LAND CAPABILITY STUDY IN THE SHIRE OF SHEPPARTON

EROSION RISK ASSESSMENT: OTHER LAND USE CONSTRAINTS: LAND MANAGEMENT GUIDELINES: SOME ENGINEERING PROPERTIES OF SOILS

Prepared by:

J. F. Woo, District Soil conservationist
P. R. Burns, Conservation Assistant
D. F. Howe, Senior Research Officer

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SOIL CONSERVATION AUTHORITY
378 Cotham Road Kew Victoria 3101

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PREFACE

Three requirements for sound land use planning are:

- an understanding of low use can be limited by natural characteristics of land
- knowing what effect the use will have on the land and water derived from runoff
- the need for special land management or structural design to overcome limitations or to restrict the impacts to acceptable levels.

Land capability assessment is a rational and systematic means of obtaining this information.

The Soil Conservation Authority is able to provide land capability information for a range of uses and at different scales to meet the various needs of planning. This information provides a relatively stable base on which to superimpose other planning considerations.

PART 1 - SUMMARY AND CONCLUSIONS

A. EROSION RISK ASSESSMENT

The study was undertaken at the request of the Shire of Shepparton for use ad an aid to planning and development at a broad scale. The report describes erosion risk and other characteristics of the land which may impose constraints on land development in the Shire.

Shepparton Shire (see locality plan) has a area of approximately 915 km^2 and varies from flat plains at about 105 m elevation receiving about 375 mm rainfall in the north, to low hill country up to 279 m elevation on Mt. Major where average annual rainfall is 560 mm.

Approximately 95% of the Shire is freehold land (870 km^2) the reminder being largely forested public land. The study concentrates on the freehold land and is less detailed on the public land.

Areas of special interest to the Soil Conservation Authority are the Cashel Bank and Dookie-Cosgrove Cooperative projects. These are detailed in Part 2.

CONCLUSIONS:

The erosion risk classes in the Shire are shown on Map 2. General management guidelines are presented in Table 2. The main conclusions and recommendations are summarised below.

1. Land with severe erosion risk (Class 5) comprises only 0.5% of the Shire. This land is considered highly hazardous and should have strong limitation placed upon its development.

   * It is recommended that subdivision of land in Erosion Risk Class 5 should not be permitted unless the developer can demonstrate to the satisfaction of the Soil Conservation Authority that the development will not result in increase soil erosion from the area.

   *Permanent clearing of Class 5 land should be prohibited and reafforestation should be actively encouraged. In general, such land should be considered as best used for forestry and passive recreation.

2. Land with high erosion risk (Class 4) comprises only 1% of the Shire.

   *Intensive small-lot subdivision and clearing should be discouraged and reafforestation should be encouraged.

   * It is recommended that all proposals fro development of land in Erosion Risk Class 4 be referred to the Soil conservation Authority for specific advice on soil conservation requirements at the earliest possible stage.

3. Land with a moderate erosion risk (Class 3), comprises 4% of the Shire. Development of most of the moderate risk land should be possible without causing increased erosion, provided specialised techniques and careful management, which take account of the natural characteristics of the land, are adopted.

   * Advice on the need for specialized design and construction techniques and follow-up management should be sought from the Soil Conservation Authority prior to approval of any development.

4. Although land in Erosion Risk Classes 2 and 1 are not generally regarded as presenting significant erosion problems, there may be small areas of higher risk which would require special management within the areas shown in those classes in Map 2. Where such areas become apparent, the Soil Conservation Authority should be consulted for advice on appropriate management.

B. ENGINEERING PROPERTIES OF THE SOILS

Areas with significant limitations of expansive behaviour and low permeability have been identified on the accompanying maps.

1. Expansive behaviour of soils (Map 3)

   * Soils with very severe expansion (linear shrinkage >19%) are the Dookie CL, Congupna C and Cashel CL indicated by areas of red on Map3)

   * Soils with severe expansion (linear shrinkage 15% to 19%) are the Goorambat L, Carrawa L, Major CL, Type A, Gowangardie L and Orvale fSL indicated by areas of orange on Map 3.

