Drainage, permeability
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, linear shrinkage
Rural Residential Development	4	Building foundations, effluent disposal, farm dams, secondary roads

MAP UNIT SYMBOL: **Qb2f(ii)** Area: 655 ha (Qb2f)	MAP UNIT: **Quaternary basalt, cracking, gentle slope**



A. GENERAL DESCRIPTION

Two soil types can be found on this map unit. Most of the soils are obviously cracking (Vertosols, Qb2f(i)), although there are some which do have the cracking characteristics in the subsoil, but have a self-mulching topsoil (Chromosols), as described in this map unit description. Once this very friable topsoil is disturbed, it is very easily eroded, and therefore cracks occur on the exposed surface. As this soil is very had to distinguish throughout the area, some areas which may have this soil type could have been mapped out as Qb1f. For the purpose of mapping, this soil type has been mapped generally as Qb2f, and the land capability assessment depicted on the maps have been base on the Qb2f(i) soil type, as it predominates in the former Shire. The land capability ratings for this soil type are written in the legend, although more detailed information can be found in the report. This soil type commonly occurs around the Malmsbury area in association with drainage depressions and black cracking clays (Vertosols). The soils are initially very well drained, as rainfall easily percolates through the strongly structured topsoil, and seep through the cracks in the subsoil before they close. Once the subsoil has had sufficient water to swell the clay, the drainage becomes very poor. Once the clay subsoil is saturated, an impermeable layer is formed. During exceptionally wet winters, water may flow above the impermeable clay and form seeps down the slopes.

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Imperfectly drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	5%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Very low	Very low	Low	Moderate
Incidence	Low	Low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K1

A11 0-10 cm — Very dark brown (10YR2/2) to dark brown (7.5YR 3/2) clay loam, self mulching, strong subangular medium structure, peds 2-5 mm, rough fabric, firm consistence, very few small, subangular basaltic pebbles, pH 6.0. Clear transition to:

A12 10-20 cm — Very dark brown (10YR2Llthology:k brown (7.5YR3/2) clay loam, self mulching, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, a few, medium subangular basaltic pebbles, pH 6.0. Clear transition to:

B1 20-45 cm — Very dark greyish brown (10YR3/2) light clay strong subangular blocky structure, peds 2-5 mm, smooth fabric, firm consistence, small to medium angular and subangular basaltic pebbles are common, pH 6.5. Gradual transition to:

B21 45-70 cm — Very dark greyish brown (10YR3/2) light medium to medium clay, very few fine faint red mottles, strong prismatic and columnar structure, peds >500 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, very few medium subangular basaltic pebbles and carbonate nodules, pH 7.25. Gradual transition to:

B22 70-80 cm — Dark greyish brown (2.5Y4/2) light medium to heavy clay, very few fine faint red and yellow mottles, strong prismatic and columnar structure, peds 20-50 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, medium subangular basaltic pebbles are common, very few carbonate nodules, pH 8.5. Clear transition to:

B23 80-100 cm — Greyish brown (2.5Y5/2) medium to heavy clay, medium, distinct orange and gleyed mottles are common, strong prismatic and columnar structure, peds 20-50 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, very few fine subangular basaltic pebbles and carbonate nodules, pH 8.5. Gradual transition to:

BC 100-150^{+} cm — Partially weathered basaltic rock.

CLASSIFICATION

Factual Key:	Dy3.12, Gn3.92
Australian Soil Classification:	Melanic-Vertic, Hypocalcic, Black CHROMOSOL; medium, slightly gravelly, clay loamy / clayey, deep.
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.7	4	VL	M	D	S	S	H	VL
A12	5.0	15	VL	M	D	D	S	H	L
B1	5.8	6	VL	H	D	D	S	M	L
B21	6.8	9	VL	VH	D	D	S	L	L
B22	7.1	8	VL	VH	D	D	S	L	L
B23	7.1	2	VL	VH	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

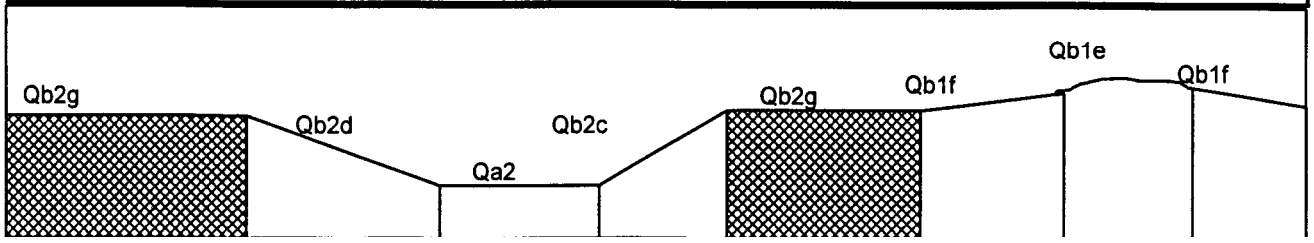
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow to very slow (average 10 mm/day, range 0-30 mm/day)
Available Water Capacity:	Moderate (142 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_3S_3$	Growing season, slope, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	4	Drainage, permeability
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, linear shrinkage
Rural Residential Development	4	Effluent disposal, farm dams, secondary roads, building foundations

MAP UNIT SYMBOL: **Qb2g(ii)** Area: 663 ha (Qb2g)	MAP UNIT: **Quaternary basalt, cracking, very gentle slope**



A. GENERAL DESCRIPTION

Two soil types can be found on this map unit. Most of the soils are obviously cracking (Vertosols Qb2g(i)), although there are some which do have the cracking characteristics in the subsoil, but have a self mulching topsoil (Chromosols) as described in this map unit description. Once this very friable topsoil is disturbed, it is very easily eroded, and therefore cracks occur on the exposed surface. As this soil is very hard to distinguish throughout the area, some areas which may have this soil type could have been mapped out as Qb1g. For the purpose of mapping, this soil type has been mapped generally a Qb2g, and the land capability assessments depicted on the maps have been based on the Qb2g(i) soil type, as it predominates in the former Shire. The land capability ratings for this soil type are written in the legend, although more detailed information can be found in the report. This soil type commonly occurs around the Malmsbury area in association with drainage depressions and black cracking clays (Vertosols). The soils are initially very well drained, as rainfall easily percolates through the strongly structured topsoil, and seep through the cracks in the subsoil before they close. Once the subsoil has had sufficient water to swell the clay, the drainage becomes very poor. Once the clay subsoil is saturated, an impermeable layer is formed. During exceptionally wet winters, water may flow above the impermeable clay and form seeps down the slope.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Basalt	**Flooding Risk:**	Low
Landform Pattern:	Lava plain	**Drainage:**	Imperfectly drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	3%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:		Moderate to low	
Major Native Vegetation Species:		Manna Gum, Swamp Gum	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Very low	Very low	Very low	Low	Moderate
Incidence	Low	Low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K1

A11 0-10 cm Very dark brown (10YR2/2) to dark brown (7.5YR 3/2) clay loam, self-mulching, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, very few small, subangular basaltic pebbles, pH 6.0. Clear transition to:

A12 10-20 cm Very dark brown (10YR2/2) to dark brown (7.5YR3/2) clay loam, self-mulching, strong subangular blocky structured, peds 2-5 mm, rough fabric, firm consistence, a few, medium subangular basaltic pebbles, pH 6.0. Clear transition to:

B1 20-45 cm — Very dark greyish brown (10YR3/2) light clay strong subangular blocky structure, peds 2-5 mm, smooth fabric, firm consistence, small to medium angular and subangular basaltic pebbles are common, pH 6.5. Gradual transition to:

B21 45-70 cm — Very dark greyish brown (10YR3/2) light medium to medium clay, very few fine faint red mottles, strong prismatic and columnar structure, peds >500 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, very few medium subangular basaltic pebbles and carbonate nodules, pH 7.25. Gradual transition to:

B22 70-80 cm — Dark greyish brown (2.5Y4/2) light medium to heavy day, very few fine faint red and yellow mottles, strong prismatic and columnar structure, peds 20-50 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, medium subangular basaltic pebbles are common, very few carbonate nodules, pH 8.5. Clear transition to:

B23 80-100 cm — Greyish brown (2.5Y5/2) medium to heavy clay, medium, distinct orange and gleyed mottles are common, strong prismatic and columnar structure, peds 20-50 mm, breaking down to subangular blocky structure, smooth fabric, very strong consistence, very few fine subangular basaltic pebbles and carbonate nodules, pH 8.5. Gradual transition to:

BC 100-150^{+} cm — Partially weathered basaltic rock.

CLASSIFICATION

Factual Key:	Gn3.92, Dy3.12 (major)
Australian Soil Classification:	Melanic-Vertic, Hypocalcic, Black CHROMOSOL; medium, slightly gravelly, clay loamy / clayey, deep.
Unified Soil Group:	CH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.7	4	VL	M	D	S	S	H	VL
A12	5.0	15	VL	M	D	D	S	H	L
B1	5.8	6	VL	H	D	D	S	M	L
B21	6.8	9	VL	VH	D	D	S	L	L
B22	7.1	8	VL	VH	D	D	S	L	L
B23	7.1	2	VL	VH	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

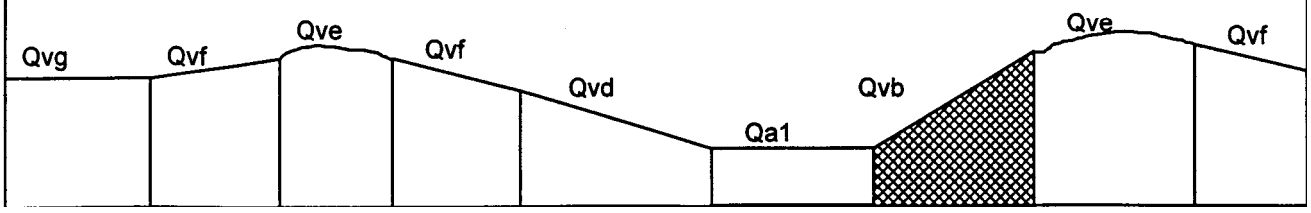
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow to very slow (average 10 mm/day, range 0-30 mm/day)
Available Water Capacity:	Moderate (142 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Growing season, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	4	Drainage, permeability
Farm Dams	4	Linear shrinkage, suitability of subsoil
Secondary Roads	4	Drainage, linear shrinkage
Rural Residential Development	4	Effluent disposal, farm dams, secondary roads, building foundations

MAP UNIT SYMBOL: **Qvb** Area: 79 ha	MAP UNIT: **Quaternary volcanic, steep slope**



A. GENERAL DESCRIPTION

This map unit only constitutes a small percentage of the Shire. It often occurs as the down cutting slopes to the Coliban River, and reservoirs. The soils are often shallow and not very developed due to the high runoff rate. The steep slopes often occur close to the transition between the volcanic flow and the sedimentary material, therefore the depth to hard rock can be variable, depending of the depth of the volcanic flow. Underlying weathered sedimentary material can occur as shallow as 0.5 m.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable**	>5.0 m
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Nil
Landform Pattern:	Steep low hills	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	35%	**Depth to Hard Rock:**	>0.7 m (variable)
Slope b) range:	32-50%		
Potential Recharge to Groundwater:		Very high	
Major Native Vegetation Species:		Manna Gum, Silver Wattle, Narrow-leaved Peppermint, Bracken Fem	
Present Land Use:		Grazing, public land	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very high	Moderate	Mod-low	Moderate	Very low	Moderate
Incidence	Low	Low	Low	Moderate	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A1 0-16 cm — Dark reddish brown (5YR3/2) loam to sandy clay loam, moderate subangular blocky structure, rough fabric, a few subangular basaltic gravel fragments, pH 6.5. Gradual transition to:

B21 16-33 cm — Dark reddish brown (5YR3/2) fine sandy clay to light clay, moderate subangular blocky structure, smooth fabric, many subangular volcanic gravel fragments, pH 6.5. Gradual transition to:

B22 33-70 — Dark reddish brown (5YR3/2AcidlficationcSusceptlbllitylay, moderate subangular blocky structure, smooth fabric, many subangular volcanic gravel fragments, pH 6.0.

CLASSIFICATION

Factual Key:	Gn3.41, Gn4.41
Australian Soil Classification:	Haplic, Eutrophic, Black DERMOSOL; medium, slightly gravelly, clay loamy / clayey, moderate-deep
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	6.5	2-10	VL	M	D	S	S	H	VL
B21	6.5	20-50	VL	M	D	S	S	VL	L
B22	6.0	20-50	VL	M	D	S	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

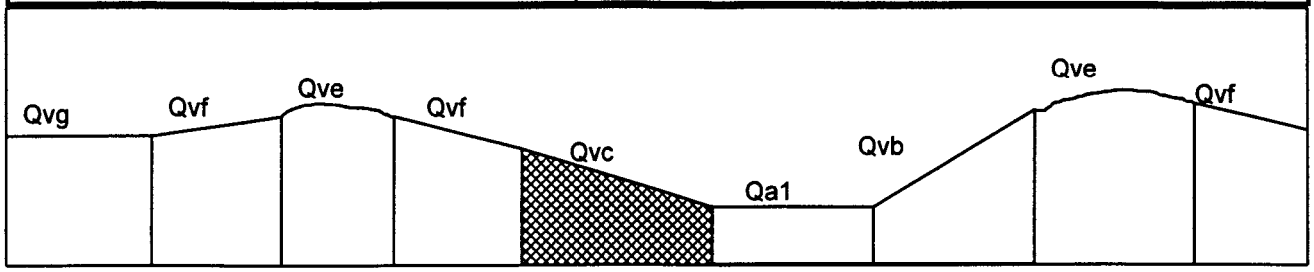
SOIL PROFILE CHARACTERISTICS:

Permeability:	Excessive (estimate)
Available Water Capacity:	Low (68-75 mm H_20)
Linear Shrinkage (B horizon):	Moderate (estimate)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_5S_5$	Slope, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope, suitability of subsoil, excessive permeability
Secondary Roads	5	Slope
Rural Residential Development	5	Effluent disposal, farm dams, Secondary roads, building foundations (slab)

MAP UNIT SYMBOL: **Qvc** Area: 276 ha	MAP UNIT: **Quaternary volcanic, moderately steep slope**



A. GENERAL DESCRIPTION

This map unit only constitutes a small percentage of the Shire. It often occurs as the down cutting slopes to the Coliban River and reservoirs. They often occur close to the transitional zone between the volcanic lithology and the sedimentary. Depth to hardrock is variable depending on the depth of the volcanic flow. Underlying weathered sedimentary rock can occur as shallow as 0.5 metres.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills / lava plain	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	25%	**Depth to Hard Rock:**	>0.8 m (variable)
Slope b) range:	21-32%		

Potential Recharge to Groundwater:	Very high
Major Native Vegetation Species:	Manna Gum, Silver Wattle, Narrow-Leaved Peppermint, Bracken Fern
Present Land Use:	Grazing, public land
Length of Growing Season:	6 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Moderate	Very low	Moderate	Very low	Moderate
Incidence	Low	Low	Very low	Low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A	0-13 cm	Dark reddish brown (5YR3/2) coarse sandy clay loam to clay loam, strong subangular blocky structure, smooth fabric a few volcanic basaltic fragments, pH7.0. Gradual transition to:
B1	13-27 cm	Dark reddish brown (5YR3/3) sandy clay to light clay, moderate to strong subangular blocky structure, smooth fabric, basaltic fragments are common, pH 6.5. Clear transition to:
B21	27-46 cm	Dark reddish brown (5YR3/3) light medium clay, strong subangular blocky structure, smooth fabric, basalt fragments are common, pH 5.5. Gradual transition to:
B3	46-68 cm	Dark reddish brown (5YR3/3) light clay, moderate subangular blocky structure, smooth fabric, basalt fragments are common, pH 5.0. Clear transition to:
BC	68-80^{+} cm	Partially weathered basaltic rock, pH 5.0.

CLASSIFICATION

Factual Key:	Gn3.11, Dr2.12
Australian Soil Classification:	Haplic, Eutrophic, Red FERROSOL; medium, slightly gravelly, clay loamy / clayey, moderate-deep
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	7.0	2-10	VL	M	D	S	T	H	VL
B1	6.5	10-20	VL	M	D	S	S	VL	L
B21	5.5	10-20	VL	M	D	S	S	VL	L
B3	5.0	10-20	VL	M	D	S	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

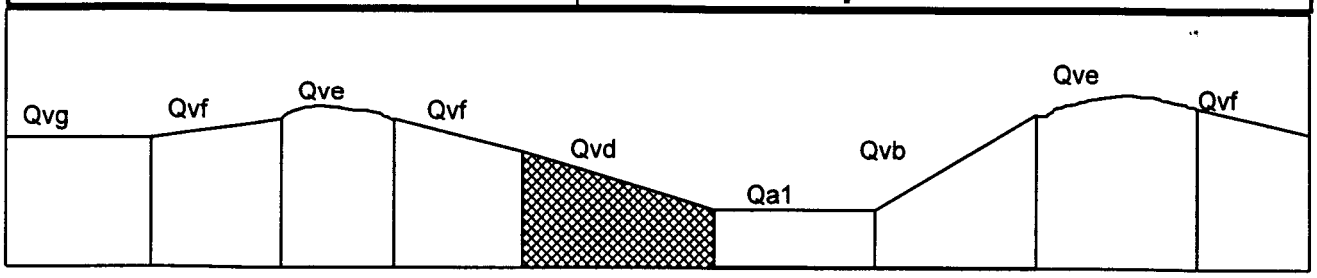
SOIL PROFILE CHARACTERISTICS:

Permeability:	Excessive (estimate)
Available Water Capacity:	Low (90-95 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, available water capacity, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	4	Slope
Farm Dams	5	Slope, suitability of subsoil, excessive permeability
Secondary Roads	4	Slope, linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qvd** Area: 630 ha	MAP UNIT: **Quaternary volcanic, moderate slope**



A. GENERAL DESCRIPTION

The depth to hardrock in this map unit is variable. Volcanic rocks can occur throughout the profile. The soil commonly have a clay loam topsoil and a clay subsoil. A transitional layer between the A and B horizon is common in the gradational variant.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills / lava plain	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	14%	**Depth to Hard Rock:**	>1.5 m (variable)
Slope b) range:	11-20%		
Potential Recharge to Groundwater:		Very high	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint, Silver Wattle, Blackwood	
Present Land Use:		Grazing	

LAND DEGRADATION

Degradation Processes	Water Erosion Sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Very low	High	Very low	High-mod
Incidence	Low	Low	Very low	Low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A1 10-17 cm — Dark reddish brown (2.5YR3/3) loam to clay loam, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, small and medium angular and subangular basaltic pebbles are common, pH 6.5. Clear transition to:

A12 17-30 cm — Dark reddish brown (2.5YR3/3) clay loam, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence; a few small subangular basaltic pebbles, pH 6.0. Gradual transition to:

A3/B1 30-60 cm — Dark reddish brown (2.5YR3/3) clay loam to light clay, moderate subangular blocky structure, peds 10-20 mm, smooth fabric, firm consistence, a few small subangular basaltic pebbles, pH 6.0. Diffuse transition to:

B2 60 - 100 cm — Dark reddish brown (2.5YR3/3) light clay, moderate to strong subangular blocky structure, peds 5-10 mm, smooth structure, very firm consistence, small and medium subangular basaltic pebbles are common, pH 6.0. Gradual transition to:

B3 100-150^{+} cm Dark reddish brown (2.5YR3/4) sandy clay, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, many medium subangular basalt pebbles, pH 6.0.

CLASSIFICATION

Factual Key:	Gn3.11, Dr2.11
Australian Soil Classification:	Haplic, Eutrophic, Red FERROSOL; thick, slightly gravelly, clay loamy / clayey, very deep
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.9	4	VL	M	D	S	T	H	VL
A12	5.1	3	VL	M	D	S	S	L	L
A3	5.5	9	VL		D	S	S	VL	L
B2	5.8	22	VL	M	D	S	S	VL	L
B3	5.6	14	VL	M	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

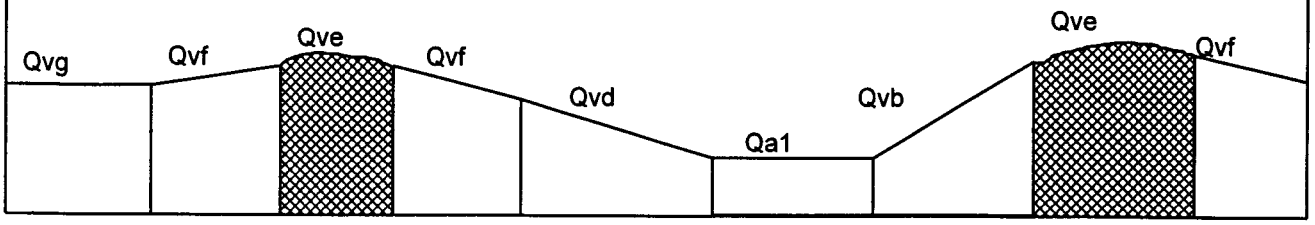
SOIL PROFILE CHARACTERISTICS:

Permeability:	Excessive (average 4 500 mm/day, range 3 500-5 200 mm/day)
Available Water Capacity:	High (195-185 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	3	Slope
Farm Dams	5	Excessive permeability
Secondary Roads	4	Slope, susceptibility to slope failure, linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qve** Area: 289 ha	MAP UNIT: **Quaternary volcanic, crest**



A. GENERAL DESCRIPTION

This map unit generally occurs as small narrow crests. Rock outcrop can occur on the surface or throughout the profile, and the percentage is variable. Gentle broad crests can occur that do not have a high percentage of rock outcrop, although they commonly have similar soils to the rocky crests. The soil profile is commonly composed of a clay loam topsoil and a clay subsoil. The soils are commonly red duplex or gradational. The gradational variant occurs when there is a transitional horizon between the A and B horizon.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	Native
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Well drained
Landform Element:	Crest	**Rock Outcrop:**	20-30% (variable)
Slope a) common:	2%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:	Very high to high		
Major Native Vegetation Species:	Manna Gum, Narrow-leaved Peppermint		
Present Land Use:	Grazing, potato cropping		
Length of Growing Season:	6 months		

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Very low	Low	Very low	Moderate
Incidence	Low	Very low	Very low	Very low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A11 0-17 cm — Dark reddish brown (2.5YR3/3) sandy clay loam to clay loam, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, small to medium angular and subangular basalt pebbles and stones are common, pH 6.5. Clear transition to:

A12 17-30 cm — Dark reddish brown (2.5YR3/3) sandy clay loam to clay loam, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, a few small subangular basalt pebbles and stones, pH 6.0. Gradual transition to:

A3/B1 30-60 cm — Dark reddish brown (2.5YR3/3) sandy clay loam to clay loam to light clay, moderate subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, a few small subangular basalt pebbles and stones, pH 6.0. Gradual to diffuse transition to:

B2 60-150 cm — Dark reddish brown (2.5YR3/3) light clay, moderate to strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, small and medium subangular basalt pebbles and stones are common, pH 6.0. Gradual transition to:

B3 150-165^{+} cm — Dark reddish brown (2.5YR3/4) sandy clay, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, many medium subangular basaltic pebbles and stones, pH 6.0.