   * Soil with moderate expansion (linear shrinkage 10% to 15%) are the Lemnos L, Gupna L, Caniambo L, Goorambat SL, Goulbrun L and SL, Congupna CL, Koonda fSL, Lemnos fSL and SL, Shepparton fSL, L, Orvale SL, East Shepparton fSL, SL and Upotipotpon C indicated by areas of yellows on Map 3.

   Areas not coloured on Map 3 generally do not contain significant problems or else only relatively minor occurrences of hazardous soils.

2. Permeability for on-site absorption of effluent (Map 4)

   * Soils with very low permeability are the Congupna C and CL, Cashel CL, Lemnos L and SL. Major CL, Dookie CL, Orvale L, Shepparton SL and East Shepparton SL together with swamps and active flood plains indicated by areas of red on Map 4.

   * Soils with low permeability are the Shepparton fSL, Orvale SL and Gupna fSL and L indicated by areas of orange on Map 4.

   * Soils with moderate permeability are the East Shepparton fSL and Carrawa L indicated by areas of yellow on Map 4.

   Areas not coloured on Map 4 generally do not contain soils with significant permeability-related problems for effluent disposal. It should be noted however that where hydraulic conductivity measurements indicate excessively high permeabilities, the risk of pollution of local water bodies or aquifers should be investigated.

PART 2 - TECHNICAL ASPECTS OF THE STUDY A. EROSION RISK ASSESSMENT

In order to identify and map areas of land with differing land capability, a systematic study of the natural characteristics of land has been made. Areas of land which have consistent patterns of landforms, soils and native vegetation on similar rock types and with a limited range of climate are identified. Such areas are referred to as land systems and these have provided the basis for the Erosion Risk mapping.

Within the Shire, nine land systems have been identified on a variety of parent materials. These are shown on Map 1.

Because land systems consist of sequences of land types and are not homogeneous, there may be a range of erosion risk within each. The land system information has been reinterpreted on the basis of local knowledge of the erosion risk of the various land types to produce a map of erosion risk classes, Map 2.

The land system descriptions (Appendix A) provide a range of information which can be adapted or use by planners for purposes other than erosion control. In particular, areas subject to flooding or having poor effluent disposal or water holding characteristics can be identified. Where these constraints exist they are referred to in the Constraints section of the tables in Appendix A.

ASSESSMENT PROCEDURE

The components of the land systems are assessed for the risk of erosion of all types if the land is subjected to poor management or to disturbance such as exposure of bare soil during development. The steepness of the land, the erodibility of soil, including the soil depth, permeability and structure, and the effect of increased soil-water accumulation if plant cover is decreased are taken into consideration.

The erosion risk is assessed n five classes – Class 5 being highest. Definitions of the classes are presented in Table 1.

For each land system, the proportion which fall into the five erosion risk classes are determined and these are indicated in bar-chart form in the tables of Appendix A.

It should be realized that because of the broad scale of mapping (1:50 000), the map units can only represent a general level of erosion risk over relatively large areas. Obviously at a more detailed level, local variation will be found. It is important therefore, that where areas of land are nominated for intensive development, such as small lot subdivision, the need for further detailed mapping at a much larger scale is recognized.

The Soil Conservation Authority is able to provide assistance in determining the capability of land for a range of land uses at more detailed levels of scale. Regional staff from the Authority should be consulted when a need for more specific information arises.