CLASSIFICATION

Factual Key:	Gn3.11, Dr2.11
Australian Soil Classification:	Haplic, Eutrophic, Red FERROSOL; thick, slightly gravelly, clay loamy / clayey, very deep
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.9	4	VL	M	D	S	T	H	VL
A12	5.1	3	VL	M	D	S	S	L	L
A3	5.5	9	VL	M	D	S	S	VL	L
B2	5.8	22	VL	M	D	S	S	VL	L
B3	5.6	14	VL	M	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

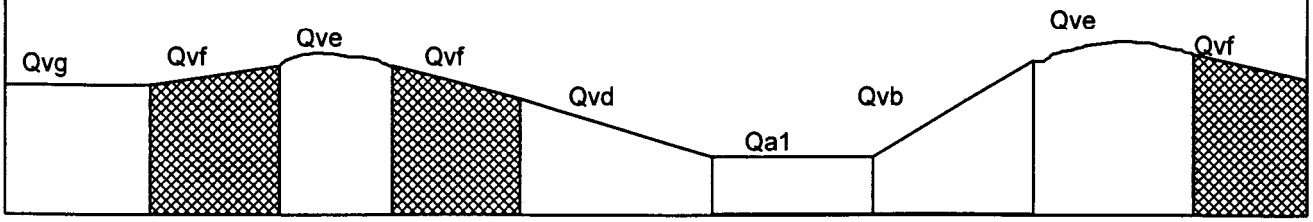
SOIL PROFILE CHARACTERISTICS:

Permeability:	Excessive (average 4 500 mm/day, range 3 500-5 200 mm/day)
Available Water Capacity:	High - Very high (175-210 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Length of growing season, permeability-rainfall index, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	5	Excessive permeability
Secondary Roads	4	Linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qvf** Area: 5921 ha	MAP UNIT: **Quaternary volcanic, gentle slope**



A. GENERAL DESCRIPTION

The soils on the volcanic gentle slopes are generally well drained and are structurally very fertile, due the strong structure, particularly in the subsoil, and have a moderate nutrient status. They commonly have a clay loam topsoil and a clay subsoil. The soils are commonly red duplex or gradational. The gradational variant occurs when there is a transitional layer between the A and B horizon.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-10%
Slope a) common:	6%	**Depth to Hard Rock:**	>1.7 m
Slope b) range:	4-10%		
Potential Recharge to Groundwater:		Very high to high	
Major Native Vegetation Species:		Manna Gum, Messmate, Narrow-leaved Peppermint, Blackwood, Black	
Present Land Use:		Grazing, potato cropping, perennial pasture, summer fodder crops	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Very low	Low	Low	Moderate
Incidence	Low	Low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K11

A11 0-17 cm — Dark reddish brown (2.5YR3/3) clay loam, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, small to medium angular and subangular basalt pebbles are common, pH 6.5. Clear transition to:

A12 17-30 cm — Dark reddish brown (2.5YR3/3) clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, very few small subangular basalt pebbles, pH 6.0. Gradual transition to:

A3 30-60 cm — Dark reddish brown (2.5YR3/3) clay loam to light clay, moderate to strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, very few small subangular basalt pebbles, pH 6.0. Gradual to diffuse transition to:

B2 60-150 cm — Dark reddish brown (2.5YR3/3) light clay, strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, small and medium subangular basalt pebbles are common, pH 6.0. Gradual transition to:

B3 150-165 $^{+}$ cm Dark reddish brown (2.5YR3/4) sandy clay, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, many medium subangular basaltic pebbles, pH 6.0.

CLASSIFICATION

Factual Key:	Gn3.11, Dr2.11
Australian Soil Classification:	Haplic, Eutrophic, Red FERROSOL; thick, slightly gravelly, clay loamy / clayey, very deep
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.9	4	VL	M	D	S	T	H	VL
A12	5.1	3	VL	M	D	S	S	L	L
A3	5.5	9	VL	M	D	S	S	VL	L
B2	5.8	22	VL	M	D	S	S	VL	L
B3	5.6	14	VL	M	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

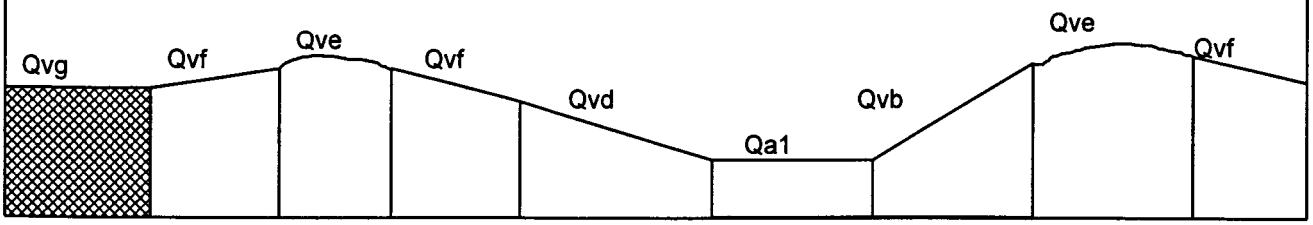
SOIL PROFILE CHARACTERISTICS:

Permeability:	Excessive (average 4 500 mm/day, range 3 500-5 200 mm/day)
Available Water Capacity:	Very high (208 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_3S_3$	Length of growing season, slope, permeability-rainfall index, susceptibility to sheet and gully erosion
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	5	Excessive permeability
Secondary Roads	4	Linear Shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qvg** Area: 2403 ha	MAP UNIT: **Quaternary volcanic, very gentle slope**



A. GENERAL DESCRIPTION

The fertile and well drained soils of the volcanic very gentle slopes are often red duplex or gradational soils. The texture of the soil ranges for a clay loam topsoil to a clayey subsoil. Red duplex or gradational soils are the major soil types, with the gradational variant occurring when a transitional layer occurs between the A and B horizon.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Nil
Landform Pattern:	Lava Plain	**Drainage:**	Well Drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-1
Slope a) common:	2%	**Depth to Hard Rock:**	>1.7 m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:		Very high to high	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint, Blackwood, Black Wattle	
Present Land Use:		Grazing, potato cropping, perennial pasture	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Very low	Low	Low	Moderate
Incidence	Low	Low	Very low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K11

A11 0-17 cm — Dark reddish brown (2.5YR3/3) clay loam, strong subangular blocky structure, peds 2-5 mm, rough fabric, firm consistence, small to medium angular and subangular basalt pebbles are common, pH 6.5. Clear transition to:

A12 17-30 cm — Dark reddish brown (2.5YR3/3) clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, very few small subangular basalt pebbles, pH 6.0. Gradual transition to:

A3 30-60 cm — Dark reddish brown (2.5YR3/3) clay loam to light clay, moderate to strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, very few small subangular basalt pebbles, pH 6.0. Gradual to diffuse transition to:

B2 60-150 cm — Dark reddish brown (2.5YR3/3) light clay, strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, small and medium subangular basalt pebbles are common, pH .0. Gradual transition to:

B3 150-165^{+} cm — Dark reddish brown (2.5YR3/4) sandy clay, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, many medium subangular basaltic pebbles, pH 6.0.

CLASSIFICATION

Factual Key:	Gn3.11, Dr2.11
Australian Soil Classification:	Haplic, Eutrophic, Red FERROSOL; thick, slightly gravelly, clay loamy / clayey, very deep
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS•

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.9	4	VL	M	D	S	T	H	VL
A12	5.1	3	VL	M	D	S	S	L	L
A3	**5.5**	9	VL	M	D	S	S	VL	L
B2	5.8	22	VL	M	D	S	S	VL	L
B3	5.6	14	VL	M	D	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

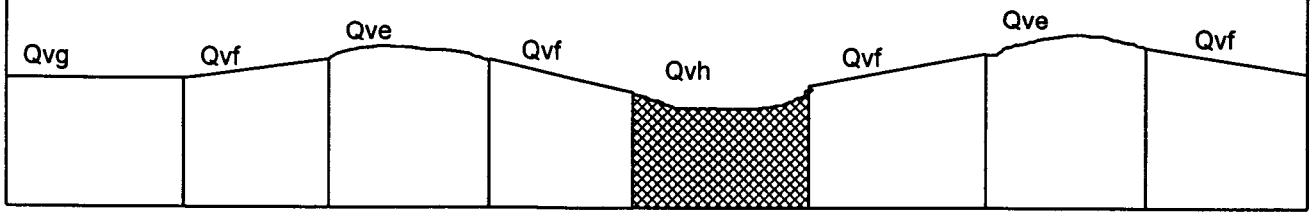
SOIL PROFILE CHARACTERISTICS:

Permeability:	Excessive (average 4 500 mm/day, range 3 500 – 5 200 mm/day)
Available Water Capacity:	Very high (265-285 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Length of growing season, permeability-rainfall index, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	5	Excessive permeability
Secondary Roads	4	Linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Qvh** Area: 620 ha	MAP UNIT: **Quaternary volcanic, drainage depression**



A. GENERAL DESCRIPTION

The soils of the volcanic drainage depression are generally red or dark duplex soils. They generally have a light textured topsoil and a clay subsoil. Sand is often present due to past flooding events. The flood risk varies depending on the catchment surrounding the drainage depression.

SITE CHARACTERISTICS

Parent Material Age:	Quaternary	**Depth to Seas. Watertable:**	>1.5 m
Parent Material Lithology:	Volcanic	**Flooding Risk:**	Moderate-Low
Landform Pattern:	Lava plain	**Drainage:**	Moderately well drained
Landform Element:	Drainage depression	**Rock Outcrop:**	0-2%
Slope a) common:	1-3%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	2%		

Potential Recharge to Groundwater:	Moderate
Major Native Vegetation Species:	Manna Gum, Narrow-leaved Peppermint, Blackwood, Black Wattle
Present Land Use:	Grazing
Length of Growing Season:	6 months

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Moderate	Very low	Low	High
Incidence	Very low	Low	Low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K12

A1 0-13 cm — Dark reddish brown (5YR3/2) loam with coarse sand, moderate subangular blocky structure, peds 5-10 mm, very firm consistence, very few small and medium subangular and rounded basalt pebbles, pH 7.0. Clear transition to:

A3 13-22 cm — Very dusky red (2.5YR2.5/2) clay loam with coarse sand, moderate subangular blocky structure, peds 10-20 mm, weak consistence, very few small and medium subangular and rounded basalt pebbles, pH 6.0. Gradual transition to:

B21 22-40 cm — Dark reddish brown (2.5YR2.5/3) light medium clay with coarse sand, moderate to strong subangular blocky structure, peds 5-10 mm, firm consistence, a few small subangular and subrounded basaltic pebbles, pH 6.5. Gradual transition to:

B22 40-65 cm — Dusky red (2.5YR3/2) medium clay with coarse sand, medium subangular blocky structure, peds 5-10 mm, firm consistence, many small medium and large subangular and rounded basaltic pebbles, pH 6.5. Clear transition to:

C 65-140 cm — Weathered basaltic rock.

CLASSIFICATION

Factual Key:	Dr2.12, Dd1.12
Australian Soil Classification:	Haplic, Eutrophic, Red CHROMOSOL; medium, gravelly, loamy / clayey, very deep
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	5.0	14	VL	M	S	S	S	H	VL
A3	5.0	16	VL	M	S	S	S	H	VL
B21	**5.3**	22	VL	M	S	S	S	L	L
B22	5.4	35	VL	M	S	D	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

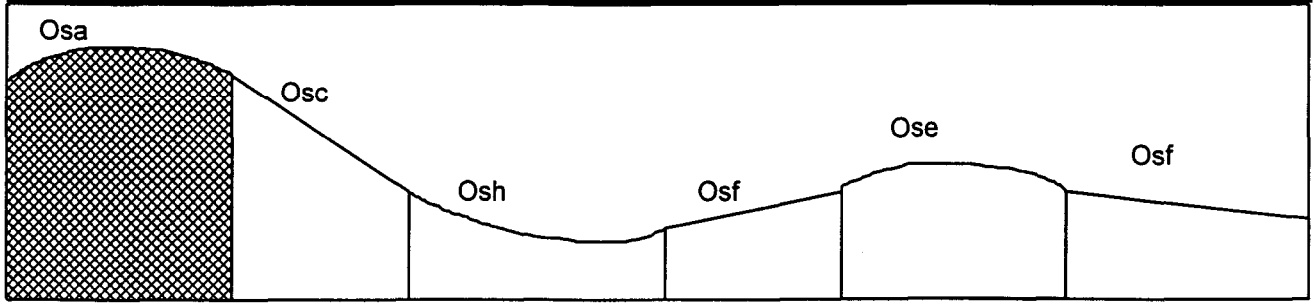
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (estimate)
Available Water Capacity:	Low (82 mm H_20)
Linear Shrinkage (B horizon):	Moderate (17%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_4$	Available water capacity
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Suitability of subsoil, depth to hardrock, permeability
Secondary Roads	3	Linear shrinkage, drainage, proportion of stones, unified soil group (subsoil)
Rural Residential Development	4	Farm dams

MAP UNIT SYMBOL: **Osa** Area: 102 ha	MAP UNIT: **Ordovician sedimentary, steep crest**



A. GENERAL DESCRIPTION

The soils on this map unit are generally similar to the gentle crest (Ose), although they are sometimes shallower. They occasionally have mottled subsoils, and A2 horizons with a clay loam to fine sandy clay loam texture. The slopes surrounding the crests are generally moderate to moderately steep. Depth of soil is variable.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Well drained
Landform Element:	Hill crest	**Rock Outcrop:**	0-2%
Slope a) common:	2%	**Depth to Hard Rock:**	>0.7 m
Slope b) range:	0-3%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Messmate, Narrow-leaved Peppermint, Candlebark, Silver	
Present Land Use:		Grazing, partially forested	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Low	Mod-low	Very low	Very low	Mod-high
Incidence	Low	Low	Low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A 0-10 cm — Dark brown (7.5YR3/3) loam to coarse sandy clay loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, sedimentary gravel fragments are common, pH 5.5. Clear to sharp transition to:

B21 10-25 cm — Brown (7.5YR5/4) light clay, moderate subangular blocky structure, rough (sometimes smooth) fabric, many sedimentary gravel fragments, pH 5.5. Gradual transition to:

B22 25-50 cm — Brown (7.5YR5/4) light clay, occasional mottling, moderate subangular blocky structure, rough fabric (sometimes smooth), many sedimentary basalt fragments, pH 6.0. Gradual transition to:

BC 50^{+} cm — Partially weathered sedimentary rock, variable in depth.

CLASSIFICATION

Factual Key:	Dy2.11, Gn3.74
Australian Soil Classification:	Haplic, ?, Brown CHROMOSOL; medium, gravelly, clay loamy / clayey, shallow (confidence level 4)
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_20)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	5.5	10-20	VL	VL	S	S	T	H	VL
B21	5.5	20-50	VL	L	D	D	T	L	VL
B22	6.0	20-50	VL	L	D	D	T	L	VL

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

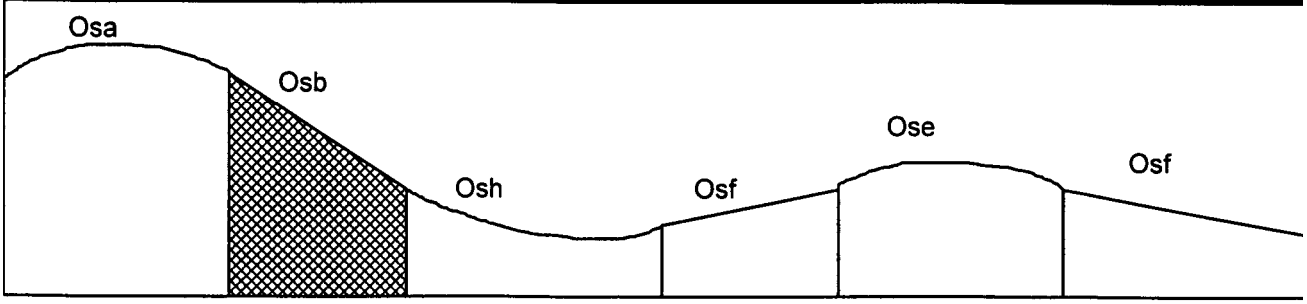
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 240 mm/day, range 10-400 mm/day)
Available Water Capacity:	Very low (46 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_5$	Available water capacity
Effluent Disposal (septic tanks)	2	Nil
Farm Dams	5	Suitability of subsoil, low dispersibility of subsoil
Secondary Roads	4	Proportion of stone and boulders, linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Osb** Area: 303 ha	MAP UNIT: **Ordovician sediments, steep slope**



A. GENERAL DESCRIPTION

The sedimentary steep slopes tend to occur as slopes down cut to drainage lines and depressions. This map unit occupies a small area of the Shire and is prone to slumping and water erosion due to the steepness of the slopes. The soils are generally gradational (Dermosols). The depth of soil is generally quite shallow, although the depth to hardrock is variable, depending on the depth of the weathered sedimentary rock.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Steep low hills	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2%
Slope a) common:	35%	**Depth to Hard Rock:**	0.5 m-1.0 m (variable)
Slope b) range:	33-56%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint	
Present Land Use:		Grazing, partially forested	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Very high	Moderate	Moderate	Moderate	Very low	Mod-high
Incidence	Moderate	Mod-low	Low	Moderate	Nil	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A1 0-20 cm — Very dark greyish brown (10YR3/2) loam, weak to moderate subangular blocky structure, rough fabric, pH 6.5. Clear transition to:

B2 20-25 cm — Brown (10YR4/3) fine sandy clay loam, moderate subangular blocky structure, rough fabric, pH 6.0. Gradual transition to:

B3 25-30 cm — Brown (10YR4/3) light clay, moderate subangular blocky structure, rough fabric, partially weathered sedimentary rocky is common. Gradual transition to:

BC 30^{+} cm — Partially weathered sedimentary rock, variable in depth.

CLASSIFICATION

Factual Key:	Gn4.31, Db1.11
Australian Soil Classification:	Melanic, ?, Brown DERMOSOL; medium, slightly gravelly, loamy / clayey, shallow
Unified Soil Group:	Not available

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH (H_2O)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	6.5	NA	NA	NA	NA	NA	NA	NA	NA
B2	6.0	NA	NA	NA	NA	NA	NA	NA	NA
B3	NA	12-20	NA	NA	NA	NA	NA	NA	NA

VL: Very Low L: Low M: Moderate H: High VH: Very high D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

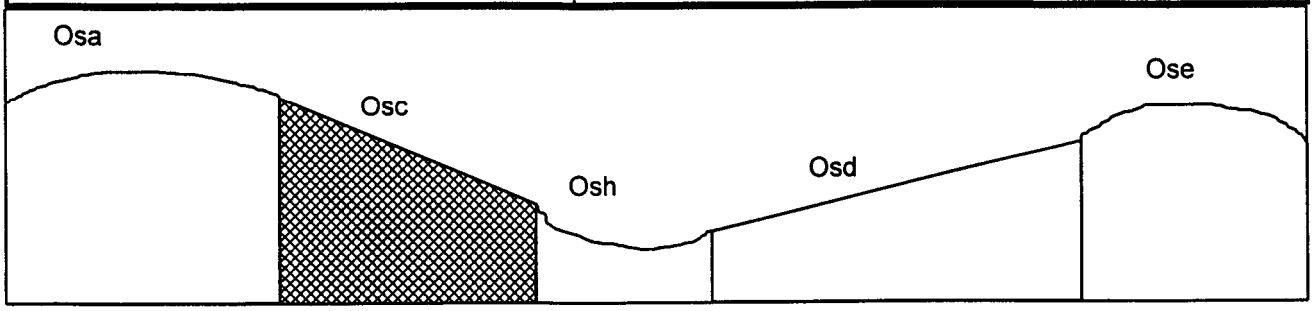
SOIL PROFILE CHARACTERISTICS:

Permeability:	Rapid (estimate)
Available Water Capacity:	Low (65 mm H_20)
Linear Shrinkage (B horizon):	Not available

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_5S_5$	Slope, susceptibility to sheet erosion
Effluent Disposal (septic tanks)	5	Slope
Farm Dams	5	Slope, suitability of subsoil
Secondary Roads	5	Slope
Rural Residential Development	5	Effluent disposal, farm dams, secondary roads, building foundations (Slab)

MAP UNIT SYMBOL: **Osc(i)** Area: 1178 ha (Osc)	MAP UNIT: **Ordovician sediments, moderately steep slope, deep soil**



A. GENERAL DESCRIPTION

The soil on this map unit is variable, although two major soil types dominate, shallow soils (Osc(ii)) and the deeper, more developed soil as described in this map unit (Osc(i)). As this soil type is more predominant on the sedimentary moderately steep slopes, the capability ratings depicted on the maps are pertaining to this soil type. Soils are more developed and retain more water on the fop of a catchment area or when there is more percolation into the soil profile than runoff. Soils range from duplex soils (Chromosols, Kurosols) to gradational soils (Dermosols) and commonly have an A2 horizon that may or may not be bleached, and the subsoils are often mottled. Most of the gradational soils are tending towards duplex but are not true duplex soils due mainly to the clayey A2 horizon.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2%
Slope a) common:	23%	**Depth to Hard Rock:**	>1.2m
Slope b) range:	21-32%		
Potential Recharge to Groundwater:		Low	
Major Native Vegetation Species:		Narrow-leaved Peppermint, Candlebark, Messmate, Blackwood, Silver Wattle, Black Wattle	
Present Land Use:		Grazing, public land (minor)	
Length of Growing Season:		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Mod-high	Mod-high	Moderate	Moderate	Low	High-mod
Incidence	Moderate	Low	Low	Moderate	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site 13

A1 0-10 cm Dark brown (7.5YR3/3) loam to silty clay loam, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, small and medium subangular and subrounded sedimentary pebbles are common, pH 6.0. Clear transition to

A21 10-24 cm Brown (7.5YR5/4) fine sandy clay loam to sandy clay, sporadically bleached (7.5Y8/4) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, small to medium subangular and subrounded sedimentary pebbles are common, pH 5.0. Clear transition to:

A22	24-49 cm	Brown (7.5YR5/4) fine sandy clay, sporadically bleached (7.5YR7/4) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, a few small subangular and subrounded sedimentary pebbles, pH 6.5. Gradual transition to:
B1	49-69 cm	Brown (7.5YR4/4) fine sandy clay to light clay, medium distinct red mottles are common, moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, small to medium subangular and subrounded sedimentary pebbles are common. pH 6.5. Gradual transition to:
B2	69-120 cm	Brown (7.5YR5/4) light medium clay to heavy clay, medium distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, small and medium subangular and subrounded sedimentary pebbles are common, pH 5.0. Gradual transition to:
BC	120-123^{+} cm	Partially weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn3.01/4 (major), Dy3 (minor)
Australian Soil Classification:	Mottled, Eutrophic, Brown DERMOSOL; medium, moderately gravelly, loamy / clayey, deep.
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.7	24	VL	M	D	S	T	H	VL
A21	4.3**	29	VL	VL	D	S	T	L	L
A22	4.6	18	VL	L	D	S	T	VL	L
B1	4.7	27	VL	L	D	S	S	VL	L
B2	4.9	28	VL	L	D	S	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

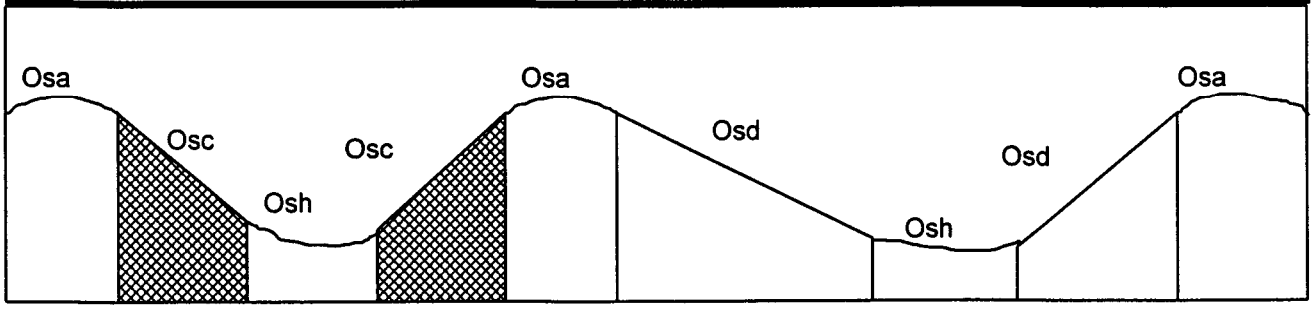
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 50 mm/day, range 0-80 mm/day)
Available Water Capacity:	Moderate (132 mm H_20)
Linear Shrinkage (B horizon):	Moderate (13%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, gravel and stone content
Effluent Disposal (septic tanks)	4	Slope, permeability
Farm Dams	5	Slope
Secondary Roads	4	Slope, proportion of stones
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Osc(ii)** Area: 1178 ha (Osc)	MAP UNIT: **Ordovician sediments, moderately steep slope, shallow soil**



A. GENERAL DESCRIPTION

The soil types on this map unit are variable, although there are two dominant soil types present; the deeper, more developed soil (Osc(i)) and the shallow soil profile described in this description (Osc(ii)). As the deeper soils predominate, they are used for the capability ratings, although this soil type is also an important element of the moderately steep sedimentary slopes. The shallow soil commonly occurs on areas where runoff is very high and there are numerous drainage depressions in the landscape. The soils have had little chance to develop, due to the high runoff rate. Pockets of deeper soils sometimes occur between these shallow soils, therefore care must be taken when working on this land type to establish which soil type is present or dominant.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2%
Slope a) common	23%	**Depth to Hard Rock:**	0.3m
Slope b) range:	21-32%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint, Candlebark	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Low	Low	Very low	Low
Incidence	Low	Low	Low	Low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K7

A 0-15 cm — Dark yellowish brown (10YR4/4) coarse sandy clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, small and medium angular and subangular quartz and sedimentary pebbles are common, pH 6.0. Clear transition to:

B 15-30 cm — Brown (7.5YR5/4) coarse sandy clay, weak subangular blocky structure, peds 10-20 mm, rough firm consistence, many small angular and subangular sedimentary pebbles, pH 6.0. Clear transition to:

R 30-80^{+} cm — Sedimentary rock

CLASSIFICATION

Factual Key:	Gn4.51
Australian Soil Classification:	Haplic, Mesotrophic, Brown KANDOSOL; medium, moderately gravelly, clay loamy / clayey, shallow
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	4.2**	24	VL	VL	D	S	T	H	VL
B	4.5	59	VL	VL	D	D	T	L	VL

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

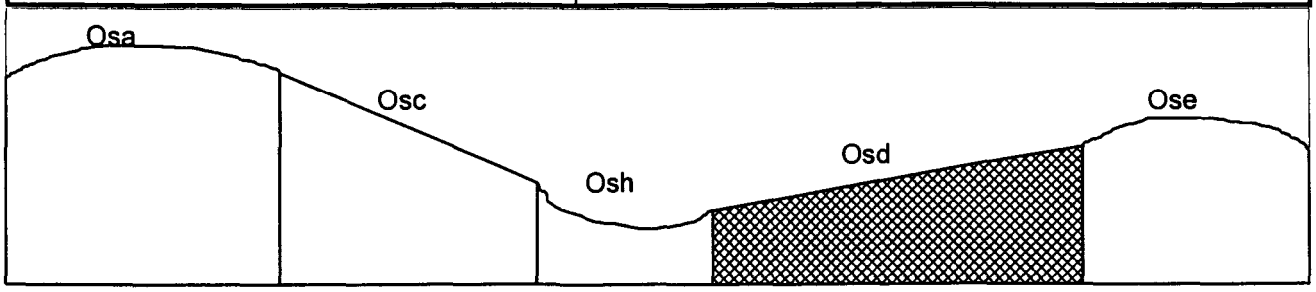
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 295 mm/day, range 150-570 mm/day)
Available Water Capacity:	Very low (32 mm H_20)
Linear Shrinkage (B horizon):	Very low (6%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_5$	Depth to hardrock, available water capacity
Effluent Disposal (septic tanks)	5	Depth to impermeable layer
Farm Dams	5	Slope, suitability of subsoil, depth to hardrock, low dispersibility of subsoil
Secondary Roads	4	Slope, proportion of stones, depth to hardrock
Rural Residential Development	5	Effluent disposal, farm dams

MAP UNIT SYMBOL: **Osd(i)** Area: 2368 ha (Osd)	MAP UNIT: **Ordovician sediments, moderate slope, deep soil**



A. GENERAL DESCRIPTION

Two main soil types occur on this land unit, shallow soils (Osd(ii)) and the deeper more developed soils as described in this description. As this soil type predominates, the capability ratings depicted on the maps are related to this soil profile description. The soil associated with this map unit tends to occur on slopes that are slightly undulating, sometimes with small terraces along the slope. The soils are variable, often with A2 horizons that are conspicuously bleached, sporadically bleached or not bleached. Occasionally, there are horizons that are bleached but are not technically A2 horizons. The subsoil may or may not be mottled. The soils tend to gradational, although some have properties of duplex soils, except the A2 horizon is too heavy. The textures of the A2 horizon varies between fine sandy clay loam and fine sandy clay. The soils fit into a range of gradational soils according to the Factual Key, due mainly to the variation in colour.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2%
Slope a) common:	16%	**Depth to Hard Rock:**	>1.3 m
Slope b) range:	11-20%		
Potential Recharge to Groundwater:		Low	
Major Native Vegetation Species:		Messmate, Narrow-leaved Peppermint, Candlebark, Manna Gum, Silver	
Present Land Use:		Grazing, partly forested	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Mod-high	Mod-high	Moderate	Moderate	Low	High
Incidence	Moderate	Low	Low	Mod-high	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site 13

A1 0-10 cm — Dark brown (7.5YR3/3) loam to silty clay loam, weak to moderate subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, small and medium subangular and subrounded sedimentary pebbles are common, pH 6.0. Clear transition to

A21 10-2 cm — Brown (7.5YR5/4) fine sandy clay loam to sandy clay, sporadically bleached (7.5YR8/4) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, small to medium subangular and subrounded sedimentary pebbles are common, pH 5.0. Clear transition to:

A22 24-49 cm — Brown (7.5YR5/4) fine sandy clay, sporadically bleached (7.5YR7/4) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, a few small subangular and subrounded sedimentary pebbles, pH 6.5. Gradual transition to:

B1	49-69 cm	Brown (7.5YR4/4) fine sandy clay to light clay, medium distinct red mottles are common, moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, a few small to medium subangular and subrounded sedimentary pebbles. pH 6.5. Gradual transition to:
B2	69-120 cm	Brown (7.5YR5/4) light medium clay to heavy clay, medium distinct red mottles are common, strong subangular blocky structure, peds 5-10 mm, smooth fabric, firm consistence, small and medium subangular and subrounded sedimentary pebbles are common, pH 5.0. Gradual transition to:
BC	120-123^{+} cm	Partially weathered sedimentary rock.

CLASSIFICATION

Factual Key:	Gn3.01/4 (major) Dy3 (minor)
Australian Soil Classification:	Mottled, Eutrophic, Brown DERMOSOL; medium, moderately gravelly, loamy / clayey, deep
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.7	24	VL	M	D	S	T	H	VL
A21	4.3**	29	VL	VL	D	S	T	L	L
A22	4.6	18	VL	L	D	S	T	VL	L
B1	4.7	27	VL	L	D	S	S	VL	L
B2	4.9	28	VL	L	D	S	S	VL	L

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

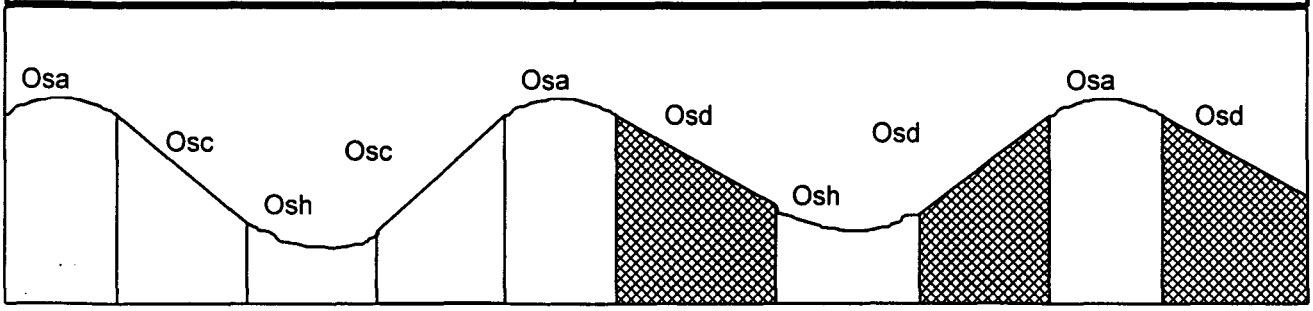
SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 50 mm/day, range 0-80 mm/day)
Available Water Capacity:	Moderate (132 mm H_20)
Linear Shrinkage (B horizon):	Moderate (13%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_4$	Slope, gravel and stone content
Effluent Disposal (septic tanks)	4-3	Permeability
Farm Dams	4	Slope
Secondary Roads	4	Slope, proportion of stones
Rural Residential Development	4	Effluent disposal, farm dams, secondary roads, building foundations (slab)

MAP UNIT SYMBOL: **Osd(ii)** Area: 2368 ha (Osd)	MAP UNIT: **Ordovician sediments, moderate slope, shallow soil**



A. GENERAL DESCRIPTION

Two major soil types occur on this map unit; deep, developed soils (Osd(i)), and shallow soils, (Osd(ii)) as described in this description. The deeper soils are predominant and are depicted in the land capability maps. The shallow variant associated with the sedimentary moderate slopes tend to occur on the long simple slopes where there is a high runoff rate. The landscape is generally dissected with drainage lines. Pockets of more developed soils can occur due to the striking of bedrock, therefore care must be taken when working with this map unit to establish which soil type occurs and to what percentage.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Rolling low hills	**Drainage:**	Well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2 %
Slope a) common:	11-20 %	**Depth to Hard Rock:**	0.3 m (variable)
Slope b) range:	19 %		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Messmate, Narrow-leaved Peppermint, Candlebark	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	High	Low	Low	Low	Very low	Low
Incidence	Mod-low	Low	Low	Low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K7

A 0-15 cm — Dark yellowish brown (10YR4/4) coarse sandy clay loam, moderate subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, small and medium angular and subangular quartz and sedimentary pebbles are common, pH 6.0. Clear transition to:

B 15-30 cm — Brown (7.5YR5/4) coarse sandy clay, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, many small angular and subangular sedimentary pebbles, pH 6.0. Clear transition to:

R 30-80^{+} cm — Sedimentary rock

CLASSIFICATION

Factual Key:	Gn4.51
Australian Soil Classification:	Haplic, Mesotrophic, Brown KANDOSOL; medium, moderately gravelly, clay loamy / clayey, shallow
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	4.2	24	VL	VL	D	S	T	H	VL
B	4.5	59	VL	VL	D	D	T	L	VL

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix 0 for analytical results ** Strongly Acidic

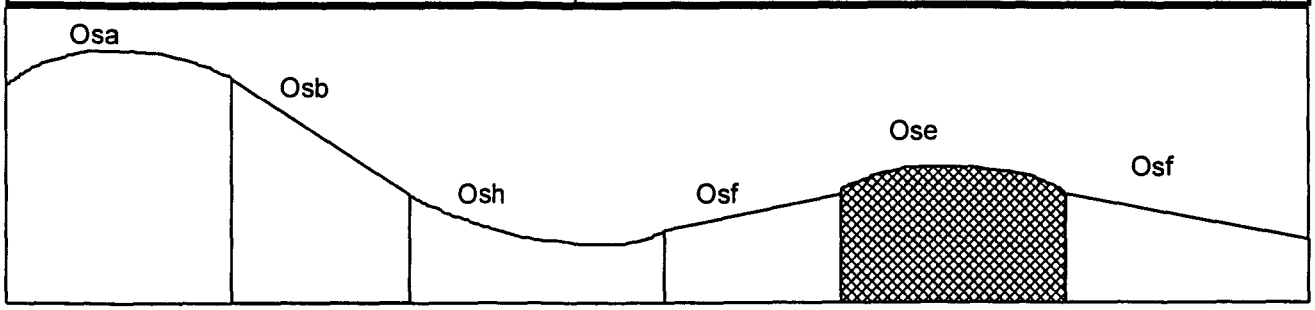
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 295 mm/day, range 150-570 mm/day)
Available Water Capacity:	Very low (32 mm H_20)
Linear Shrinkage (B horizon):	Very low (6%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_4S_5$	Depth to hardrock, available water capacity
Effluent Disposal (septic tanks)	5	Depth to impermeable layer
Farm Dams	5	Suitability of subsoil, depth to hardrock, low dispersibility of subsoil
Secondary Roads	4	Slope, proportion of stones, depth to hardrock
Rural Residential Development	5	Effluent disposal, farm dams

MAP UNIT SYMBOL: **Ose** Area: 176 ha	MAP UNIT: **Ordovician sediments, gentle crest**



A. GENERAL DESCRIPTION

The sedimentary gentle crests are generally quite broad, and are usually associated with gentle to moderate slopes. They occasionally have bleached horizons which are not technically A2 horizons. The colours of the subsoil and depth to hardrock are quite variable.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>5.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Undulating low hills	**Drainage:**	Moderately well drained
Landform Element:	Hillcrest	**Rock Outcrop:**	0-2%
Slope a) common:	2%	**Depth to Hard Rock:**	>1.7m
Slope b) range:	1-3%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Messmate, Manna Gum, Narrow-leaved Peppermint, Silver Wattle	
Present Land Use:		Grazing, public land (minor)	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Low	Moderate	Moderate	Very low	Very low	Mod-low
Incidence	Low	Low	Low	Very low	Very low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K9

A11 0-6 cm — Very dark greyish brown (10YR3/2) loam with fine sand, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, a few small subangular and subrounded sedimentary and quartz pebbles, pH 5.0. Clear transition

A12 6-20 cm — Dark greyish brown (10YR4/2) coarse sandy clay loam to fine sandy clay loam, weak subangular blocky structure, peds 10-20 mm, rough fabric, firm consistence, small subangular, rounded and subrounded sedimentary pebbles are common, pH 5.5. Gradual transition to:

A2 20-33 cm — Greyish brown (10YR5/4) fine sandy clay, bleached (10YR7/4) when dry, weak subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, small subangular and subrounded sedimentary pebbles are common, pH 5.0. Abrupt transition to:

B2 33-73 cm — Yellowish brown (10YR5/6) light clay to medium clay, coarse distinct red mottles are common, strong subangular blocky structure, peds 5-10 cm, smooth fabric, very firm consistence, many small and medium subangular sedimentary pebbles and stones, pH 5.0. diffuse transition to:

BC 73-170 cm — Partially weathered sedimentary rock

CLASSIFICATION

Factual Key:	Gn3.84
Australian Soil Classification:	Acidic-Mottled / Bleached-Acidic, Mesotrophic, Brown DERMOSOL; medium, gravelly, loamy / clayey, moderate
Unified Soil Group:	MH

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A11	4.4**	18	VL	VL	S	S	T	H	VL
A12	4.4**	10	VL	VL	D	S	T	H	VL
A2	4.3**	28	VL	VL	D	D	T	L	L
B2	4.2**	60	VL	L	D	D	T	VL	VL

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

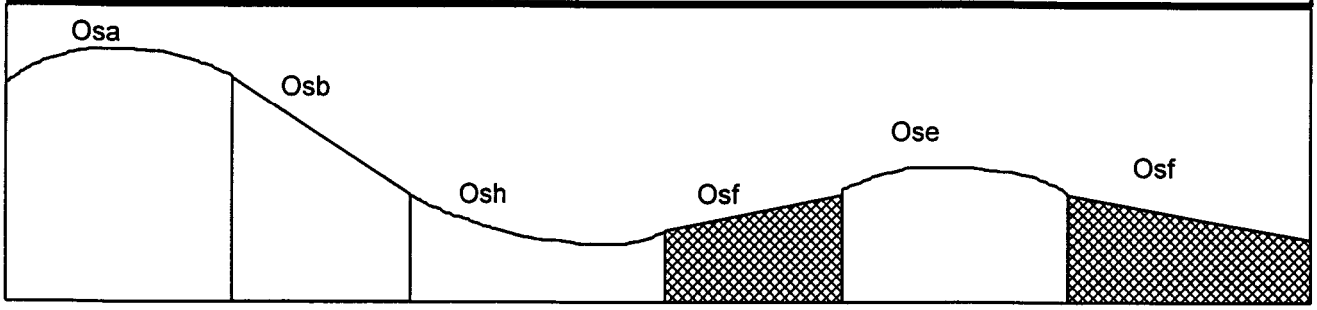
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 240 mm/day, range 10 - 400 mm/day)
Available Water Capacity:	Low (65 mm H_20)
Linear Shrinkage (B horizon):	High (20%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_4$	Available water capacity, gravel and stone content
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	5	Suitability of subsoil, low dispersibility of subsoil
Secondary Roads	4	Proportion of stones, linear shrinkage
Rural Residential Development	5	Farm dams

MAP UNIT SYMBOL: **Osf** Area: 5337 ha	MAP UNIT: **Ordovician sediments, gentle slope**



A. GENERAL DESCRIPTION

The soils are variable on the sedimentary gentle slopes. They commonly have an A2 horizon that may or may not be bleached. Occasionally there are bleached horizons that are not technically A2 horizons. Depth to hard rock can vary in depth to 0.7 m to greater than 1.5 m. Mottling of the subsoil is sometimes absent.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Undulating low hills	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2%
Slope a) common:	8%	**Depth to Hard Rock:**	0.7 m (variable)
Slope b) range:	4-10%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint, Black Wattle, Messmate, Broad-leaved Peppermint, Blackwood, Silver Wattle	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Low-mod	Very low	Moderate	High-mod
Incidence	Low	Low-mod	Low	Very low	Low	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K8

A1 0-16 cm — Dark Brown (7.5YR3/2) loam to clay loam, moderate to strong subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, a few medium angular and subangular sedimentary pebbles, pH 6.0. Abrupt transition to:

A2 16-26 cm — Brown (7.5YR5/4) clay loam to fine sandy clay loam, sometimes bleached, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, a few medium angular platy and angular sedimentary pebbles, pH 6.0. Gradual transition to:

B1 26-43 cm — Yellowish red (5YR 5/6) light clay, coarse faint orange mottles are common, moderate to strong subangular blocky structure, peds 10 -20 mm, rough fabric, very firm consistence, medium angular, subangular and rounded sedimentary pebbles are common, pH 5.5. Clear transition to:

B2 43-60 cm — Yellowish red (5YR5/6) medium heavy clay to heavy clay, coarse faint and distinct orange and yellow mottles are common, moderate to strong subangular blocky structure, peds 5-10 mm, smooth fabric, very firm consistence, large subangular, angular and rounded sedimentary pebbles are common, pH 5.5. Gradual transition to:

BC 60-70 cm Partially weathered sedimentary rock

R 70-90^{+} cm Sedimentary rock (variable in depth)

CLASSIFICATION

Factual Key:	Gn3.74, Gn3.8 (major) Dy3.41, Dy3.21 (minor)
Australian Soil Classification:	Mottled, Mesotrophic, Red DERMOSOL; medium, gravelly, clay loamy / clayey, moderate
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	24	VL	L	D	S	T	H	L
A2	4.4**	19	VL	VL	D	S	T	VL	L
B1	4.3**	11	VL	VL	D	D	T	VL	VL
B2	4.2**	39	VL	VL	D	D	T	VL	VL

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

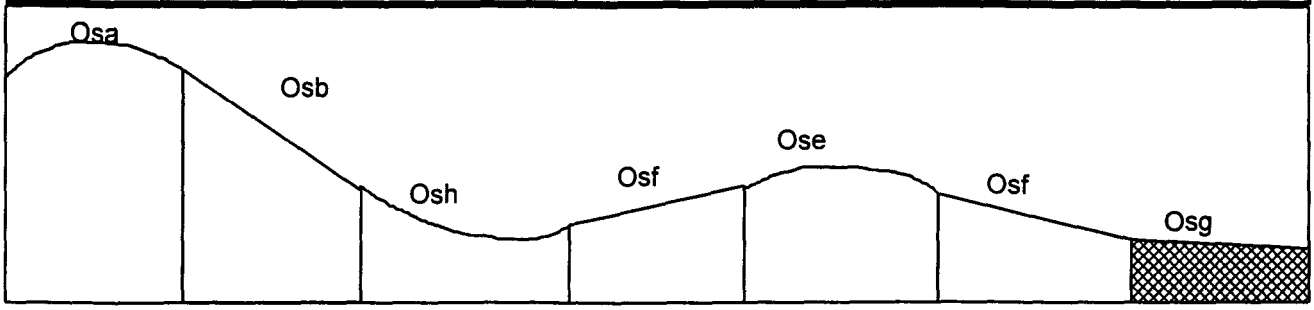
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 230 mm/day, range 20-360 mm/day)
Available Water Capacity:	Low - Moderate (80-122 mm H_20)
Linear Shrinkage (B horizon):	Moderate (13%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_3S_4$	Depth to hardrock
Effluent Disposal (septic tanks)	4	Depth to impermeable layer
Farm Dams	4	Depth to hard rock, suitability of subsoil
Secondary Roads	3	Slope, drainage, proportion of stones, linear shrinkage, unified soil group
Rural Residential Development	4	Effluent disposal, farm dams, building foundations

MAP UNIT SYMBOL: **Osg** Area: 583 ha	MAP UNIT: **Ordovician sediments, very gentle slope**



A. GENERAL DESCRIPTION

The soils are variable on the sedimentary very gentle slopes. The soils are commonly gradational (Dermosols), although duplex soils (Chromosols, Kurosols) can occur when the transitional horizon is absent. A2 horizons may be absent, and if present, may be bleached. Mottling of the subsoil may be absent on better structured and better drained soils.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>2.0 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Nil
Landform Pattern:	Undulating low hills	**Drainage:**	Moderately well drained
Landform Element:	Hill slope	**Rock Outcrop:**	0-2%
Slope a) common:	1-3%	**Depth to Hard Rock:**	>1.0 m
Slope b) range:	2%		
Potential Recharge to Groundwater:		Moderate	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint, Black Wattle, Silver Wattle	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Low-mod	Very low	Moderate	High-mod
Incidence	Low	Moderate	Low	Very low	Moderate	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION

A1 0-16 cm — Dark Brown (7.5YR3/2) loam to clay loam, moderate to strong subangular blocky structure, peds 10-20 mm, rough fabric, very firm consistence, a few medium angular and subangular sedimentary pebbles, pH 6.0. Abrupt transition to:

A2 16-26 cm — Brown (7.5YR5/4) clay loam to fine sandy clay loam, sometimes bleached, weak subangular blocky structure, peds 20-50 mm, rough fabric, very firm consistence, a few medium angular platy and angular sedimentary pebbles, pH 6.0. Gradual transition to:

B1 26-43 cm — Yellowish red (5YR 5/6) light clay, coarse faint orange mottles are common, moderate to strong subangular blocky structure, peds 10 -20 mm, rough fabric, very firm consistence, medium angular, subangular and rounded sedimentary pebbles are common, pH 5.5. Clear transition to:

B2 43-60 cm — Yellowish red (5YR5/6) medium heavy clay to heavy clay, coarse faint and distinct orange and yellow mottles are common, moderate to strong subangular blocky structure, peds 5-10 mm, smooth fabric, very firm consistence, large subangular, angular and rounded sedimentary pebbles are common, pH 5.5. Gradual transition to:

CLASSIFICATION

Factual Key:	Gn3.84, Gn3.91 (major) Dy3 (minor)
Australian Soil Classification:	Mottled, Mesotrophic, Red DERMOSOL; medium, gravelly, clay loamy / clayey, moderate
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A1	4.6	24	VL	L	D	S	T	H	L
A2	4.4**	19	VL	VL	D	S	T	VL	L
B1	4.3**	11	VL	VL	D	D	T	VL	VL
B2	4.2**	39	VL	VL	D	D	T	VL	VL

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

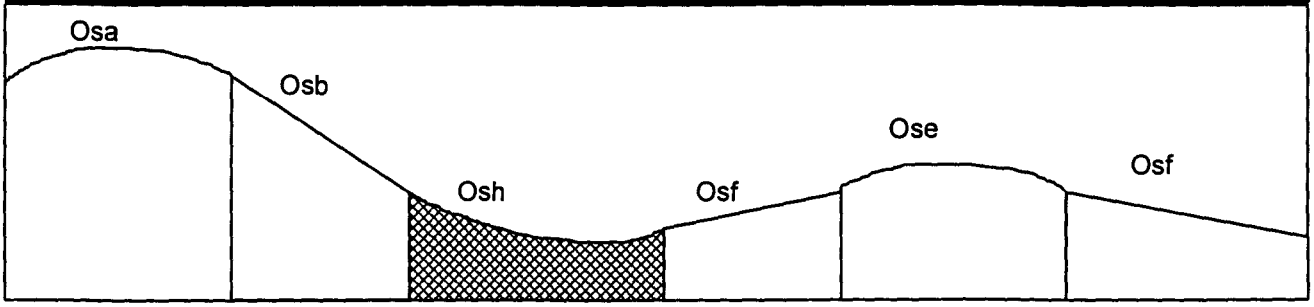
SOIL PROFILE CHARACTERISTICS:

Permeability:	Moderate (average 230 mm/day, 20-360 mm/day)
Available Water Capacity:	Moderate (122 mm H_20)
Linear Shrinkage (B horizon):	Moderate (13%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_2S_3$	Length of growing season, depth to hardrock, available water capacity, gravel and stone content, susceptibility to sheet and gully erosion
Effluent Disposal (septic tanks)	3	Drainage
Farm Dams	4	Depth to hardrock
Secondary Roads	3	Drainage, proportion of stones and boulders, linear shrinkage, unified soil group
Rural Residential Development	4	Farm dams, building foundations

MAP UNIT SYMBOL: **Osh** Area: 1139 ha	MAP UNIT: **Ordovician sediments, drainage depression**



A. GENERAL DESCRIPTION

The soils are variable on the Ordovician sedimentary drainage depressions. The presence of the gravel layer is variable, depending of the flooding history of the drainage lines. The gradational variant (Dermosol) has a transitional horizon between the topsoil (A horizon) and the subsoil (B2 horizon). Mottles can occur and there may be presence of an A2 horizon that may or may not be bleached. Occasionally there are horizons that are not technically A2 horizons which may be bleached. Depth of soil also varies. Dams in this map unit may need to be lined due to the shallow depth to the partially weathered bedrock, and the high dispersion of the clayey subsoil in more developed soil profiles. Salting is common in the sedimentary drainage depression.

SITE CHARACTERISTICS

Parent Material Age:	Ordovician	**Depth to Seas. Watertable:**	>1.5 m
Parent Material Lithology:	Sedimentary	**Flooding Risk:**	Moderate
Landform Pattern:	Undulating low hills	**Drainage:**	Moderately well drained
Landform Element:	Drainage depression	**Rock Outcrop:**	0-2%
Slope a) common:	2-20%	**Depth to Hard Rock:**	>1.5 m
Slope b) range:	4%		
Potential Recharge to Groundwater:		Low	
Major Native Vegetation Species:		Manna Gum, Narrow-leaved Peppermint, Black Wattle, Silver Wattle	
Present Land Use:		Grazing	
Length of Growing Season		6 months	

LAND DEGRADATION

Degradation Processes	Water Erosion sheet/rill	Water Erosion gully	Wind Erosion	Mass Movement	Salting	Acidification
Susceptibility	Moderate	Moderate	Moderate	Very low	High	Mod-low
Incidence	Low	Moderate	Low	Very low	Mod-high	Not available

B. SOIL PROFILE

PROFILE DESCRIPTION Site K6

A 0-13 cm — Dark greyish brown (10YR4/2) loam to clay loam with sand, weak subangular blocky structure, peds 10-20 mm, rough fabric, weak consistence, pH 4.5. Clear transition to:

B 13-64 cm — Dark grayish brown (10YR4/2) silty clay to light clay, bleached (5YR7/1) weak subangular blocky structure, peds 20-50 mm, rough fabric, weak consistence, pH 4.5. Abrupt transition to:

Gravel 64-69 cm — Light greyish brown (2.5Y6/2) medium day, bleached (5YR7/1) weak subangular blocky structure, peds 5-10 mm, rough fabric, many small and medium angular and subrounded quartz pebbles, pH 6.0. Abrupt transition to:

BC 69-140 cm — Partially weathered sedimentary rock, pH 5.5.

CLASSIFICATION

Factual Key:	Dy2.11, Gn4.51, Dy3.11
Australian Soil Classification:	Haplic, Natric, Grey KUROSOL; medium, slightly gravelly, loamy / clayey, moderate
Unified Soil Group:	CL

INTERPRETATION OF LABORATORY ANALYSIS*

Horizon	pH ($CaCl_2$)	% Gravel	EC (salts)	Nutrient Status	P	K	Al	Organic Matter	Dispersibility
A	4.1"	4	M	L	D	S	T	H	VL
B	4.2**	0	VL	VL	D	D	T	L	L
GRAVEL	4.5	72	VL	L	D	D	T	VL	H

VL: Very Low L: Low M: Moderate H: High VH: Very High D: Deficient S: Satisfactory
T: Potentially Toxic NA: Not Available * see Appendix D for analytical results ** Strongly Acidic

SOIL PROFILE CHARACTERISTICS:

Permeability:	Slow (average 35 mm/day, range 7-85 mm/day)
Available Water Capacity:	Low (93 mm H_20)
Linear Shrinkage (B horizon):	Low (8%)

C. LAND CAPABILITY ASSESSMENT

Land Use	Class	Major Limiting Feature(s)/Land Use
Agriculture	$C_3T_3S_4$	Available water capacity, gravel content
Effluent Disposal (septic tanks)	4	Permeability
Farm Dams	4	Suitability of subsoil, depth to hardrock
Secondary Roads	4	Proportion of stones
Rural Residential Development	4	Effluent disposal, farm dams, secondary roads, building foundations

5.2 Land systems descriptions and capability ratings for rural residential development.

5.2.1 Land systems

The north east corner of the former Shire has been mapped at a scale of 1:100 000, and has been described as land systems based on lithology, landform and soil type.

The land systems have been divided into land components, each with individual landforms, physical properties and land degradation hazards. These properties have been used to determine the capability of the land components to support rural residential development (<2.0 ha), highlighting the limiting land uses(s) and the major limiting features within that land use(s).

As land systems are not described in the same detail as the map units, they should not be used in the same context. Should more intensive use of this land be contemplated, additional site specific information would be required for both planning and evaluation of proposal(s).

The majority of the area consists of Devonian granite or granodiorite that have been described as Sidonia, Theaden Hill and Cobaw Land Systems. The landform generally consists of rolling hills with steep to moderate slopes and crests that are often rocky.

Soil development is quite shallow on the steeper rocky sites and the topsoil is generally light textured and sandy. The sandy loam topsoil makes this lithology susceptible to sheet, rill and wind erosion if cleared of vegetation.

5.2.2 Descriptions of Land Systems

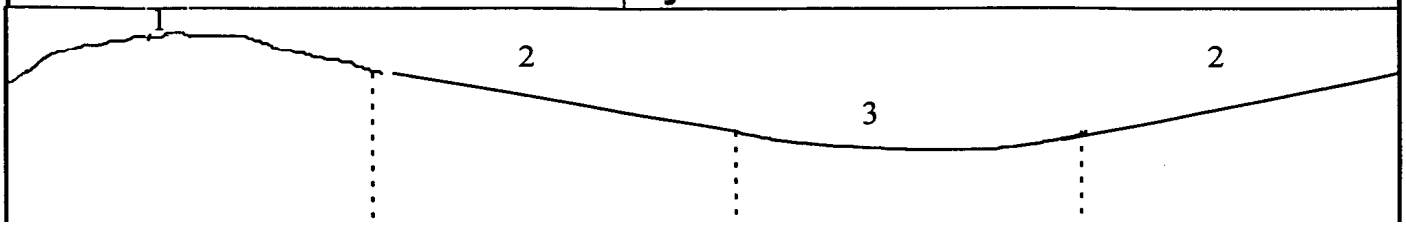
The granitic lithology is poorly suited to residential development mainly due to the shallow soils, steep to moderate slopes and the highly permeable sandy loam soils on some land components.

The rolling sedimentary hills of the Koala and the Wolfscrag land systems have steeper slopes and shallower soils than the sedimentary map units in the rest of the Shire. Due to the steeper slopes, the area is more susceptible to erosion, particularly sheet and rill erosion.

Capability for rural residential development is generally poor as most land uses are limited by the shallow soils on the Koala land system and the steep crests and slopes of the Wolfscrag land systems. On the lower reaches of the landscape on the Wolfscrag land systems the soils are yellow duplex with a bleached A2 horizon with an occasionally mottled subsoil. This indicates that permeability is relatively slow and therefore this could pose a problem for septic tanks as a form of effluent disposal.

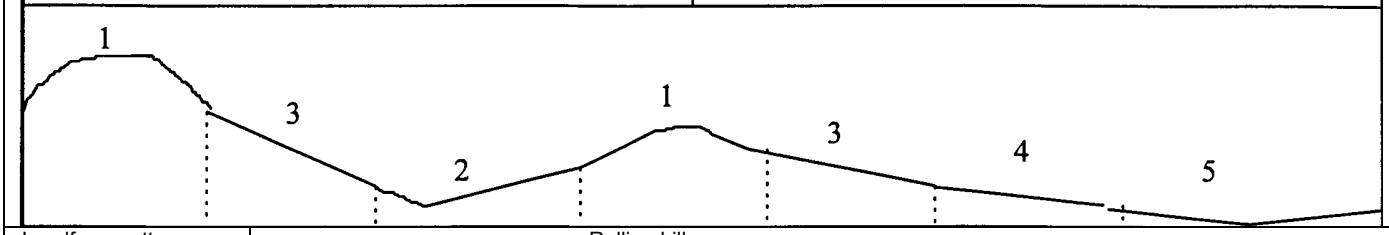
The Pastoria East and Redesdale land systems consist of undulating plains and rolling low hills with rocky volcanic cones and steep rocky scarps and slopes. The shallow depth of soil on the steeper slopes and cones limits most land uses associated with rural residential development. The poor drainage and slow permeability on the lower slopes, particularly on the gilgaing slopes and drainage depressions, limits the capacity of these landforms to support septic tanks as a form of effluent disposal.

MAP UNIT SYMBOL: **Sa** Area:6041ha	MAP UNIT: **Sidonia granitic land system**



Land form pattern	Undulating rises		
Land component number	1	2	3
Land form element	Crest	Very gentle to gentle slope	Drainage depression
Slope Range	4-7 %	1-10 %	1-3 %
Geology: Age Lithology	Devonian Granitic	Devonian Granitic	Devonian Granitic
Site drainage	Well drained	Well drained	Moderately well drained
Permeability	Slow	Slow	Rapid (Uniform); Slow(duplex)
Rock outcrop	0-2 %	0%	0%
Depth to hardrock/hardpan	40-90 cm	90-200 cm	>200 cm
Unified Soil Group	CH	CH	SM
Factual Key	Dy3.41	Dy3.41	Uc2.34, Dy3.41
Soil: Topsoil Subsoil	**A1** 0-10 cm: Loamy coarse sand to coarse sandy loam, low nutrient status, pH5.6; **A2** 10-45 cm: Bleached, clay with coarse sand, very low nutrient status, pH 6.1; **B2** 45-90 cm : Mottled yellowish grey, medium clay, low nutrient status, pH 6.2; **C** 90cm+: Weathered granitic rock variable in depth (sometimes shallower)	**A1** 0-10 cm: Loamy coarse sand to coarse sandy loam, very low nutrient status, pH 5.0; **A2** 10-45 cm: Bleached coarse sandy clay loam, very low nutrient status, pH 5.0; **B2** 45-90 cm: Mottled yellow and yellowish grey light clay, low nutrient status, pH 4.9, **C** 90 cm+: Weathered granitic rock	**UNIFORM** **A1** 0-30 cm: Loamy coarse sand to coarse sandy, very low nutrient status, pH 4.7- 5.3; **A2** 30-55 cm: Bleached coarse sand, very low nutrient status, pH 5.0; **C** 55-120 cm+: Weathered granitic rock **DUPLEX** Mottled yellowish grey duplex soil
Land Degradation-susceptibility	Sheet and rill erosion-low to moderate Wind erosion-low Leaching of nutrients-high	Sheet and rill erosion-low to moderate Wind erosion-low Leaching of nutrients-high	Gully erosion-moderate Compaction-low Leaching of nutrients-moderate
Land Degradation-incidence	Minor sheet erosion Minor wind erosion	Minor sheet erosion Minor wind erosion	Gully erosion common Minor salting
Dominant Vegetation	Candlebark, Manna Gum, Narrow-leaved Peppermint, Yellow Box	Candlebark, Manna Gum, Narrow-leaved Peppermint, Yellow Box	River Red Gum, Swamp Gum. Manna Gum, Yellow Box
Land Use	Grazing, minor cropping	Grazing, minor cropping	Grazing
Capability for residential development (<2.0ha)-major limiting land use(s); major limiting features	Poor - Effluent disposal; depth to hardrock, permeability Earthen dams; depth to hardrock	Poor to moderate - Effluent disposal; depth to hardrock; permeability Earthen dams; depth to hardrock	Very poor - Earthen dams-suitability of subsoil (uniform);

MAP UNIT SYMBOL: **TH** Area:16856ha	MAP UNIT: **Theaden Hill, granitic land system**



Landform pattern	Rolling hills				
Land component number	1	2	3	4	5
Landform element	Rocky crest	Upper drainage depression	Rocky slope, often steep	Gentle slope and saddle	Major drainage depression
Slope Range	3-20 %	6-10 %	5-40 %	2-12 %	1-4 %
Geology: Age Lithology	Devonian Granitic	Alluvium & colluvium	Devonian Granitic	Devonian Granitic	 Alluvium
Site Drainage	Excessively drained	Well drained	Excessively drained	Well drained	Moderately well
Factual Key	Uc1.41	Uc1.41	Dy3.41, Uc1.41	Dy3.41, minor Uc1.41, Uc2.21	Uc1.41, Uc1.42; minor Uf6.32, Dy3
Soil: Topsoil	**A** 0-30 cm: Brown loamy coarse sand, low to very low nutrient status, pH 4.1;	**A** 0-30cm: Brown or grey sandy loam, low nutrient status, pH 5.5-5.9;	**A1:** Coarse sandy loam, low to moderate nutrient status **A2:** bleached	**A1** 0-20 cm: Loamy sand to coarse sandy loam, very low nutrient status, pH 5.5; **A2** 20 -60 cm: Coarse sandy clay loam, very low nutrient status, pH5.5;	**A** 0-10 cm: Sandy loam, low nutrient status, pH5.2;
Subsoil	**AC 3**0-130 cm+: Weathered granitic bedrock	**C** 30-158 cm: Unconsolidated parent material	**B:** Mottled yellowish grey clay	**B** 60-107 cm: Yellow mottled medium clay, moderate nutrient status, pH5.9 **BC** 107+cm partially weathered rock	**C** 10-120 cm: Unconsolidated parent material
Permeability	Rapid	Rapid	Rapid (Uniform); slow (duplex)	Slow	Moderate to rapid
Rock outcrop	20-100 %	0-5 %	10-90 %	0-2 %	0-5 %
Depth to hardrock	10-50 cm	>150 cm	30-60 cm	>120 cm	>200 cm
Unified Soil Group	SM	SM	Not available	CL	SM
Land Degradation-susceptibility	Sheet & fill erosion-low to moderate Wind erosion-moderate Leaching of nutrients-high	Gully erosion-low Leaching of nutrients-moderate to high Compaction of topsoil-low to moderate	Sheet & rill erosion-moderate Wind erosion-moderate Leaching of nutrients-high Landslip-low	Sheet & rill erosion-moderate Wind erosion-moderate Leaching of nutrients (topsoil)- high	Gully erosion- low to moderate Leaching of nutrients-moderate to high Compaction of topsoil-low to mod
Land Degradation-incidence	Minor sheet and wind erosion	Minor gully erosion	Sheet erosion common, minor wind erosion	Minor sheet erosion	Moderate gully erosion
Dominant Vegetation	Messmate, Manna Gum, Candlebark	Manna Gum, Narrow-leaved Peppermint	Messmate, Manna Gum, Candlebark	Manna Gum, Yellow Box	Swamp Gum, Manna Gum

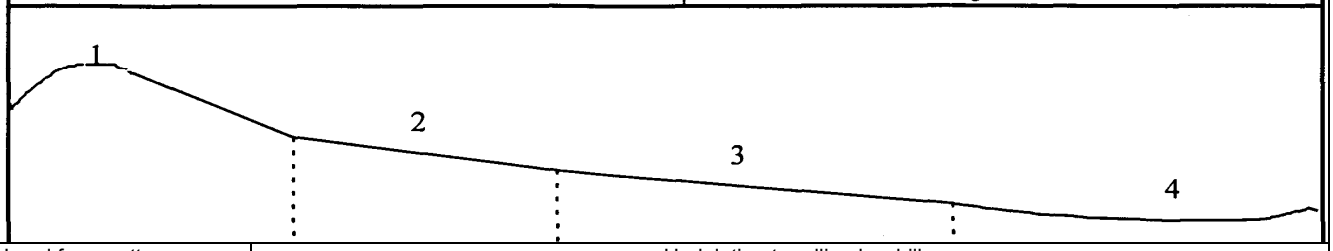
MAP UNIT SYMBOL: TH Area: 16856 ha			**MAP UNIT: Theaden Hill, granitic land system**		
Land Use	Grazing	Grazing	Grazing	Grazing	Grazing
Capability for residential development (<2.0ha)- major limiting land use(s); major limiting features	Very poor - Effluent disposal; depth to hardrock Earthen dams; depth hardrock, suitability subsoil, permeability Secondary roads, Building foundations; depth hardrock, rock outcrop	Very poor - Earthen dams; suitability of subsoil, permeability	Very poor - Effluent disposal; depth to hardrock, Earthen dams; depth to hardrock, Secondary roads, Building foundations; rock outcrop	Moderate - Effluent disposal; permeability Earthen dams; suitability subsoil, permeability, depth hardrock Secondary Roads; USG Building foundations; slope (slab)	Very poor - Earthen dams; suitability of subsoil