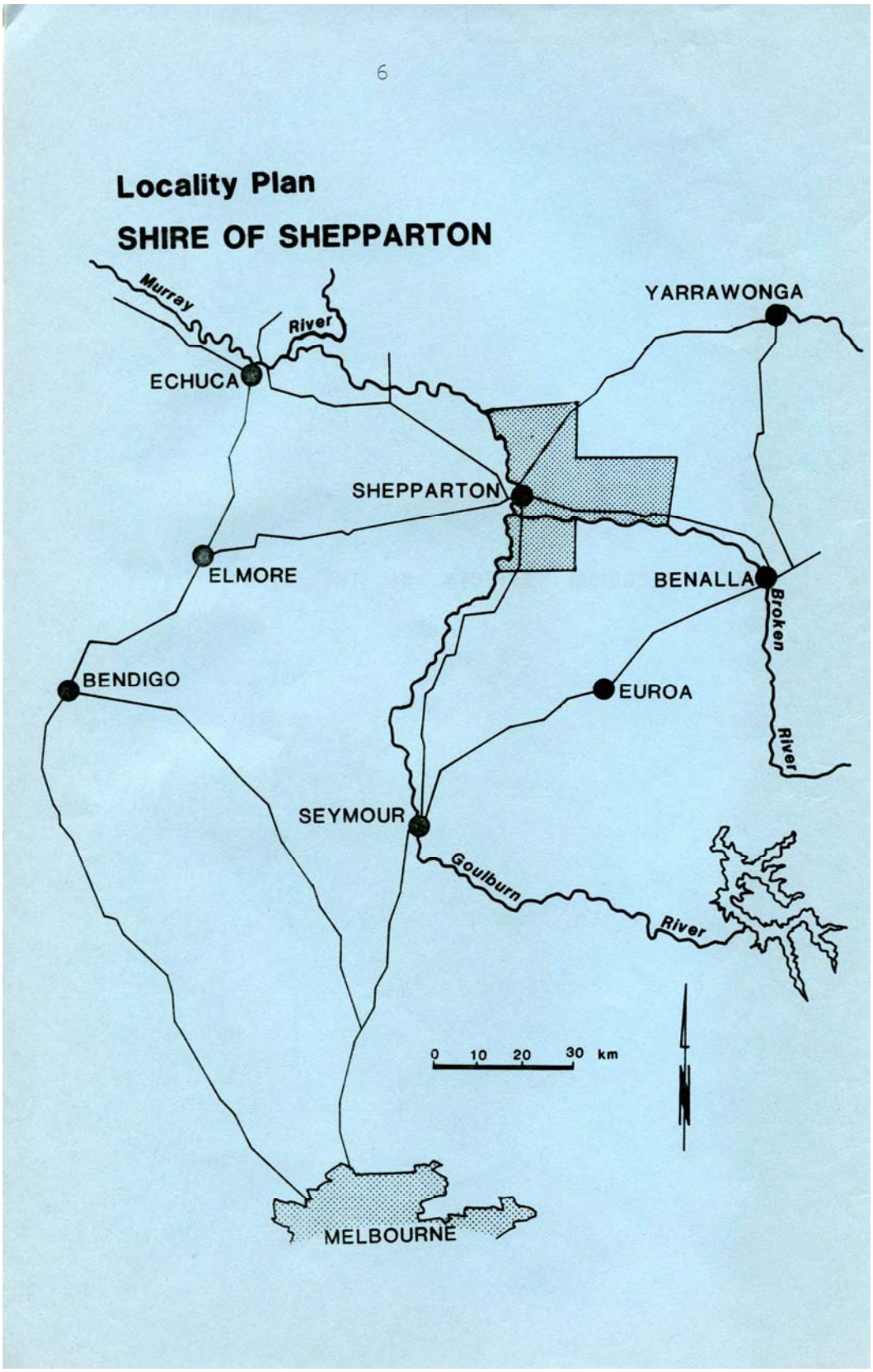
Locality Plan
SHIRE OF SHEPPARTON
Murray
River
ECHUCA
YARRAWONGA
SHEPPARTON
ELMORE
BENALLA
Broken
River
BENDIGO
EUROA
SEYMOUR
Goulburn
River
0 10 20 30 km
MELBOURNE

TABLE 1 - EROSION RISK CLASSES

(Read in conjunction with Map No. 2)

CLASS	EROSION RISK	GENERAL LIMITATIONS ON DEVELOPMENT
1	None to very slight	Erosion risk does not occur or is very slight. Standard designs and installation techniques and normal site preparation and management should be possible without risk of erosion
2	Slight	Slight erosion risk exists. Areas of high erosion risk may be avoided by not disturbing drainage lines and steeper slopes. Careful planning, and use of standard specifications for site preparation, construction and follow-up management should be satisfactory to minimize erosion.
3	Moderate	Moderate to high erosion risk exists which may lead to difficulties during and after construction. Specialised design, construction techniques and follow-up management are necessary to overcome these difficulties and minimize erosion.
4	High	High erosion risk. Avoidance of erosion during and after construction is difficult and long term problems may occur. Adverse effects may be inflicted upon adjoining land. Extensively modified design and installation techniques, exceptionally careful site preparation and management would be necessary.
5	Severe	Severe erosion risk and/or danger of large landslides is prevalent. Any development will cause instability which cannot be practically overcome.