MAP UNIT SYMBOL: **Cw** Area:1517ha	MAP UNIT: **Cobaw, granitic land system**

Land form pattern	Rolling hills		
Land component number	1	2	3
Landform element	Rocky crest and knoll	Slope, often rocky	Drainage depression
Slope range	0-25 %	5-40 %	0-1 %
Geology: Age Lithology	Devonian Granitic	Devonian Granitic	Devonian Granitic
Site drainage	Excessively drained	Excessively drained	Well drained
Factual Key	Uc2.12, Uc1.43	Dy3.41, Dr2.41, Uc1.42; minor Dy2.41	Uc1.21
Soil: Topsoil	**A1** 0-20 cm: Loamy coarse sand, low to very low nutrient status, pH 6.1 **A2** 20-60 cm: Coarse sand, conspicuously bleached, very low nutrient status pH 6.2 . **AC** 60-90 cm: Loamy sandy, very low nutrient status, pH 6.1 Depth frequently shallow	**Al** 0-17 cm: Loamy sand, low to very low nutrient status, pH 5.6-5.2 **A2** 17-60 cm: Coarse sandy clay loam, very low nutrient status, pH 5.8	**A** 0-20 cm: Sandy loam, low to very low nutrient status, pH 7.0
Subsoil		**B2** 60-110 cm: Light medium clay, mottled and yellow on lower slopes, whole coloured and red on steep slopes, low nutrient status, pH5.9 **BC** 110-150cm: Clay loam low nutrient status, pH 5.7	**C1** 20-90 cm: Loamy coarse sand, very low nutrient status, pH 5.7-6.0 **C2** 90-150 cm: Coarse sand, very low nutrient status, pH 6.1-7.2 C horizons colluvial or alluvial
Permeability	Rapid	Sandy soils-rapid Duplex soils-slow	Rapid
Rock outcrop	10-50%	0-30%	0%
Depth to hardrock/pan	0-120 cm	50-150 cm	>200 cm
Unified Soil Group	SM	CL	SM
Land Degradation-susceptibility	Sheet and rill erosion- low to moderate Wind erosion-moderate to high Land slips-low to moderate Leaching of nutrients-high	Sheet and rill erosion-moderate wind erosion-moderate Leaching of nutrients (topsoil)-high	Gully erosion-low Leaching of nutrients (high)

MAP UNIT SYMBOL: Cw Area: 1517ha		**MAP UNIT: Cobaw, granitic land system**	
Land Degradation-incidence	Sheet erosion very high on cleared steep slopes	Sheet erosion very high on steep slopes when cleared	minor gully erosion in cleared lower drainage depression
Dominant Vegetation	Messmate, Manna Gum	Messmate, Manna Gum	Swamp Gum
Land Use	Forestry	Grazing, forestry	Minor grazing
Capability for residential development (<2.0ha) major limiting land use(s); major limiting features	Very poor – Effluent disposal, secondary roads, building foundations; depth to hardrock (variable) Earthen dams; suitability of subsoil, depth to hardrock,	Poor-moderate – Effluent disposal; depth to hardrock (variable), permeability (duplex) Earthen dams; depth to hardrock, permeability (uniform) Secondary roads, building foundations; rock outcrop, steep slope	Very poor – Earthen dams; suitability of subsoil, permeability

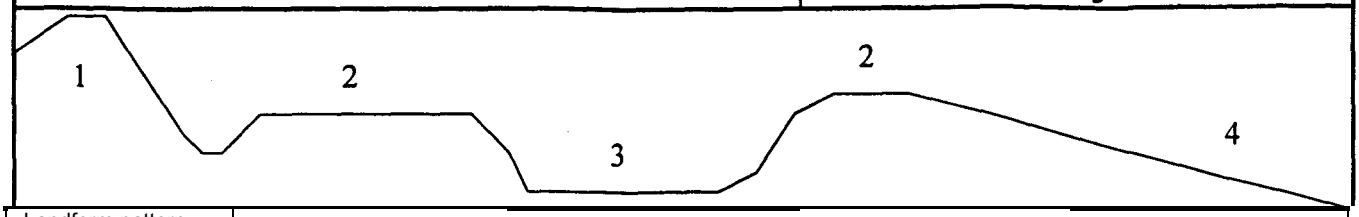
MAP UNIT SYMBOL: **PE** Area:1348ha	MAP UNIT: **Pastoria East, basaltic land system**



Land form pattern	Undulating to rolling low hills			
Land component number	1	2	3	4
Landform element	Crest and upper slope	Colluvial slope below hill	Gentle lower slope	Drainage depression
Slope range	5-30 %	5-20 %	1-8 %	1-3 %
Geology: Age Lithology	Pliocene Oligoclase basalt	Pliocene Colluvium	Pliocene Oligoclase basalt	Pliocene Alluvium
Site drainage	Excessively drained	Well drained	Well drained	Poorly drained
Factual Key	Gn3.11	Gn4.11	Gn3.1, Dr2.42; minor Dy3.4	Uc over Gn3.42, Gn3.42
Soil: Topsoil	**A** 0-10 cm: heavy loam, moderate nutrient status, pH 5.6;	**A** 0-20 cm: Heavy loam, low to moderate nutrient status, pH 5.6-5.8;	**A1** 0-10 cm: Loam, low nutrient status, pH 5.7; **A2** 10-37 cm: Silty clay loam , bleached, low nutrient status, pH 6.0-6.3	Soils variable; commonly dark gradational soils overlain by a sandy granitic wash
Subsoil	**BC** 10-30 cm: Red clay loam, high nutrient status, pH 5.7	**B21** 20-76 cm: Red clay loam to light clay, moderate to low nutrient status, pH 5.9-6.4; **B22** 76-120 cm: Medium clay, low nutrient status, pH 6.2	**B2** 37 60 cm: Red, whole coloured medium clay, high nutrient status, pH 6.2	
Permeability	Moderate to rapid	Moderate	Moderate	Moderate
Rock outcrop	10-50 %	0%	0%	0%
Depth to hardrock/hardpan	20-50 cm	>200 cm	>100 cm	>200 cm
Unified Soil Group	CL	MH	MH	Not available
Land Degradation-susceptibility	Sheet & rill erosion-low Compaction of topsoil-moderate	Sheet & rill erosion-low Compaction of topsoil-moderate	Sheet & rill erosion-low Compaction of topsoil-moderate	Gully erosion- low Compaction of topsoil-moderate to high
Land Degradation-incidence	Minor sheet erosion, usually on steeper slopes when cultivated	Minor sheet erosion, usually on steeper slopes when cultivated	Nil	Minor gully erosion
Dominant Vegetation	Manna Gum	Manna Gum	Manna Gum & Swamp Gum	Swamp Gum

MAP UNIT SYMBOL: PE Area: 1348ha		**MAP UNIT: Pastoria East, basaltic land system**		
Land Use	Grazing	Grazing, cropping	Grazing, cropping	Grazing
Capability for residential development (<2.0ha)- major limiting land use(s); major limiting features	Very poor - Effluent disposal; depth to hardrock Earthen dams; suitability of subsoil, depth to hardrock	Moderate – Effluent disposal; permeability, slope Earthen dams; Linear shrinkage, permeability susceptibility to slope failure, slope Secondary roads; slope, susceptibility to slope failure, linear shrinkage, USG Building foundations; Slope, susceptibility to slope failure	Moderate - Effluent disposal; permeability Earthen dams, suitability of subsoil, permeability Secondary Roads; USG	Poor – Effluent disposal, Building Foundations, Secondary Roads; drainage

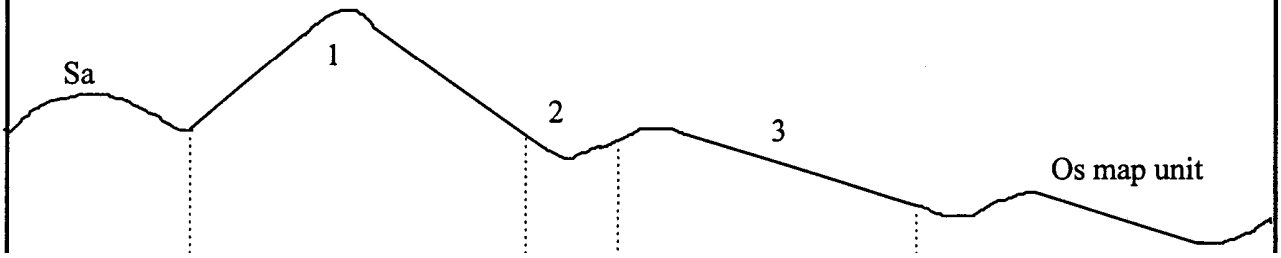
MAP UNIT SYMBOL: **Rs** Area:1800ha	MAP UNIT: **Redesdale, basaltic land system**



Landform pattern	Gently undulating plain bounded by scarps			
Land component number	1	2	3	4
Landform element	crest and slope of volcanic cone	Undulating plain, gilgaied in parts	Minor drainage depression	Scarp
Slope range	10-30 %	0-6 % .	0-2 %	5-30 %
Geology: Age Lithology	Pliocene Basalt	Pliocene Basalt	Pliocene Basalt	Pliocene Basalt
Site Drainage	Excessively drained	Moderately well drained	Poorly drained	Excessively drained
Factual Key	Gn2.12, Gn3.11	Gn3.1, Ug5.25, Dy3.1	Urn, Dy3.12	Gn3.11, minor Uf6.32
Soil:	Shallow red gradation soils with a silty loam topsoil	**Gilgai puff:** **A** 0-6 cm: Light clay, moderate nutrient status, pH 5.7 **B** 6-20 cm: Medium clay, high nutrient status pH 6.6 **Depressions:** **A** 0-20 cm: Fine sandy clay loam, moderate nutrient status, pH 6.3 **B21** 20-60 cm: Medium clay, high nutrient status, pH 6.6-5.5 **B22** 60-105 cm: Medium clay, high nutrient status pH 4.6 **B23** 105-175 cm: Medium to heavy clay, high nutrient status, pH 4.6 **BC** 175 cm+: Medium clay, high nutrient status pH 4.8	Variable; often loamy deposits over buried, dark clay soils	**A** 0-20 cm: Clay loam, moderate nutrient status, pH5.2 **B** 20-45 cm: Medium clay, high nutrient status, pH 5.9-6.1 **BC** 45-90 cm Occasionally shallow friable clay soils
Permeability	Rapid	Moderate (red soils), Slow (others)	Moderate to slow	Rapid to moderate
Rock outcrop	10-50%	0-5%	0%	20-30%
Depth to hardrock	20-60 cm	50-200 cm	100->200 cm	30-60 cm
Unified Soil Group	Not available	CH	CL	CH
Land Degradation-susceptibility	Sheet and rill erosion-low Compaction of topsoil-moderate	Compaction of topsoil-moderate to high Compaction of topsoil-moderate to high	Gully erosion-low Compaction of topsoil-moderate to high	Sheet and rill erosion-low Landslip-low to moderate Compaction of topsoil-low to moderate
Land Degradation-incidence	Minor sheet erosion	Compaction of surface soil	Minor gully erosion	Minor sheet erosion, occasional landslips
Dominant Vegetation	Manna Gum	River Red Gum, Manna Gum, Swamp gum	River Red Gum, Manna Gum, Swamp Gum	River Red Gum, Yellow Box, Manna Gum

MAP UNIT SYMBOL: Rs Area: 1800ha		**MAP UNIT: Redesdale, basaltic land system**		
Land Use	Grazing	Grazing, cropping of cereals and legumes	Grazing	Grazing
Capability for residential development (<2.0ha)- major limiting land use(s); major limiting features	Very poor – Effluent disposal; depth to hardrock Earthen dams; suitability of subsoil, depth to hardrock, permeable subsoil Secondary roads, building foundations; depth to hardrock	Poor – Effluent disposal; permeability	Very poor – Effluent disposal, secondary roads, building foundations; drainage	Very poor – Effluent disposal; depth to hardrock Earthen dams; suitability of subsoil, depth to hardrock Building foundations; slope

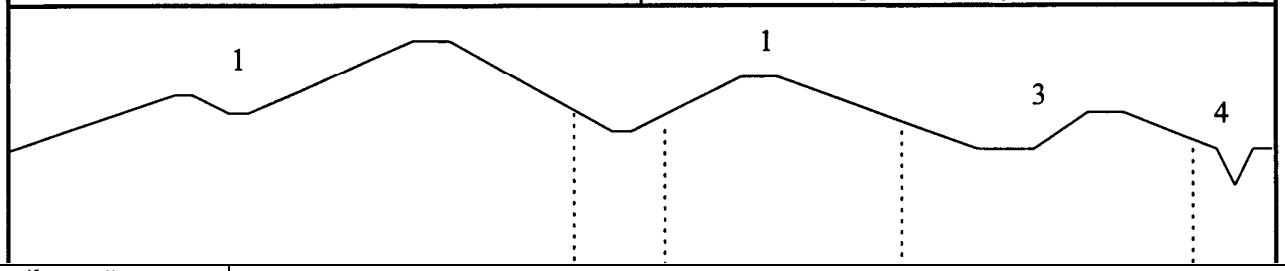
MAP UNIT SYMBOL: **Ka** Area:1105ha	MAP UNIT: **Koala, sedimentary land system**



Land form pattern	Rolling low hills forming prominent ridges		
Land component number	1	2	3
Land form element	Steep slope and narrow crest	Minor drainage depression	Gentle lower slope
Slope range	15-50 %	1-10 %	5-15 %
Geology: Age Parent material	Ordovician Sandstone and mudstone	Alluvium and colluvium	Ordovician Sandstone and mudstone
Site Drainage	Excessively drained	Moderately well drained	Excessively drained
Factual Key	Gn3, Uc1.23, Um; minor Dy3.41	Uc, Urn, Dy	Gn3, Dy3.41
Soil:	Shallow stony soils of uniform or gradational texture; yellow duplex soils in deeper pockets	Variable soils; usually sandy soils or mottled yellow duplex soils	Yellowish or reddish brown gradational or duplex soils
Permeability	Moderate to rapid	Moderate	Moderate
Rock outcrop	0-20 %	0 %	0-10 %
Depth to hardrock/hardpan	10-100 cm	50-200 cm	30-1.5 cm
Unified Soil Group	Not available	Not available	Not available
Land Degradation-susceptibility	Sheet & rill erosion-high Wind erosion-low to moderate Leaching of nutrients-Moderate Compaction of topsoil- low to moderate	Gully erosion-moderate Compaction of topsoil-moderate	Sheet & rill erosion-moderate Compaction of topsoil-moderate
Land Degradation-incidence	Sheet erosion common and often severe	Gully erosion common in the lower depressions	Sheet erosion common
Dominant Vegetation	Messmate, Candlebark, Manna Gum	Long-leaved Box, Red Stringybark, Grey Box, Yellow Box, Manna Gum, Messmate, Candlebark	Long-leaved Box, Red Stringybark, Grey Box, Yellow Box, Manna Gum, Messmate, Candlebark
Land Use	Grazing	Grazing	Grazing

MAP UNIT SYMBOL: Ka Area: 1105ha		**MAP UNIT: Koala, sedimentary land system**	
Capability for residential development (<2.0ha)- major limiting land use(s); major limiting features	Very poor-poor – Effluent disposal, slope, depth to hardrock Earthen dams; slope suitability of subsoil (uniform) Depth to hardrock, permeability Secondary roads; slope, depth to hardrock Building foundations; slope, depth to hardrock	Poor – Earthen dams, depth to hardrock, suitability of subsoil (uniform) Moderate to poor - effluent disposal; depth to hardrock	Very poor to poor – Effluent disposal, farm dams, secondary roads, building foundations; depth to hardrock (variable)

MAP UNIT SYMBOL: **Wg** Area:511ha	MAP UNIT: **Wolfscrag, sedimentary land system**



Landform pattern	Rolling low hills			
Land component number	1	2	3	4
Landform element	Steep crest and slope with outcropping rock strata	Minor drainage depression	Gentle lower crest and slope	Major drainage depression
Slope range	10-40 %	1-6 %	1-12 %	0-2 %
Geology: Age Lithology	Ordovician Sedimentary	Ordovician Sedimentary	Ordovician Sedimentary	Ordovician Sedimentary
Site drainage	Excessively drained	Moderately well drained	Well drained	Poorly drained
Factual Key	Gn3.14, Gn3.71, Um; minor Dy2.11, Gn3.17	Dy3.41; minor Gn3.04, Gn4.51	Dy3.41; minor Dy3.21, Gn3.14, Gn3.84, Dr2.41	Dy3.41, Urn over Dy3.41; minor Urn
Soil: Topsoil	Reddish brown or brown gradational soils, frequently stony; minor stony loamy	Yellowish brown duplex soils with bleached A2 horizons	Yellowish brown duplex soils with bleached A2 horizons; occasional red duplex or red or yellowish brown gradational soils	Variable; commonly mottled yellow duplex soils overlain by a loamy wash
Permeability	Moderate	Slow	Slow	Slow
Rock outcrop	10-80%	0%	0-10%	0%
Depth to hardrock/hardpan	10-70 cm	100-150 cm	50-150 cm	>200 cm
Unified Soil Group	Not available	Not available	Not available	Not available
Land Degradation-susceptibility	Sheet and rill erosion-high Leaching of nutrients-moderate Compaction of topsoil-moderate	Gully erosion-moderate Compaction of topsoil-moderate Salting-moderate	Sheet and rill erosion-moderate Compaction of topsoil-moderate Salting-moderate	Stream-bank erosion-moderate Salting-high Compaction of topsoil-moderate.
Land Degradation-incidence	Sheet erosion common and locally severe	gully erosion and salting common	Minor sheet erosion and salting	Gully erosion common and often sever, salting common

MAP UNIT SYMBOL: Wg Area: 511 ha		**MAP UNIT: Wolfscrag, sedimentary land system**		
Dominant Vegetation	Red Box, Long-leaved Box, Red Stringybark, Grey Box, Yellow Box, Candlebark	River Red Gum, Yellow Box, Grey Box, Red Box, Red Stringybark, Long-leaved Box	Grey Box, Red Box, Long-leaved Box, Red Stringybark, Yellow Box, White Box	River Red Gum, Yellow Box, Candlebark
Land Use	Grazing	Grazing	Grazing, minor cropping	Grazing
Capability for residential development (<2.0ha)- major limiting land use(s); major limiting features	Very poor – poor – Effluent disposal earthen dams; depth to hardrock Secondary roads, building foundations; rock outcrop, depth to hardrock	Poor – Effluent disposal; permeability	Poor-very poor – Effluent disposal; permeability Earthen dams-depth to hardrock	Poor – Effluent disposal; drainage

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APPENDIX A. NOTES TO ACCOMPANY LAND CAPABILITY RATING TABLES

A.1 Total amount of water available to plants

Available Water Capacity (AWC) is a measure of the amount of useable water in the soil for plant growth. It is determined from the difference between the amount of water retained by the soil after drainage (field capacity) and the moisture content of a soil at wilting (permanent wilting point). There is a reasonable correlation between soil texture and AWC (Salter and Williams 1969) (Table A.1)

Table A.1 Available water capacity of soils.

Range (mm/m)	Average value for calculations (mm/m)	Sands	Sandy loams	Loams	Clay loams	Clays
76 - 100	90	KS				
101 - 125	110	LKS	KSL			
126 - 150	130	S				SC, C
151 - 175	160	CS, LS	SL	L	SCL	
176 - 200	190	FS	FSL	CL, ZL	ZCL	ZC
201 - 225	210	LFS				

The total amount of water available to plants can be calculated by adding the amount of available water in each horizon down to a maximum depth of 2 metres.

Note that gravel content of the soil horizons should be taken into account.

Soil horizon	Texture	Depth of horizon (m)	AWC of horizon (mm/m)	Available water in horizon (mm)
A	SL	0.15	160	24
B2	SC	1.25	130	143

For example, the total amount of water in the worked example above = 167 (Class 2)

A.2 Bearing capacity

Measurements were not taken of bearing capacities.

A.3 Coarse fragment sizes

Gravel:	2 - 60 mm
Cobbles:	60 - 200 mm
Stones:	200 - 600 mm
Boulders:	600 - 2000 mm

A.4 Linear shrinkage

The Linear Shrinkage and depth of solum can replace the value for reactivity of a soil. Reactivity is used in the Australian Standard AS 2870.2 (SAA 1977), and is based on the depth of the clay layer and its shrink-swell capacity. Different areas of Victoria are identified, with 0.6 m depth being a common cut-off mark between two categories.

A.5 Condition of the topsoil

The texture, organic matter content and the size/strength of soil aggregates all influence the general behaviour of soils when subjected to different agricultural land uses and management practices. The lack of knowledge relating the performance of soils to specific attributes does not allow values for the above criteria to be divided into meaningful classes - certainly not the 5-class system used in these land capability rating tables. The concept of "Condition of topsoil" combines the score placed on each criteria to give a total score that is then compared to a 5-class rating, (Table A.2).

Table A.2 Rating for topsoil condition.

Criteria	Description	Score
Texture	Sands	1
	Sandy loams	2
	Loams	5
	Clay limns	4
	Clays	3
Structure (grade)	Apedal, massive	1
	Apedal, loose	2
	Weak	3
	Moderate	4
	Strong	5
Structure(size)	Very large (> 200 mm)	1
	Large (50 - 200 mm)	2
	Moderate (10 - 50 mm)	4
	Small (2 - 10 mm)	5
	Very small (< 2 mm)	3
Organic matter content (org.0 x 1.72)	Very low (< 1%)	1
	Low (1 - 2%)	2
	Moderate (2 - 3%)	4
	High (> 3%)	5
Nutrient status of topsoil (sum of exch. Ca, Mg, K)	Very low (< 4 meq/100g)	1
	Low (4-8 meq/100g)	2
	Moderate (9-18 meq/100g)	3
	High (19-30 meq/100g) Very	4
	high (> 30 meq\ 100g)	5
Rating for topsoil condition:	**Class**	**Total score**
	1	21-25
	2	16-20
	3	11-15
	4	6-10
	5	5

For profiles with more than one A horizon, i.e. Al and A2, top soil conditions should be determined separately for each horizon and then averaged.

Nutrient status of topsoil: The topsoil is considered the major source of nutrients for plant growth whereas the subsoil is the more reliable source of moisture. Nutrient status of topsoil = sum of exchangeable base cations (Ca, Mg, K) (Lorimer and Schoknecht 1987).

A.6 Depth to hard rock or impermeable layer

This criterion provides a measure of the effectiveness of the soil profile in filtering the nutrient and bacterial content from the effluent. The Septic Tank Code of Practice (Environment Protection Authority *et al.* 1990) requires a depth of at least one metre.

A.7 Depth to seasonal watertable

The Septic Tank Code of Practice (Environment Protection Authority *et al.* 1990) requires a minimum of 1 m depth of unsaturated soil for the proper functioning of effluent disposal trenches. Ideally the groundwater table should be much lower than one m, thereby reducing the risk of a rising groundwater table influencing the effectiveness of the absorption trenches. The risk of surface salting problems also increases when a saline groundwater table rises to within 1 - 1.5 m of the soil surface.

A.8 Depth of topsoil

Topsoil depth is considered during dam construction and is used when measuring the susceptibility of topsoils to erosion (Table A. 10). Depth of topsoil influences the quantity of overburden that needs to be scraped clear and kept for spreading back on a dam embankment to establish a grass cover, once the construction is completed.

A.9 Dispersibility

Sustainable land use requires that the soil be able to withstand the physical forces of cultivation and compaction without adverse structural change. Soil aggregate stability can be measured by the Emerson Aggregate Test (Emerson 1977). In the case of secondary roads, dispersion can significantly effect the condition of the road when slopes are greater than 4%. Because of the close correlation between dispersible soils and high exchangeable sodium percentages in those soils, it is unnecessary to include both criteria in the capability rating table.

A.10 Drainage

This parameter is the combination of several criteria that influence the moisture status of the soil profile, viz slope, subsurface and surface flow, water holding capacity, level of groundwater tables, perched or permanent, and permeability. Only because of its general usage, reasonable definition (McDonald et al. 1984) and direct relevance to effluent disposal fields, building foundations and secondary roads has this criterion been retained.

A.11 Electrical conductivity

The following correlation in Table A.3 between the electrical conductivity of soil samples taken from the 0 - 50 cm layer of the soil profile and soil salinity has been established.

Table A.3 The effects of soil salting on plant growth.

Class	Severity of salting	E.C. dS/m *	Site characteristics
1	Nil/very low	< 0.3	Plant growth unaffected
2	Low	0.30 - 0.53	Growth of salt-sensitive plants, e.g. cereals and clover is restricted
3	Moderate	0.53 - 1.26	Patchy pasture growth; salt-sensitive plants are replaced with species that are more salt-tolerant
4	High	1.26 - 2.5	Small areas of bare ground; surviving plant species have high salt tolerance
5	Very high/severe	> 2.5	Large areas of bare ground; highly salt-tolerant plants; trees may be dead or dying

* NB: 1000 pS/cm =1 dS/m

A.12 Flooding risk

Building regulations prohibit building on flood-prone land, therefore land with some risk of flooding must be identified. Flooding is unlikely to cause a septic tank to fail, however the risk of polluting the floodwaters with phosphorus, nitrogen and bacterial organisms increases with the number of effluent disposal fields involved. The dilution factor will be dependent on the quantity of floodwater.

Dams are built to intercept and store run-off water. It is not possible in these tables to distinguish between seasonal run-off and seasonal flooding; the latter poses a threat to the stability of the dam, and the risk of flooding will depend on the intensity and duration of rainfall, the run-off characteristics of the catchment and the land use within the catchment. Flooding risk is rated in Table A.4.

Table A.4 Flooding risk.

Risk	Class	Limitation	Condition of flood
Nil	1	No limitation	No flooding
Low	2	Minor	Minor inundation No debris Flood return period: annual
Moderate	3	Significant	Broad, slow moving No debris Flood return period: 1 in 20 to 1 in 50 years
High	4	Major	Broad, slow moving Little debris Flood return period: 1 in 100 years
Severe	5	Prohibitive	Deep channel, fast flowing Debris carrying Flood return period: 1 in 100 years

A.13 Length of the growing season

Agricultural production is governed by moisture, temperature and photoperiod (photoperiod is taken to be consistent throughout Victoria).

Length of Growing Season (months) = 12 - (P + T)

P = Number of months where monthly evapotranspiration > average monthly rainfall

T = Number of months where mean monthly temperature < 6° C

A.14 Number of months per year when average daily rainfall > K_{sat}

This parameter is included (although it is closely aligned to drainage) to provide an indication from climatic, rather than soil and topographic data, of the period of time each year when effluent absorption trenches might cease to function.

Data required:

- Average monthly rainfall figures.
- Average number of wet days for each month.
- K_{sat} values.

Assumptions made:

- Evapotranspiration <1 for winter months.
- Winter-early spring months are when problems arise.
- The soil profile is at field capacity.
- Where slope is significant, run-off = run-on.

A.15 Permeability of a soil profile (Ksat)

Permeability is controlled by the least permeable layer of a soil profile and its ability to transmit water. Permeability is independent of climate and surface drainage. The rate at which water moves down through the soil profile is an indicator of the tendency of a soil to saturate, it is an important feature if plant growth is to be maintained in areas where rainfall is spasmodic or unreliable.

Permeability provides a measure of the rate at which a saturated soil profile will conduct water to depth. K_{sat} measurements may over-estimate the value for the disposal of effluent because the soil macropores are transmitting water, whereas the real situation must take into account the clogging effect of effluent on the bottom of effluent disposal trenches, thereby reducing the rate of water movement into the soil.

The measurement of K_{sat} often produces quite variable results even between replicates on the same site, so the setting of class limits is difficult and by necessity must be very broad. Estimates of permeability can be made using the features of the least permeable soil horizon if K_{sat} values are not available, however it should be clearly indicated where estimates have been made (Table A.5).

Table A.5 Permeability characteristics of a soil profile.

Estimated permeability	K_{sat} range (mm/day)	Time taken for saturated soil to drain to field capacity	Soil features
Very low	< 10	Months	Absence of visible pores
Low	10 - 100	Weeks	Some pores visible
Moderate	100 - 500	Days	Clearly visible pores
High	500 - 1500	Hours	Large, continuous clearly visible pores
Very high	1500 - 3000	Rarely saturated	Abundant large pores
Excessive	> 3000	Never saturated	No restriction to water movement through the soil profile

A.16 Index for permeability/rainfall

This relationship has been included to take into account the situation where a strongly structured soil with very high permeability would be assessed as having a major limitation. In a dry climate, this would be correct as the soil would be drought- prone most of the year, however in a high rainfall area such a soil may be highly productive. Conversely a soil with low permeability may experience waterlogging for extended periods in a high rainfall area, but store sufficient moisture to extend the average growing season of a low rainfall area. A method of combining permeability and rainfall is shown in Table A.6.

Table A.6 Index for permeability/rainfall.

Permeability		Average annual rainfall (mm/year)				
Estimated	K_{sat} (mm/day)	< 400	400 - 600	600 - 800	800 - 1000	> 1000
Very low	< 10	High	High	Moderate	Low	Very low
Low	10 - 100	High	Very high	High	Moderate	Low
Moderate	100 - 500	Moderate	High	Very high	High	Moderate
High	500 - 1500	Low	Moderate	High	Very high	High
Very high	> 1500	Very low	Low	Moderate	High	Very high

A.17 Rock outcrop

This estimate has not been included as a parameter that influences the performance of earthen dams because the parameter, depth to hard rock, is inversely correlated to the proportion of rock outcropping at the soil surface, and is a good surrogate.

A.18 Slope

As the slope increases, so too does the chance of run-on water entering effluent disposal trenches and saturating the system. In addition, run-off of unfiltered effluent is more likely to enter minor drainage depressions and water courses. The increasing incidence of algal blooms in water storages emphasises the need to eliminate the entry of unfiltered effluent into watercourses.

The best ratio of earth moved to water stored in dams occurs on land with slopes between 3-7%. Gentler slopes involve greater expense as the above ratio approaches unity, whereas steeper slopes require higher embankments for proportionally less water stored.

A.19 Susceptibility to gully erosion

No single factor can adequately represent the susceptibility of an area to the gully erosion process. A number of factors are involved and each should *be* scored independently and then the sum of the scores can be related back to a 5 - class rating (Table A.7).

Table A.7 Susceptibility to gully erosion.

Criteria	Description	Score
Slope	< 1% 1 - 3% 4 - 10% 11 - 32% >32%	1 2 3 4 5
Sub-soil dispersibility	El E2, E3(3), E3(4) E3(1), E3(2) E4, E5 E6, E7, E8	5 4 3 2 1
Depth to rock/hardpan	0 - 0.5m 0.6 - 1.0m 1.1 - 1.5m 1.6 - 2.0m > 2.0m	1 2 3 4 5
Subsoil structure	Apedal, massive Weak fine <2 mm mod. 2 - 10 mm coarse > 10 mm Moderate fine <2 mm mod. 2 - 10 mm coarse > 10 mm Strong fine < 2 mm mod. 2- 10 rum coarse > 10 mm Apedal, single grained	1 3 2 1 4 3 2 5 3 1 5
Lithology of substrate	Basalt Volcanic Rhyodacite Granite Alluvium Colluvium Tillite Ordovician sandstone/mudstone Silurian sandstone/mudstone	1 2 2 4 3 5 4 5 4
Rating for susceptibility to gully erosion:	**Class** 1. Very low 2. Low 3. Moderate 4. High 5. Very high	**Total score** 6-10 11 - 13 14 - 17 18 - 20 21 - 25

A.20 Susceptibility to slope failure

The instability of slopes in a catchment area of a dam poses a threat to the storage capacity of that dam. Additional costs are also involved if the dam requires regular desludging. This assessment considers that land slips are the result of factors such as soil depth, slope, soil texture, volume of water held in the soil, permeability of the solum and the underlying parent material.

Since the quantity of water in a profile is itself a function of soil texture, depth and permeability, the table below is presented as a first attempt to assess the susceptibility of land to slope failure by relating the total amount of water in the soil profile to the slope (Table A.8).

Table A.8 Susceptibility to slope failure.

Slope %	Total amount of water in the soil profile		
	Low (< 70 mm H_20)	Moderate (70-170 mm H_20)	High (> 170 mm 11_20)
Gentle < 10	Very low	Very low	Low
Moderate 10-32	Low	Moderate	High
Steep > 33	Moderate	High	Very high

A.21 Suitability of subsoil for earthen dams

In the building of earthen dams, suitability of subsoil is dependent on the nature of the material, which is represented by the Unified Soil Group classification, and depth of the material. Refer to Table A.9

Table A.9 Suitability of subsoil for earthen dams.

Unified soil group of subsoil					
DEPTH OF SUBSOIL (m)	SP, SW, GP, GW, Pt, OH, OL	ML, MH	GM, CH, SM	CL	GC, SC
< 0.5	Very low	Very low	Very low	Very low	Very low
dispersibility	Very low	Low	Moderate	Moderate	Moderate
1.5 - 1.0	Very low	Moderate	High	High	High
> 1.5	Very low	Moderate	High	High	Very high

A.22 Susceptibility of soil to sheet and rill erosion by water

The table following (Table A.10) has been adapted from Elliott and Leys (199l). The erodibility index for a range of soil properties closely relates to the susceptibility of soils to erosion by water, and in the tables below, the same soil properties have then used (texture, structure grade, topsoil depth and dispersibility (Emerson aggregate test)) and then related to slope :o determine a rating for susceptibility. The final rating for susceptibility to sheet/rill erosion is read from Table A.11 once the erodibility of the topsoil and the slope of the area have been assessed.

Table A.10 Erodibility of topsoils.

Texture group (A1)	Structure grade (A1)	Horizon depth (A1 + A2)	Dispersibility		
			VL-L E3(1), E3(2), E4, E5, E6, E7, E8	M – H E3(3), E3(4), E2	VH E1
Sand	Apedal	<0.2 m	M		
		0.2 – 0.4 m	L		
		>0.4 m	L		
Sand loam	Apedal	<0.2 m	M	H	
		0.2 – 0.4 m	L	M	
		>0.4 m	L		
	Weakly pedal	<0.2 m	H	E	
		0.2 – 0.4 m	M	V	
		>0.4 m	M		
Loam	Apedal	<0.2 m	M		
		0.2 – 0.4 m	L	H	
		>0.4 m	L	M	
	Weakly pedal	<0.2 m	H		
		0.2 – 0.4 m	M	E	
		>0.4 m	M	V	
	Peds evident	<0.2 m	H		
		0.2 – 0.4 m	H	E	
		>0.4 m	H		
Clay loam	Apedal	<0.2 m	M	H	
		0.2 – 0.4 m	L	M	
		>0.4 m	L		
	Weakly pedal	<0.2 m	H	E	
		0.2 – 0.4 m	M	V	
		>0.4 m	M		
	Peds evident	<0.2 m	H	E	
		0.2 – 0.4 m	H	E	
		>0.4 m	M		
Light clay	Weakly pedal	<0.2 m	H	E	
		0.2 – 0.4 m	M	V	
		>0.4 m	M	V	E
	Peds evident	<0.2 m	M	V	E
		0.2 – 0.4 m	M	H	E
		>0.4 m	M	H	E
	Highly pedal	<0.2 m	H	E	E
		0.2 – 0.4 m	M	V	
		>0.4 m	M	V	
Medium to heavy clay	Weakly pedal	<0.2 m	M	H	E
		0.2 – 0.4 m	M	H	V
		>0.4 m	M	H	V
	Peds evident	<0.2 m	H	E	E
		0.2 – 0.4 m	M	V	E
		>0.4 m	M	V	E
	Highly pedal	<0.2 m	H	E	E
		0.2 – 0.4 m	M	V	E
		>0.4 m	M	V	E

L – Low M – Moderate H – High V – Very high E - Extreme

Table A.11 Susceptibility of soil to sheet and rill erosion.*

Slope %	Topsoil erodibility (from Table A.10)				
	Low	**Moderate**	**High**	**Very high**	**Extreme**
< 1 %	Very low	Very low	Low	Low	Moderate
1 - 3 %	Very low	Low	Moderate	Moderate	High
4 - 10%	Low	Moderate	Moderate	High	Very high
11 - 32%	Moderate	Moderate	High	Very high	Very high
> 32%	Moderate	High	Very high	Very high	Very high

*Note: Topsoil erodibility is determined from the texture, structure, depth and dispersibility of the topsoil (Table A.10). The susceptibility of the topsoil to sheet and rill erosion relates to the combined effect of slope and topsoil erodibility (Table A.11).

A.23 Susceptibility of soil to erosion by wind

The susceptibility of land to wind erosion is a function of soil erodibility, the probability of erosive winds when the soil is dry and the exposure of the land component to wind (Lorimer 1985).capability rating tables (Table A.12). Soil erodibility is a very important factor to consider in land

Table A.12 Soil erodibility.

Soil type		Rating
1.	Surface soil has a strong blocky structure (aggregates > 0.8 mm), or is apedal and cohesive or has a dense layer of stones, rock or gravel	Very low
	Surface soil has strong fine structure (aggregates < 0.8 mm)	Moderate
	Surface soil has a weak-moderate structure or is apedal and loose	Go to 2
2.	Surface soils with organic matter > 20%	High
	Surface soils with organic matter 7 - 20%	Moderate
	Surface soils with organic matter < 7%	Go to 3
3.	Surface soils with the following textures:	
	Fine-medium sands	Very high
	Loamy sands	High
	Sandy loams, silty loams	High
	Loams, coarse sands	Moderate
	Clay looms	Low
	Clays	Very low

A.24 Susceptibility to acidification

Soil acidification is usually observed over time as a decrease in soil pH. It may take place in the topsoil or subsoil. Soil acidification will cause contrasting effects depending upon the initial pH of the soil. In general, soil pH below 4.5 ($CaC1_2$) will cause toxic aluminium and manganese to be released. This causes retarded root growth in plants and may cause retarded growth of soil plants and increase leaching of soil nutrients into groundwater, rivers and streams.

Measurement of susceptibility to acidification for this report is based upon the following table (Table A.13) and analysis of topsoils from each map unit.

Table A.13 Susceptibility of soil to acidification.

Susceptibility	Texture	pH (CaCl2)	Annual rainfall
Low	Medium	< 4.5	> 450 mm
	Heavy	All	> 450 mm
Moderate	Medium	> 4.5	> 450 mm
	Light	< 4.5	> 450 mm
High	Light	> 4.5	> 450 mm

Note: Land management, such as pasture species and stocking rates can contribute to acidification. Organic matter is not used as an indicator for susceptibility as its effects are complex.

APPENDIX B. WORKING TABLES FOR LAND CAPABILITY CLASSES

B.1 Agriculture

MAP UNITS	Qa1	Qa2	Qbla	Qblc	Qbld	Qble	Qblf	Qblg	Qb2b(i)	Qb2c(i)	Qb2d(i)	Qb2e(i)	Qb2f(i)	Qb2g(i)	Qb2h(i)	Qb21	Qb2e(ii)	Qb2f(ii)	Qb2g(ii)
climate	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
topography	2	2	2	4	4	2	3	2	5	4	4	2	3	2	2	2	2	3	2
topsoil conditions A1,A2	1	1	1	1 /2	1 /2	1	2	2/1	1 /2	1	1	1	1	1	1	1	1	1	1
depth of topsoil	2	3	2	2	2	2	2	2	4	4	4	3	3/4	3/4	3/4	2	2	2	2
depth to hard rock/pan	1	1	4	2	2	2/3	2/3	2	3	3	3	3	2	2	2	2	2	2	2
depth to seasonal watertable	5	5	1	1	1	1	2	2	1	1	1	1	2	2	2	5	2	2	2
available water capacity	1	1	5	4	4	3	3	3	3	4	4	3	3	3	3	2	3	3	3
permeability-rainfall index	1	2/3	2	2	2	2	1	1	1/2	1/2	1/2	3/2	3	3	3	3	2/3	2/3	2/3
dispersibility of topsoil	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1/2	1\2	1\2
gravel /stone / boulder content	2	1	4	4/3	4/3	3	3/4	3/4	3	3	3	4/3	3	2	2	2	2	2	2
electrical conductivity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
susceptibility to sheet erosion	3	2	3	4	4	3	3	3	5	4	4	3	3	3	3	3	3	3	3
susceptibility to gully erosion	3	2/3	1	2	2	1	2	1	2	2	2	1	1	1	1	2	1	2	1
susceptibility to wind erosion	1	1	1	3/2	3/2	2	3	3	1	3/2	3/2	1	1	1	1	1	1	1	1

B.1 Agriculture

MAP UNITS	Qvb	Qvc	Qvd	five	Qvf	Qvg	Qvh	Osa	Osb	Osc(i)	Osc(ii)	Osd(i)	Osd(ii)	Ose	Osf	Osg	Osh
climate	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
topography	5	4	4	2	3	2	2	2	5	4	4	4	4	2	3	2	3
topsoil conditions A1,A2	1	1	1	1	1	1	1	2	2	2\3	2	2\3	2	2\3	2\3	2\3	2
depth of topsoil	2	3	2	2	2	2	2	4\3	2	3	3	3	3	2	2	2	3
depth to hard rock/pan	3	3	2	2	2	2	2	3	4	3	5	3	5	2	4	3	2
depth to seasonal watertable	1	1	1	1	2	2	2\3	1	1	1	1	1	1	1	2	2	3/2
available water capacity	4	4	2	1	1	1	4	5	4	3	5	3	5	4	3	3	4
permeability-rainfall index	3	3	3	3	3	3	1	1	2	2	1	2	1	1	1	1	2
dispersibility of topsoil	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1
gravel /stone / boulder content	4	3	2	2	2	2	3	4	3	4	4\5	4	4\5	4	3	3	4
electrical conductivity	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3
susceptibility to sheet erosion	5	4	4	3	3	3	3	3	5	3\4	4	3\4	4	2	3	3	3
susceptibility to gully erosion	3	3	2	2	3	2	2	2	3	3\4	2	3\4	2	3	3	3	3
susceptibility to wind erosion	3\2	1	1	1	1	1	3	2\3	3	3	2	3	2	3	2\3	2\3	3

B.2 Effluent Disposal

MAP UNITS	Qa1	Qa2	Qb1 a	Qblc	Qbld	Qble	Qblf	Qblg	Qb2b(i)	Qb2c(i)	Qb2d(i)	Qb2e(i)	Qb2f(i)	Qb2g(i)	Qb2h(i)	Qb2I	Qb2e(ii)	Qb2f(ii)	Qb2g(ii)
slope	1	1	1	4	3	1	2	1	5	4	3	1	2	1	1	1	1	2	1
flooding risk	2	2	1	1	1	1	1	1	1	1	1	1	1	2	4	3	1	1	2
drainage	4	4	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	4
depth to seasonal watertable	5	4	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1
depth to impermeable layer	1	1	4	2	1	2	2	1	2	2	2	2	1	1	1	1	1	1	1
no. of months/year ay. rainfall > Ksat	1	2	1	1	1	1	1	1	1	1	1	1	5	5	5	5	1	1	1
permeability	2	4	1	1	1	2/1	3/2	3/2	4/2	4/2	3/2	4/5	5	5	5	5	4	4	4

MAP UNITS	Qvb	Qvc	Qvd	Qve	Qvf	Qvg	Qvh	Osa	Osb	Osc(i)	Osc(ii)	Osd(i)	Osd(ii)	Ose	Osf	Osg	Osh
slope	5	4	3	1	2	1	1	1	5	4	4	3	3	1	2	1	2
flooding risk	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	3
drainage	2	2	2	2	2	2	3	2	2	2	2	2	2	3	3	3	3
depth to seasonal watertable	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
depth to impermeable layer	2	2	1	1	1	1	1	2	4	1	5	1	5	1	4	2	1
no. of months/year ay. rainfall > Ksat	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
permeability	1	1	1	1	1	1	2	2	1	4/3	2	4/3	2	2	2	2	4

B.3 Farm Dams

MAP UNITS	Qa1	Qa2	Qbla	Qblc	Qbld	Qble	Qblf	Qblg	Qb2b(i)	Qb2c(i)	Qb2d(l)	Qb2e(i)	Qb2f(i)	Qb2g(i)	Qb2h(i)	Qb2I	Qb2e(ii)	Qb2f(ii)	Qb2g(ii)
slope	2	2	1\2	5	4	1\2	1	2	5	5	4	2	1	2	1	2	2	1	2
linear shrinkage	2	4	2\3	2	2	2	4	4	4	4	4	4	4	4	4	4	4	4	4
suitability of subsoil	3/4	3\2	5	5	5	3/4	4	4	5	5	5/4	4	4	4	4	3	4	4	4
depth to seasonal watertable	5	5	1	1	1	1	3	3	1	1	1	1	3	3	3	5	3	3	3
depth to hard rock	1\2	2\1	5	4	4	4	4	4\3	4	4	4\3	4\3	4\3	4\3	4\3	4\3	4\3	4\3	4\3
permeability	4	2/3	5	4	4	4	4	4	3/4	3/4	3/4	2/3	2	2	2	2	2/3	2/3	2/3
dispersibility of subsoil	3\4	3	_	5	5	_	3	3	3/2	3/2	3/2	3/2	3/2	3/2	3/2	2\3	2/3	2/3	2/3
susceptibility to slope failure	2	2	1	2	2	1	1	1	4	3	3	1	1	1	1	2	1	1	1

B.3 Farm Dams

MAP UNITS	Qvb	Qvc	Qvd	Qve	Qvf	Qvg	Qvh	Osa	Osb	Osc(i)	Osc(ii)	Osd(i)	Osd(ii)	Ose	Osf	Osg	Osh
slope	5	5	4	2	1	2	2	2	5	5	5	4	4	2	3	2	3
linear shrinkage	3	4	4	4	4	4	3	4	4	3	2	3	2	4	3	3	2
suitability of subsoil	5	5	4	4	3\4	3\4	4	5	5	3	5	3	5	5	4	3\4	4
depth to seasonal watertable	1	1	1	1	1	1	3	1	1	1	1	1	1	1	3	3	3
depth to hard rock	4\3	4\3	3	3	3	3	4	4/3	4\5	3\4	5	3\4	5	3	4/5	4	4
permeability	5	5	5	5	5	5	4	3/4	4	3	4	3	4	3/4	3/4	3/4	3
dispersibility of subsoil	4	4	4	4	4	4	3	5	_	3	5	3	5	5	3	3	1/3
susceptibility to slope failure	3	3	4	2	2	2	1	1	3	3	2	3	2	1	1	1	1