MANAGEMENT GUIDELINES

There are considerable variations in standards of land management which can substantially affect stability, particularly in areas with high erosion risk. Similarly, techniques of earthwork construction and follow-up treatment can vary considerably with possible significant or drastic effect upon stability where these are inadequate or inappropriate.

The guidelines in Table 2 outline the kind and levels of management considered necessary to guard against unacceptable land deterioration within each erosion risk map unit.

TABLE 2 - LAND MANAGEMENT GUIDELINES

(Read in conjunction with Map No. 2)

CLASS	EROSION RISK	GENERAL LIMITATIONS ON DEVELOPMENT
1	None to very slight	Generally no specific conservation management practices are required in this map unit, except along drainage lines where erosion may occur. To minimize the danger of erosion in drainage lines, avoid disturbance and maintain a protective vegetative cover. Roads which cross drainage lines where high flows are likely should be designed with adequate culvert capacity or alternatively low profile floodway fords. Crossings should be as near as practicable at right angles to the flow to minimize cost and erosion potential. To avoid problems with spillways when siting farm dams in drainage lines which carry large flows, off-stream storages are recommended.
2	Slight	Generally only limited special management inputs are required in this map unit to prevent soil erosion, except along drainage lines where erosion is likely to occur. To minimize the danger of erosion in drainage lines, avoid disturbance and maintain a protective vegetative cover. Roads which cross drainage lines where high flows are likely, should be designed as for Unit 1 above. In addition, roads should be aligned close to contour and have adequate surface and/or subsurface cross drainage or be aligned directly up and down dispersed laterally. Areas disturbed during construction works should be revegetated by top-soiling and sowing. To avoid problems with spillways when siting farm dams in drainage lines which carry large flows, off-stream storages are recommended. Planning for fence locations should take account of significant topographical features so that it is possible to conform to the criteria above.
3	Moderate	Specialised land management techniques are required to minimize soil erosion. Moreover, localized areas of severe risk occur in which intensive development of any kind should be avoided. To minimize the danger of erosion in drainage lines, avoid disturbance and maintain a protective vegetative cover. Employ contour cultivation or minimum tillage techniques for cropping and contour cultivation for pasture establishment.

CLASS	EROSION RISK	GENERAL LIMITATIONS ON DEVELOPMENT
		Locate roads and fences on contour, along ridges or directly up and down slope. Disperse water from roads at frequent intervals by surface or sub-surface drainage. Design roads as recommend under Unit 1 above. Take care to minimize disturbed areas during construction and undertake adequate soil conservation measures. Conserve topsoil for respreading after construction. Revegetation of these areas may require special treatment as well as sowing and adequate maintenance. All dams constructed in this unit will require careful siting design and construction techniques. Generally a vigorous vegetative groundcover should be maintained throughout this unit. Existing timbered areas should remain and reafforestation should be encouraged in the more hazardous areas. Subdivision into areas of small lots could cause increased erosion unless carefully planned, and die consideration is given to topographical features. Planning of fence locations should also take into account these features sot that it is possible to conform to the above criteria.
It is recommended that: Advice on the need for specialized design and construction techniques and follow-up management should be sought from the SCA prior to approval of any development		
4	High	High inputs of specialized land management techniques are required to minimise soil erosion and/or landslides. Localised areas of severe risk occur in which any development should be avoided. Employ contour cultivation or aerial seeding for pasture establishment. Specialised management techniques for grazing are required. Cropping is not advisable. SCA advice should be sought. A vigorous vegetative groundcover should be maintained throughout this unit. Prevention of further forest clearing is very desirable and reafforestation should be encouraged. All earthworks, including dam construction, roading and other construction works, should employ conservation specifications suitable for each site and include topsoil saving, rapid revegetation, and other soil stabilization measures and maintenance. Limited subdivision may be possible with careful planning and due consideration to topographical features. SCA advice should be sought at the earliest planning stage.