B.4 Secondary Roads

MAP UNITS	Qa1	Qa2	Qbla	Qblc	Qbld	Qble	Qblf	Qblg	Qb2b(i)	Qb2c(i)	Qb2d(i)	Qb2e(i)	Qb2f(i)	Qb2g(i)	Qb2h(i)	Qb21	Qb2e(ii)	Qb2f(ii)	Qb2g(ii)
slope	2	1	2	4	4	2	3	2	1	4	4	2	2/3	1 /2	2	1	2	3	2
drainage	4	4	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	4
depth to seasonal watertable	5	4	1	1	1	1	2	2	1	1	1	1	2	2	3/2	5	2	2	2
proportion of stone and boulder	2	1	4/5	4	4	3	4	4	3	3	3	4	3	2	2	2	2	2	2
depth to hard rock	1	1	4	1	1	2/1	1	1	2	2	2	2	1	1	1	1	1	1	1
susceptibility to slope failure	2	2	1	2	2	1	1	1	4	3	3	1	1	1	1	2	1	1	1
linear shrinkage	2	4	-	2	2	-	4	4	4	4	4	4	4	4	4	4	4	4	4
flooding risk	2	2	1	1	1	1	1	1	1	1	1	1	1	2	4	4	1	1	2
dispersibility of subsoil (>4% slope)		-	-	1	1	-	2	2	-	-	-	-	2	2	-	-	-	2	
USG subsoil	4	3	-	3	3	-	3	3	3	3	3	3	3	3	3	3	3	3	3

B.4 Secondary Roads

MAP UNITS	Qvb	Qvc	Qvd	Qve	Qvf	Qvg	Qvh	Osa	Osb	Osc(i)	Osc(ii)	Osd(i)	Osd(ii)	Ose	Osf	Osg	Osh
slope	5	4	4	2	3	2	2	2	5	4	4	4	4	2	3	2	2/4
drainage	2	2	2	2	2	2	3	2	2	2	2	2	2	3	3	3	3
depth to seasonal watertable	1	1	1	1	2	2	2/3	1	1	1	1	1	1	1	2	2	3/2
proportion of stone and boulder	4	3	2	3/4	2	2	3	4	2	4	4	4	4	4	3	3	4
depth to hard rock	2	2	1	1	1	1	1	2	3	1	4	1	4	1	3/2	2	1
susceptibility to slope failure	3	3	4	2	2	2	1	1	3	3	2	3	2	1	1	1	1
linear shrinkage	3	4	4	4	4	4	3	4	-	3	1	3	1 .	4	3	3	2
flooding risk	1	1	1	1	1	1	3/2	1	1	1	1	1	1	1	1	1	3
dispersibility of subsoil (>4% slope)	2	2	2	-	2	-	-	_	-	2	1	2	1	1	2	2	2/4
USG subsoil	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	3	3

B.5 Rural Residential Development

MAP UNITS	Qa1	Qa2	Ob1a	Qblc	Qbld	Qb1e	Qblf	Qblg	Qb2b(i)	Qb2c(i)	Qb2d(i)	Qb2e(i)	Qb2f(i)	Qb2g(i)	Qb2h(i)	Qb2I	Qb2e(ii)	Qb2f(ii)	Qb2g(ii)
effluent disposal	5	4	4	4	3	3	3	3	5	4	3	4	5	5	5	5	4	4	4
farm dams	5	5	5	5	5	4	4	4	5	5	5	4	4	4	4	5	4	4	4
secondary roads	5	4	5	4	4	3	4	4	4	4	4	4	4	4	4	5	4	4	4
building foundation i);ii)	5	4	4	4/3	4/3	3	4	4	5/4	4/3	3/4	4	4	4	4/5	5	4	4	4

MAP UNITS	Qvb	Qvc	Qvd	Qve	Qvf	Qvg	Qvh	Osa	Osb	Osc(i)	Osc(ii)	Osd(i)	Osd(ii)	Ose	Osf	Osg	Osh
effluent disposal	5	4	3	2	2	2	3	2	5	4	5	4	5	3	4	3	4
farm dams	5	5	5	5	5	5	4	5	5	5	5	4	5	5	4	4	4
secondary roads	5	4	4	4	4	4	3	4	5	4	4	4	4	4	3	3	4
building foundation i);ii)	5/4	3/4	4	4	3/4	3/4	3	4	5/4	3/4	4	4/3	4	4	4	4	4

APPENDIX C. SPECIFIC METHODOLOGY

C.1 Map unit determination

Map units were delineated according to geology and slope category (McDonald *et al.* 1984) using geological mapping, topographical mapping, aerial photography and field survey techniques.

C.2 Field observations

Most field descriptions are based on McDonald *et al.* (1984), Northcote (1979) and Isbell (1994). The definition for soil horizon boundaries is listed below.

S	Sharp	< 5 mm
A	Abrupt	5 - 20 mm
C	Clear	20 - 50 mm
G	Gradual	50 - 100 mm
D	Diffuse	> 100 mm
+	Continuing	

C.3 Field tests

C.3.1 Saturated hydraulic conductivity

Site selection:

Considerable time and effort is required to obtain meaningful permeability (IC_{sat}) values. It is imperative that sites are chosen carefully prior to the day of measurement. The sites should have nil, or at most, minimal disturbance.

Procedure:

i) Insert five small (35 cm diameter) and five large (40 cm diameter) infiltration rings with the small rings placed inside the large rings, so that each ring is approximately 100 mm into the main clay horizon. Remove some topsoil if necessary but care should be taken to cause minimal soil disturbance.

ii) Rings need to be at least two metres apart and located at random. Relocate rings if obstacles such as stones or roots prevent an even downward movement of the ring into the soil.

iii) Fill rings with water and set up reservoir tanks so that water is added when the level drops below the outlet tube. Record the time and date on field sheets.

iv) Place lids on rings to minimise evaporation and interference.

v) Check that all containers are full and will last overnight to allow soil to saturate and conductivity rate to equilibrate.

vi) Record water levels at various times during the day (depending upon infiltration rate), and leave for 24 hour period without any interruptions to the water flow, if possible .

vii) Next day dig out each ring taking care not to disturb the soil contained within the ring. Up-end the ring and record the proportion of soil area that has been transmitting water for each ring and record if water movement has been evenly distributed or confined to root/worm holes or structural cracks. Note any other differences, i.e. rocks, sand, clay patches.

C.4 Establishing Recharge Values

Characteristics of Very High Recharge Area

Permeability of profile: >1000 mm/day

Characteristics of High Recharge Areas

Soil depth:	<25 cm
and/or outcropping bedrock:	>10%
and/or permeability of profile:	>200 mm/day
and/or clay content of clayiest layer:	<25%
and/or soil type:	uniform sands, loamy sands, uniform loams, sandy, silt loams, loams (Uc, Um, GC)
and/or duplex soils:	red and whole coloured, A2 horizons present but not bleached, high Fe_20_3 throughout B horizon
side slopes:	>25%

Characteristics of Moderate Recharge Areas

soil depth:	25-100 cm
outcropping bedrock:	1-10%
profile permeability:	50-200 mm/day
clay content of clayiest layer:	25-35%
soil type:	Gradational, Duplex acid, whole coloured, Duplex, A2 may be present and sporadically bleached

Characteristics of Low-Nil Recharge Areas

soil depth:	>100 cm
outcropping bedrock:	0%
profile permeability:	<50 mm/day
clay content of clayiest layer:	>35%

soil type: Uniform clays (Uf), Uniform cracking clays (Ug), Duplex soils with conspicuously bleached A2, mottled B horizons and/or gleying characteristics.

C.5 Laboratory analysis

Samples collected for each soil horizon were air dried, ground with a mortar and pestle and separated with 4.75 and 2 mm sieves into a gravel fraction (4.75 - 2 mm), and soil. The gravel fraction was reported as a percentage of the air dried field sample and discarded, while all subsequent tests were carried out on the soil samples and reported in terms of oven dried (105 °C) samples (except for EC, pH and Cl).

C.5.1 Physical properties

1. Particle size analysis

The method used for particle size analysis is based upon that of Hutton (1956), which divides the soil sample into the following four principal size groups:

Coarse sand	2.0 - 0.20 mm
Fine sand	0.20 - 0.02 mm
Silt	0.02 - 0.002 mm
Clay	< 0.002 mm

In this method the soil sample is mechanically dispersed using pentasodium triphosphate (sodium tripolyphosphate), shaken in a sedimentation cylinder, and silt and clay percentages determined on a 2% soil water mixture using a plummet balance. After hand decanting the silt and clay suspension, the sand fractions are determined by sieving and weighing the oven dried (105 °C) sand fractions.

Due to the presence of both organic material and solutes in the soil and also due to the limitations of the technique used, the sum of the four fractions does not always equal 100%. Limits of 4% variation for surface horizons and 2% variation for lower horizons are regarded as acceptable. The determination is repeated for samples outside these limits. If repeat samples still remain outside these limits, then the closest result is accepted.

2. Emerson class

Soil dispersion is tested using the method of Emerson, (1967), and based upon the Australian Standard AS1289, C8.1, (1980). This gives eight dispersion classes from El to E8, where El is the most dispersive class and E8 the least dispersive class. Class E5 was further divided into four sub-classes E5(A), E5(B), E5(C) and E5(D), where E5(A) is more dispersive than E5(D). Also, classes E2 and E3 were each divided into four sub-classes according to the modification of Loveday and Pyle (1973), as quoted in Craze and Hamilton (1991). In this classification E2(1) is less dispersive than E2(4) and E3(1) is less dispersive than E3(4).

The order of soil dispersion from most dispersive to least dispersive is therefore:

E1
E2(4), E2(3), E2(2), E2(1)
E3(4), E3(3), E3(2), E3(1)
E4
E5(A), E5(B), E5(C), E5(D)
E6
E7
E8

3. Atterberg limits

Atterberg investigated the behaviour of fine grained soil with varying water content. He used the following definitions, quoted in Hicks (1991):

(a) The liquid limit is the water content at which a trapezoidal groove of specified shape, cut in moist soil held in a special cup, is closed after 25 taps on a hard rubber plate.

(b) The plastic limit is the water content at which the soil begins to break apart and crumble when rolled by hand into threads three mm in diameter.

(c) The shrinkage limit is the water content at which the soil reaches its theoretical minimum volume, as it dries out from a saturated condition.

The plasticity index is the difference between the liquid and plastic limits, and represents the range of water contents that the soil remains in the plastic state.

Atterberg limits are determined on a sieved soil fraction with particles < 0.425 mm in size. The methods are based upon the Australian Standard 1289 (1977), as follows:

Liquid limit	AS1289. C1.1
Plastic limit	AS1289. C2.1
Plasticity index	AS 1289. C3.1
Linear shrinkage	AS 1289. C4.1

C.5.2 Chemical properties

Soil chemical analyses were carried out by the State Chemistry Laboratory, South Road, Werribee, Vic., 3030.

1. EC, pH, and CI determinations

These determinations are carried out on a 1:5 water suspension shaken for one hour, and allowed to equilibrate.

(a) Electrical conductivity

This test is used to estimate the concentration of soluble salts in the soil. Measurements are made on the soil water suspension using a dip cell and direct reading meter. Values are determined at 25^{o}C.

State Chemistry Laboratory, Method 009 (1986).

(b) pH in H_2O at 20^{o}C

The pH of the above suspension is determined using a calomel electrode and digital pH meter.

State Chemistry Laboratory, Method 009 (1986).

(c) pH in $CaCl_2$

This is carried out on the soil water suspension after the pH in H_2O determination. One ml of 1M calcium chloride solution is added to the soil water suspension, and the mixture stirred. The pH is then measured again.

State Chemistry Laboratory, Method 009 (1986).

(d) Chloride

A fresh 1:5 soil water suspension is titrated with a silver nitrate solution, using an electrical circuit to determine the end point of the titration. Note that this determination may be omitted if the EC determination is <0.1 dS/m.

State Chemistry Laboratory, Method 003 (1982).

2. Oxidizable organic carbon

In this determination the soil sample is oxidized by chromic acid in the presence of excess sulphuric acid, without the application of external heat (Walkley and Black, 1934). The colour produced is measured with a spectrophotometer.

State Chemistry Laboratory, Method 014 (1987).

3. Total nitrogen

Total nitrogen is determined by a Kjeldahl method, where the sample is digested with a sulphuric acid/selenious acid mixture. The resulting solution is analysed for nitrogen colorimetrically.

State Chemistry Laboratory, Method 021 (1985).

4. Available potassium

The Skene method is used where soil potassium is extracted with 0.05M hydrochloric acid, and the potassium determined with an atomic absorption spectrophotometer (Skene 1956).

State Chemistry Laboratory, Method 011 (1987).

5. Available phosphorus

Phosphorus is determined by the Olsen method in which the soil phosphorus is extracted with a 0.5M sodium bicarbonate solution at pH 8.5, (Olsen *et al*. 1954). The phosphorus is then measured colourimetrically after reduction with ascorbic acid.

State Chemistry Laboratory, Method 010 (1982).

6. Exchangeable aluminium and manganese

The soil sample is extracted with a 1M potassium chloride solution, and both determinations are made on the one extract. Aluminium is determined colourimetrically using pyrocatechol violet. Manganese is determined by atomic absorption spectrometry.

State Chemistry Laboratory, Method 001 (1985).

7. Extractable bases, calcium, magnesium, potassium and sodium

The bases are extracted from the soil with a 1M ammonium acetate solution at pH 7, and the bases are then analysed by atomic absorption spectroscopy.

State Chemistry Laboratory (1993) – draft procedure.

8. Total exchangeable bases

This is a calculated value consisting of the sum of the exchangeable bases calcium, magnesium, potassium and sodium, as determined in method 7 above.

9. Exchangeable hydrogen

The exchangeable hydrogen is extracted from the soil using 0.053N triethanolamine and back titrated with 0.2M hydrochloric acid. This is a method modified by Peech *at al*. (1962).

State Chemistry Laboratory, Method 005 (1984).

10. Cation exchange capacity

This is a calculated value consisting of the sum of the exchangeable bases calcium, magnesium, potassium and sodium plus exchangeable hydrogen, as determined in methods 7 and 9 (above).

APPENDIX D. PHYSICAL LABORATORY RESULTS

Map Unit	Site Number	Laboratory Number	Horizon	Horizon Depth mm	Air Dry Water Content %	Particle Size Distribution							Emerson Class	Atterberg Limits			
						Gravel > 2mm %	Coarse sand %	Fine Sand %	Silt %	Clay %	Total Fine Earth %	Fines <0.074 mm %		Liquid Limit %	Plastic Limit %	Linear Shrinkage %	Plasticity Index %
Qb2f(ii)	K1	950373	A11	110	5.94	4	7	29	32	29	97	80	E8				
	K1	950374	A12	210	4.98	15	8	27	35	30	100	85	E5(A)				
	K1	950375	B1	440	5.08	6	10	24	28	38	100	85	E3(1)				
	K1	950376	B21	700	7.56	9	8	14	15	63	100	89	E3(1)	86	36	20	50
	K1	950377	B22	810	7.58	8	7	21	19	54	100	89	E5(A)				
	K1	950378	B23	970	8.48	2	9	17	14	60	100	85	E5(A)				
Qb2f(i)	K2	950379	A1	100	7.52	0	6	31	18	43	97	83	E7				
	K2	950380	B21	300	8.07	10	7	29	14	49	98	85	E7	77	30	17	47
	K2	950381	B22	900	8.45	2	8	31	13	47	99	84	E5(A)	80	26	20	54
	K2	950382	B3	1200	4.87	30	20	45	8	27	100	64	E3(1)				
Qb2l	K3	950383	A1	160	4.20	0	4	42	29	26	100	87	E8				
	K3	950384	B1	470	4.04	6	2	39	26	32	99	93	E8				
	K3	950385	B21	1160	5.64	5	1	32	22	44	99	95	E3(4)	60	21	17	39
	K3	950386	B22	1450	8.02	16	0	24	18	57	99	96	E2(1)	82	27	18	55
Qb1g	K4	950387	A1	200	4.65	19	8	31	28	29	96	78	E8				
	K4	950388	B1	400	4.36	71	23	21	22	33	99	71	E7				
	K4	950389	B21	760	6.58	27	4	12	13	71	99	93	E5(B)	73	37	19	36
	K4	950390	B22	950	7.72	17	2	14	14	70	100	95	E5(B)				
	K4	950391	B3	1300	6.97	38	8	23	14	54	100	82	E5(A)				
Qb1c	K5	950392	A1	190	4.62	14	6	54	28	13	101	73	E7				
	K5	950393	B2	350	5.25	42	9	48	20	23	100	75	E7	43	24	12	19
	K5	950394	B3	620	7.16	25	9	45	20	25	99	73	E5(B)				
Osh	K6	950395	A1	130	2.92	4	9	33	29	24	96	68	E8				
	K6	950396	B	640	1.66	0	6	25	34	33	98	83	E3(2)	36	22	8	15
	K6	950397	GRAV	690	1.74	72	6	18	33	41	98	85	E2(2)				
Osd(ii)	K7	950398	A	150	2.18	24	18	40	22	17	97	57	E8				
	K7	950399	B	250	1.89	59	13	40	23	23	98	66	E8	30	23	6	7
Osf	K8	950400	A1	160	1.98	24	13	40	26	19	98	65	E8				
	K8	950401	A2	260	1.85	19	11	40	25	23	99	70	E7				
	K8	950402	B1	430	2.22	11	9	32	23	34	98	76	E5(A)	31	18	8	13
	K8	950403	B2	600	3.33	39	9	48	21	23	101	75	E5(A)	43	23	13	21
Ose	K9	950404	A11	60	2.69	18	9	47	22	23	100	73	E8				
	K9	950405	A12	200	2.17	10	10	52	23	14	100	61	E8				
	K9	950406	A2	330	1.78	28	6	25	35	32	98	81	E5A)				
	K9	950407	B2	730	4.79	60	7	25	17	50	99	84	E6	68	38	20	30

APPENDIX D. PHYSICAL LABORATORY RESULTS

Map Unit	Site Number	Laboratory Number	Horizon	Horizon Depth mm	Air Dry Water Content %	Particle Size Distribution							Emerson Class	Atterberg Limits			
						Gravel > 2mm %	Coarse sand %	Fine Sand %	Silt %	Clay %	Total Fine Earth %	Fines <0.074 mm %		Liquid Limit %	Plastic Limit %	Linear Shrinkage %	Plasticity Index %
Qa1	K10	950408	A1	230	4.56	1	18	41	23	16	98	59	E7				
	K10	950409	B1	450	3.47	1	14	41	24	21	100	66	E5(A)	42	27	11	14
	K10	950410	B21	1040	2.42	8	11	43	27	17	99	66	E5(A)	33	21	10	12
	K10	950411	B22	1090	2.53	7	12	40	27	21	100	71	E2(1)				
	K10	950412	B23	1900	2.65	16	4	50	22	25	100	73	E2(4)				
Qvg	K11	950413	A11	170	4.99	4	5	34	39	22	100	85	E7				
	K11	950414	A12	300	4.91	3	3	31	31	36	102	91	E5(A)				
	K11	950415	A3	630	5.12	9	3	27	22	49	101	91	E5(B)				
	K11	950416	B2	1470	6.28	22	4	22	21	54	100	92	E5(C)	60	30	20	29
	K11	950417	B3	1640	8.84	14	10	39	26	25	100	75	E5(D)				
Qvh	K12	950418	A1	130	5.71	14	11	31	34	23	99	76	E7				
	K12	950419	A3	220	5.16	16	9	29	34	28	100	82	E7				
	K12	950420	B21	400	6.23	22	9	24	22	45	100	85	E5B)	56	29	17	27
	K12	950421	B22	650	5.96	35	19	22	20	38	99	73	E5(A)				
Osd(i)	K13	950422	A1	100	4.77	24	14	28	42	12	97	71	E7				
	K13	950423	B11	240	2.56	29	7	23	51	18	99	87	E3(1)				
	K13	950424	B12	490	2.42	18	5	21	52	20	98	90	E3(1)				
	K13	950425	B13	690	3.13	27	6	21	45	26	97	86	E3(1)	32	24	6	8
	K13	950426	B2	1200	4.49	28	5	15	29	47	97	86	E5(A)	47	25	13	22

APPENDIX E. CHEMICAL LABORATORY RESULTS

Map Unit	Site Number	Laboratory Number	Horizon	1:5 Soil Water Suspension			ph Buffer Capacity Index	Cl as NaCl %	Total Soluble Salts	Oxidizable Org. Carbon %	Total Nitrogen %	Skene K ug/g	Olsen P ug/g	Exchangeable Al+++ ug/g	Exchangeable Mn++ ug/g	Extractable Bases				Total of Extractable Bases	Calcium:Magnesium Ratio	Exchangeable H+ meq/100g	Cation Exchange Capacity
				pH H2O	pH CaCl2	EC dS/m										Ca ++ meq/100g	Mg++ meq/100g	Na+ meq/100g	K+ meq/100g				
Qb2f(ii)	K1	950373	A11	5.4	4.7	0.11	9	0.00	0.04	5.10	0.43	101	4.8	11	53	10.63	4.36	0.40	0.36	15.8	2.4	23.8	39.6
	K1	950374	A12	5.8	5.0	0.06	8	0.00	0.02	2.63	0.24	79	3.1	0	20	10.52	4.95	0.37	0.31	16.1	2.1	17.9	34.0
	K1	950375	B1	7.0	5.8	0.00	7	0.00	0.02	1.58	0.06	71	0.0	0	0	14.75	9.80	0.79	0.31	25.6	1.5	11.6	37.2
	K1	950376	B21	7.9	6.8	0.00	5	0.00	0.02	0.91	0.06	75	0.0	0	0	16.23	14.06	1.08	0.35	31.7	1.2	7.1	38.8
	K1	950377	B22	8.2	7.1	0.06	2	0.00	0.02	0.79	0.05	76	0.0	0	0	17.31	14.07	0.94	0.32	32.6	1.2	4.1	36.7
	K1	950378	B23	8.1	7.1	0.07	3	0.00	0.02	0.49	0.00	68	0.0	0	0	17.48	14.20	1.09	0.32	33.1	1.2	5.2	38.3
Qb2f(i)	K2	950379	A1	6.7	5.7	0.00	6	0.00	0.02	1.95	0.06	112	2.2	0	0	20.54	20.54	0.29	0.42	41.8	1.0	9.7	51.5
	K2	950380	B21	7.6	6.5	0.00	4	0.00	0.02	1.31	0.00	99	1.5	0	0	19.58	20.67	0.32	0.40	41.0	0.9	5.9	46.9
	K2	950381	B22	6.3	5.4	0.07	6	0.00	0.02	3.60	0.17	169	6.6	0	8	19.66	17.48	0.39	0.55	38.1	1.1	10.0	48.1
	K2	950382	B3	8.4	7.4	0.06	1	0.00	0.02	0.05	0.00	24	0.0	0	0	13.67	17.87	0.28	0.14	32.0	0.8	3.2	35.2
Qb2l	K3	950383	A1	5.7	4.8	0.08	7	0.00	0.03	3.44	0.25	113	5.7	0	44	8.14	6.37	0.54	0.31	15.4	1.3	12.9	28.3
	K3	950384	B1	6.4	5.1	0.00	6	0.00	0.02	1.04	0.08	64	0.0	0	10	9.27	8.86	0.79	0.26	19.2	1.0	9.8	29.0
	K3	950385	B21	6.9	5.9	0.22	5	0.00	0.07	0.61	0.00	65	0.0	0	0	11.66	14.84	2.33	0.31	29.1	0.8	7.0	36.1
	K3	950386	B22	8.0	7.3	0.76	2	0.14	0.25	0.08	0.00	85	0.0	0	0	16.31	20.66	3.91	0.45	41.3	0.8	4.6	45.9
Qb1g	K4	950387	A1	5.2	4.5	0.14	9	0.00	0.05	4.93	0.42	356	10.1	29	77	6.29	2.73	0.20	0.89	10.1	2.3	20.3	30.4
	K4	950388	B1	5.8	5.0	0.00	7	0.00	0.02	1.57	0.19	141	3.1	0	13	5.44	3.14	0.20	0.43	9.2	1.7	11.9	21.1
	K4	950389	B21	6.6	5.5	0.00	7	0.00	0.02	0.29	0.12	50	0.0	0	0	6.85	6.64	0.55	0.27	14.3	1.0	13.1	27.4
	K4	950390	B22	7.0	5.7	0.00	7	0.00	0.02	0.68	0.09	47	0.0	0	0	5.85	7.59	0.98	0.28	14.7	0.8	13.4	28.1
	K4	950391	B3	7.0	5.8	0.00	7	0.00	0.02	0.44	0.09	46	0.0	0	0	4.62	8.60	1.50	0.26	15.0	0.5	12.9	27.9
Qb1c	K5	950392	A1	6.0	5.4	0.08	8	0.00	0.03	3.56	0.35	188	6.2	0	21	11.53	7.76	0.18	0.53	20.0	1.5	15.5	35.5
	K5	950393	B2	6.6	5.6	0.00	7	0.00	0.02	0.92	0.13	172	8.9	0	7	13.72	8.97	0.18	0.55	23.4	1.5	11.0	34.4
	K5	950394	B3	6.7	5.7	0.00	7	0.00	0.02	0.73	0.00	173	14.4	0	0	19.39	14.00	0.29	0.59	34.3	1.4	11.2	45.5

APPENDIX E. CHEMICAL LABORATORY RESULTS

Map Unit	Site Number	Laboratory Number	Horizon	1:5 Soil Water Suspension			ph Buffer Capacity Index	Cl as NaCl %	Total Soluble Salts	Oxidizable Org. Carbon %	Total Nitrogen %	Skene K ug/g	Olsen P ug/g	Exchangeable Al+++ ug/g	Exchangeable Mn++ ug/g	Extractable Bases				Total of Extractable Bases	Calcium:Magnesium Ratio	Exchangeable H+ meq/100g	Cation Exchange Capacity
				pH H2O	pH CaCl2	EC dS/m										Ca ++ meq/100g	Mg++ meq/100g	Na+ meq/100g	K+ meq/100g				
Osh	K6	950395	A1	4.5	4.1	0.99	9	0.25	0.31	5.46	0.41	132	4.4	185	0	0.97	3.09	2.68	0.39	7.1	0.3	22.9	30.0
	K6	950396	B	5.0	4.2	0.25	7	0.06	0.08	1.02	0.08	82	1.8	183	0	0.32	1.93	1.02	0.25	3.5	0.2	11.2	14.7
	K6	950397	GRAV	5.6	4.5	0.29	4	0.07	0.09	0.52	0.00	48	0.0	91	0	0.30	4.58	1.83	0.24	7.0	0.1	6.1	13.1
Osd(ii)	K7	950398	A	5.0	4.2	0.00	8	0.00	0.02	2.25	0.19	105	2.7	337	51	1.94	0.63	0.09	0.31	3.0	3.1	16.6	19.6
	K7	950399	B	5.5	4.5	0.00	7	0.00	0.02	1.12	0.10	110	2.1	153	5	2.14	0.87	0.08	0.34	3.4	2.5	11.8	15.2
Osf	K8	950400	A1	5.3	4.6	0.05	8	0.00	0.02	2.55	0.20	191	2.2	101	26	2.86	1.02	0.11	0.46	4.5	2.8	13.7	18.2
	K8	950401	A2	5.5	4.4	0.00	7	0.00	0.02	0.45	0.10	146	2.6	163	8	2.04	0.60	0.07	0.37	3.1	3.4	12.4	15.5
	K8	950402	B1	5.5	4.3	0.00	7	0.00	0.02	0.63	0.05	108	0.0	235	0	1.53	0.89	0.09	0.29	2.8	1.7	11.0	13.8
	K8	950403	B2	5.4	4.2	0.00	7	0.00	0.02	0.42	0.00	64	0.0	217	0	1.66	1.45	0.11	0.21	3.4	1.1	11.8	15.2
Ose	K9	950404	A11	5.2	4.4	0.11	8	0.00	0.04	3.60	0.26	344	7.4	154	28	2.16	0.79	0.25	0.73	3.9	2.7	14.4	18.3
	K9	950405	A12	5.3	4.4	0.00	7	0.00	0.02	2.56	0.16	142	2.1	368	8	2.25	0.47	0.11	0.34	3.2	4.8	12.9	16.1
	K9	950406	A2	5.3	4.3	0.00	7	0.00	0.02	0.94	0.00	71	0.0	234	0	1.63	0.52	0.17	0.21	2.5	3.1	11.8	14.3
	K9	950407	B2	5.1	4.2	0.00	9	0.00	0.02	0.25	0.00	86	0.0	189	0	0.89	3.47	0.30	0.34	5.0	0.3	20.2	25.2
Qa1	K10	950408	A1	5.5	4.6	0.00	9	0.00	0.02	4.40	0.39	93	5.9	82	51	3.88	3.04	0.35	0.29	7.6	1.3	25.8	33.4
	K10	950409	B1	5.9	4.6	0.00	8	0.00	0.02	1.55	0.13	36	2.0	98	20	2.49	3.21	0.36	0.18	6.2	0.8	15.5	21.7
	K10	950410	B21	6.4	4.6	0.00	6	0.00	0.02	0.47	0.00	19	2.0	0	0	0.90	3.07	0.52	0.13	4.6	0.3	9.2	13.8
	K10	950411	B22	7.3	5.5	0.00	4	0.00	0.02	0.31	0.00	22	0.0	0	0	1.23	4.92	1.33	0.15	7.6	0.2	6.0	13.6
	K10	950412	B23	8.5	6.8	0.07	1	0.00	0.02	0.20	0.00	25	2.2	0	0	1.95	5.96	1.95	0.17	10.0	0.3	3.1	13.1
Qvg	K11	950413	A11	5.6	4.9	0.05	9	0.00	0.02	3.89	0.34	346	3.8	18	53	7.68	2.00	0.14	0.89	10.7	3.8	23.4	34.1
	K11	950414	A12	6.0	5.1	0.00	8	0.00	0.02	1.16	0.13	291	2.9	0	29	7.99	1.79	0.13	0.78	10.7	4.5	16.4	27.1
	K11	950415	A3	6.3	5.5	0.00	7	0.00	0.02	0.58	0.07	125	3.9	0	11	6.96	2.32	0.18	0.42	9.9	3.0	11.2	21.1
	K11	950416	B2	6.6	5.8	0.00	7	0.00	0.02	0.42	0.07	130	3.2	0	0	6.62	3.84	0.22	0.46	11.1	1.7	12.8	23.9
	K11	950417	B3	6.6	5.6	0.00	8	0.00	0.02	0.18	0.05	67	2.9	0	0	4.17	5.92	0.91	0.25	11.2	0.7	14.3	25.5

APPENDIX E. CHEMICAL LABORATORY RESULTS

Map Unit	Site Number	Laboratory Number	Horizon	1:5 Soil Water Suspension			ph Buffer Capacity Index	Cl as NaCl %	Total Soluble Salts	Oxidizable Org. Carbon %	Total Nitrogen %	Skene K ug/g	Olsen P ug/g	Exchangeable Al+++ ug/g	Exchangeable Mn++ ug/g	Extractable Bases				Total of Extractable Bases	Calcium:Magnesium Ratio	Exchangeable H+ meq/100g	Cation Exchange Capacity
				pH H2O	pH CaCl2	EC dS/m										Ca ++ meq/100g	Mg++ meq/100g	Na+ meq/100g	K+ meq/100g				
Qvh	K12	950418	A1	5.8	5.0	0.12	9	0.00	0.04	4.98	0.38	393	8.1	11	75	6.68	4.45	0.22	1.02	12.4	1.5	26.1	38.5
	K12	950419	A3	6.2	5.0	0.00	9	0.00	0.02	2.43	0.24	230	6.0	0	35	7.17	4.22	0.24	0.73	12.4	1.7	22.1	34.5
	K12	950420	B21	6.6	5.3	0.00	7	0.00	0.02	0.66	0.09	212	7.7	0	10	7.89	5.65	0.22	0.70	14.5	1.4	13.7	28.2
	K12	950421	B22	6.7	5.4	0.00	7	0.00	0.02	0.50	0.06	101	14.2	0	6	7.23	7.44	0.31	0.43	15.4	1.0	12.8	28.2
Osd(i)	K13	950422	A1	5.5	4.7	0.11	9	0.00	0.04	5.99	0.37	307	2.9	93	28	6.62	3.15	0.76	0.88	11.4	2.1	30.0	41.4
	K13	950423	B11	5.3	4.3	0.06	8	0.00	0.02	1.13	0.00	178	0.0	236	5	0.28	1.74	0.45	0.52	3.0	0.2	14.4	17.4
	K13	950424	B12	5.9	4.6	0.00	6	0.00	0.02	0.51	0.00	173	0.0	100	0	1.33	3.18	0.52	0.55	5.6	0.4	9.8	15.4
	K13	950425	B13	6.1	4.7	0.00	6	0.00	0.02	0.32	0.00	210	0.0	0	0	1.55	4.44	0.53	0.66	7.2	0.3	8.9	16.1
	K13	950426	B2	6.1	4.9	0.05	6	0.00	0.02	0.36	0.00	241	0.0	0	0	1.36	5.24	0.80	0.79	8.2	0.3	9.2	17.4

APPENDIX F. MAP UNIT NOMENCLATURE

Geological age	Lithology	Landform element
Q: Quaternary	a: alluvium	a: steep crest/ridge
T: Tertiary	b: basalt	b: steep slope >32%
K: Cretaceous	c: colluvium	c: moderately steep slope 21-32%
P: Permian	f: fans	d: moderate slope 11-20%
D: Devonian	g: granite/granodiorite	e: gentle crest
S: Silurian	r: rhyodacite	f: gentle slope 4-10%
0: Ordovician	s: sedimentary	g: very gentle slope 1-3%
C: Cambrian	t: tillite	h: drainage depression
	v: volcanics	i: flat <1%
	m: metamorphic	l: former lake bed
		p: plain <1%
		r: rocky
		x: plateau
		1-5: river terraces

N.B.: If differentiating geology by different characteristics such as soil or site characteristics, a number is allocated. The appropriate number goes after the geological symbol.

e.g. Dg la = Devonian granitic, type I, steep crest

GLOSSARY

The following definitions have been extracted from Chant= and Murphy (1991) and McDonald *et al. (1984)*.

Acidification:

An increase in acidity in the soil due to changes in land use, particularly agriculture. Soils that are most susceptible are generally of light texture in high rainfall areas.

Aluminium (Al) toxicity:

Plant growth in agricultural crops may be affected if aluminium levels are greater than 15 peg. For the purposes of this report soils with aluminium levels greater than 15 μ/g are regarded as being potentially toxic and lime may be required to promote plant growth. (State Chemistry Laboratory, pers. comm.).

Apedal:

Describes a soil in which none of the soil material occurs as peds in the moist state. Such a soil is without apparent structure and is typically massive or single-grained.

Available water for plant growth:

The amount of water in the soil that can be held between field capacity and the moisture content at which plant growth ceases.

Bleaching:

The near-white colouration of an A2 horizon which has been subject to chemical depletion as a result of soil-forming processes including eluviation. The colour is defined for all hues as having a value greater than or equal to 7 with a Chroma less than or equal to 4 on dry soils. Conspicuous bleaching means that > 80% of the horizon is bleached whereas sporadic bleaching means that < 80% of the horizon is bleached.

Consistence:

Consistence refers to the strength of cohesion and adhesion in soil. Strength will vary according to soil water status.

Dispersibility:

Value (Emerson)	*Interpretation*
E6, E7, E8	Very low
E3(1), E3(2), E4, E5	Low
E3(3), E3(4)	Moderate
E2	High
E1	Very high

Drainage:

Drainage is a term used to summarise local soil wetness conditions. It is affected by internal attributes which include soil structure, texture, porosity, hydraulic conductivity, water holding capacity, and external attributes such as evapotranspiration, gradient and length of slope and position in the landscape.

Categories are as follows:

Very poorly drained: Free water remains at or near the surface for most of the year. Soils are usually strongly gleyed. Typically a level or depressed site and/or a clayey subsoil.

Poorly drained: All soil horizons remain wet for several months each year. Soils are usually gleyed, strongly mottled and/or have orange or rusty linings of root channels.

Imperfectly drained: Some soil horizons remain wet for periods, of several weeks. Subsoils are often mottled and may have orange or rusty linings of root channels.

Moderately well-drained: Some soils may remain wet for a week after water addition. Soils are often whole coloured, but may be mottled at depth and of medium to clayey texture.

Well-drained: No horizon remains wet for more than a few hours after water addition. Soils are usually of medium texture and not mottled.

Rapidly drained: No horizon remains wet except shortly after water addition. Soils are usually of coarse texture, or shallow, or both, and are not mottled.

Duplex soil:

A soil in which there is a sharp change in soil texture between the A and B horizons (such as loam overlying clay).

The soil profile is dominated by the mineral fraction with a texture contrast of 1.5 soil texture groups or greater between the A and B horizons. Horizon boundaries are clear to sharp.

Electrical conductivity (EC):

A measure of the conductivity of electricity through a 1:5 soil water suspension. It is used to determine the soluble salts in the extract. The unit of electrical conductivity is the 'Siemens' and soil salinity is expressed here as decisiemens per metre at *25°C.*

Value range (dS/m)	*Interpretation*
< 0.30	Very low
0.30 - 0.53	Low
0.53 - 1.26	Moderate
1.26 - 2.50	High
> 2.50	Very high

Flooding:

Includes overbank flow from streams and overland-channel flow along drainage depressions.

Gradational soil:

A soil in which there is a gradual change in soil texture between the A and B horizons (for example, loam over clay loam over light clay). The soil is dominated by the mineral fraction and shows more clayey texture grades on passing down the solum of such an order that the texture of each successive horizon changes gradually to that of the one below. Horizon boundaries are usually gradual or diffuse. The texture difference between consecutive horizons is less than 1.5 soil texture groups, while the range of texture throughout the solum exceeds the equivalent span of one texture group.

Gully erosion:

Erosion of soil or soft rock material by running water that forms channels larger and deeper than rills (i.e. 300 mm).

Hardpan:

A hardened and/or cemented horizon, or part thereof, in the soil profile. The hardness is caused by mechanical compaction or cementation of soil particles with organic matter or with materials such as silica, sesquioxides or calcium carbonate. Such pans frequently reduce soil permeability and root penetration, and thus may give rise to plant growth and drainage problems.

Land capability assessment:

A systematic and rational method of determining the relative ability of different areas of land to sustain a specific land use under a nominated level of management without being degraded or causing any long term off-site degradation.

Land units or components:

An area of land, distinct from adjacent units or components because of specific slope, soil, or geomorphological characteristics, e.g. crest, lower slope.

Land pattern/system:

An area of land, distinct from surrounding terrain, that has a specific climatic range, parent material and modal slope. Made up of a recurring sequence of land elements or components, e.g. sedimentary rolling hills.

Linear shrinkage:

See Shrink/swell potential.

Mottling:

Irregular patches of colour interspersed with and different from the dominant soil colour, that vary in number and size. Mottling can indicate impeded drainage but may also be a result of parent material weathering.

Nutrient status:

Sum of exchangeable base cations (Ca, Mg, K)

Value range (meq/100g)	*Interpretation*
< 4	Very low
4 - 8	Low
9 - 18	Moderate
19 - 30	High
> 30	Very high

Organic matter:

All constituents of the soil arising from living matter i.e. plant and microfauna detritus, fresh or decomposed. The following values for organic matter have been used in this report:

Value range (%)	*Interpretation*
< 1	Very low
1 - 2	Low
2 - 3	Moderate
> 3	High

(organic matter % = organic C% x 1.72)

Parent material/rock:

The geologic material from which a soil profile develops. It may be bed-rock or unconsolidated materials including alluvium, colluvium, aeolian deposits or other sediments.

Permeability:

The characteristic of a soil, soil horizon or soil material which governs the rate at which water moves through it. It is a composite expression of soil properties and depends largely on soil texture, soil structure, the presence of compacted or dense soil horizons and the size and distribution of pores in the soil. In this study, the permeability has been measured as K_{sat} (saturated hydraulic conductivity). Where estimates have been made, based on the properties of the soil profile, this is clearly indicated.

Value range (mm/day)	*Interpretation*
< 10	Very slow
10 - 100	Slow
100 - 500	Moderate
500 - 1500	Rapid
1500 - 3000	Very rapid
> 3000	Excessive

pH (soil reaction):

A measure of the acidity or alkalinity of a soil. A pH (H_20) of 7.0 denotes neutrality, higher values indicate alkalinity and lower values indicate acidity. Strictly, it represents the negative logarithm of the hydrogen ion concentration in a specified 1:5 soil water suspension on a scale of 0 to 14. Soil pH (H_20) levels generally fall between 5.5 and 8.0 with most plants growing best in this range.

Phosphorus (P):

Deficient when less than 6 µ/g Plasticity index:

The plasticity index of a soil is the numerical difference between the plastic limit and the liquid limit.

Potassium (K):

K deficiency

Light textures	<80 µg/g
Medium textures	<101µg/g
Heavy textures	<120 µ/g

Marginal levels of K

Light textures	80-120 µ/g
Medium textures	110-160 µ/g
Heavy textures	120-180 µ/g

Rill erosion:

Erosion by small channels less than 300 mm deep which can be completely smoothed by normal cultivation.

Recharge:

Movement of surface water down into the underlying groundwaters.

Rock outcrop:

Any exposed area of rock that is inferred to be continuous with the underlying parent material.

Sheet erosion/sheet wash:

The relatively uniform removal of soil from an area without the development of conspicuous channels.

Shrink/swell potential:

The capacity of soil material to change volume with changes in moisture content, frequently measured by a laboratory assessment of the soil's linear shrinkage. It relates to the soil's content of montmorillonite type clays. High shrink swell potential in soils, such as cracking clays, can give rise to problems in earth foundations and soil conservation structures. Categories used are:

Shrink/swell potent. (%)	*Linear shrinkage*
0 - 6	Very low
7 - 12	Low
13 - 17	Medium
18 - 22	High
> 22	Very high

Slaking:

The partial breakdown of soil aggregates in water due to the swelling of clay and the expulsion of air from pore spaces. It is a component, along with soil dispersion and soil detachment, of the process whereby soil structure is broken down in the field.

Slope:

Landform element that is neither a crest or a depression and that has an inclination greater than 1%. Slope can be broken up into the following categories:

Value range (%)	*Interpretation*
< 1%	Level
1 - 3%	Very gentle slope
4 - 10%	Gentle slope
11 - 20%	Moderate slope
21 - 32%	Moderately steep slope
> 32%	Steep slope

Soil colour:

Determined by comparison with a standard Munsell soil colour chart or its equivalent. It includes three variables of colour; hue, value and chroma.

Soil horizon:

A layer within the soil profile with distinct morphological characteristics which are different from the layers above and/or below. Horizons are more or less parallel to the land surface, except that tongues of material from one horizon may penetrate neighbouring horizons.

Soil profile:

A portion of a soil exposed in a vertical section, extending usually from the land surface to the parent material. In very general terms, a profile is made of three major layers designated A, B and C horizons. The A and B horizons are those modified by soil development. The C horizon is weathering parent material that has not yet been significantly altered by soil forming processes.

Soil texture:

The relative proportions of sand, silt and clay particles in a sample of soil. The field assessment of texture is based on the characteristics of a bolus of wetted soil moulded by hand. Six main soil texture groups are recognized.

	Texture group	*Approx. clay content*
1	Sands	< 10%
2	Sandy loams	10 - 20%
3	Loams	20 - 30%
4	Clay loams	30 - 35%
5	Light clays	35 - 40%
6	Heavy clays	> 45%

Unified soil group:

A soil classification system based on the identification of soil materials according to their particle size, grading, plasticity index and liquid limit. These properties have been correlated with the engineering behaviour of soils including soil compressibility and shear strength. The system is used to determine the suitability of soil materials for use in earthworks, optimal conditions for their construction, special precautions which may be needed, such as soil ameliorates, and final batter grades to be used to ensure stability.

GW: Well graded gravels, gravel-sand mixtures

GP: Poorly graded gravels, gravel-sand mixtures

GM: Silty gravels, poorly graded gravel-sand-silt mixtures

GC: Clayey gravels, poorly graded gravel-sand-clay mixtures

SW: Well graded sands

SP: Poorly graded sands

SM: Silty sands, poorly graded sand-silt mixtures

SC: Clayey sands, poorly graded sand-clay mixtures

ML: Inorganic silts and very fine sands, clayey fine sands with slight plasticity

CL: Inorganic clays of low to medium plasticity, sandy clays, silty clays

OL: Organic silts or organic silt-clays of low plasticity

MH: Inorganic silts, micaceous fine sandy or silty soils

CH: Inorganic clays of high plasticity

OH: Organic clays of moderate to high plasticity

Pt: Peat

Uniform soil:

A soil in which there is little, if any change in soil texture between the A and B horizons (for example, loam over loam, sandy clay over silty clay). The soil is dominated by the mineral fraction and shows minimal texture difference throughout, such that no clearly defined texture boundaries are to be found. The range of texture throughout the solum is not more than the equivalent span of one soil texture group.