CLASS	EROSION RISK	GENERAL LIMITATIONS ON DEVELOPMENT
		Planning of fence locations should take into account topographical features to avoid stock concentration in hazardous areas. SCA advice should be sought.
It is recommended that: All proposals for development of land in unit 4 be referred to the SCA for specific advice on soil conservation requirements at the earliest possible stage. Intensive small-lot subdivision and clearing should be discouraged, and reafforestation should be encouraged.		
5	Severe	Any land disturbance will require extremely high levels of specialized management input to minimize soil erosion and/or landslides. Intensive development of any kind is undesirable and should be avoided. Cultivation is inadvisable. Pastures should be sown by aerial seeding only and maintained as a vigorous groundcover. Grazing should be strictly controlled and consultation with the SCA on grazing management is highly recommended. Clearing timber should be prohibited unless for timber harvesting and then should strictly controlled and the area reafforested immediately after. Reafforestation of existing cleared areas should be actively encouraged. Earthworks of any kind should be discouraged except for emergency or fire protection purposes. In these instances strict attention to design specifications according to SCA requirements should be mandatory. Subdivision should be discouraged. However, isolated areas may be suitable for limited development. Such areas would require detailed terrain evaluation due to the severe risks involved. Planning of fence locations should take into account topographical features to minimize erosion by stock trafficking. SCA advice should be sought.
It is recommended that: Subdivision of and in this map unit should not be permitted unless the developer can demonstrate to the satisfaction of the SCA that the development will not cause increased soil erosion or land deterioration. Permanent clearing of land should be prohibited and reafforestation actively encouraged. In general, the area should be regarded as being best used for forestry and passive recreation.		

AREAS OF SPECIAL SOIL CONSERVATION INTEREST

These have been outlined on Map and shown with Roman numerals as numbered below.

I Cashel Bank Co-operative Project
II Dookie-Cosgrove Co-operative Project

The major works within these projects were carried out in the 1960's and ere aimed at controlling existing erosion, preventing erosion and utilizing land to its maximum potential. These works were implemented by co-operation between the landholders, the Shire and the Authority.

Whilst additional work apart from maintenance has been instigated in these areas recently, the Authority would appreciate the opportunity to comment on proposed developmental matters, regardless of the erosion risk classification involved.

B. ENGINEERING PROPERTIES OF THE SOILS

An investigation of some engineering properties of soils in the Shire of Shepparton was undertaken at the request of the Shire Planning Officer.

Information was needed to assist in the identification of areas of land where soil related problems might arise in development. Soil characteristics which will affect house construction and related activities have been emphasised.

The soil properties of particular interest are linear shrinkage, Atterberg limits and hydraulic conductivity. Soils which have a higher linear shrinkage value expand when moist and shrink when dry and have the ability to cause considerable damage to foundations and pavements. If the problem is not recognized and allowed for in design and management, damage may result which can be very expensive to repair.

The Atterberg limits include the parameters Liquid Limit (the moisture content of a soil when it passes from a liquid to a plastic state); Plastic Limit (the moisture content of a soil when it passes from a plastic to a solid state) and the Plasticity Index which is simply the difference between the two limits. These values are used to classify soils into groups which behave similarly when used for certain engineering purposes such as earthen embankments, roadways and fill.

Hydraulic conductivity is a measure of the rate at which moisture can pass through a soil. Low values indicate soil with low permeability (such as heavy clays) while high values indicate permeable soils. The hydraulic conductivity measurement can be used to indicate the likely performance of a soil when it is used for on-site absorption of effluent from a septic tank system. It can also provide valuable information which will determine the kind of disposal system appropriate to a particular set of soil conditions.

It should be emphasized, however, that the permeability, as indicated by soil hydraulic conductivity, is only a consideration where other overriding problems do not occur. Clearly, there is no sense in determining the hydraulic conductivity of soils on a seasonally inundated flood plain or swamp. In other words, all environmental factors must be taken into consideration when assessing land capability for effluent disposal.

METHODS

For land within the Shire of Shepparton a wealth of soils information exists. The intensive activities of agriculturalists and irrigation engineers over the years have been complemented by soil surveys, and the survey information understandably reflects a heavy agronomic bias. The Department of Agriculture has carried out detailed soil surveys of the irrigation districts (Skene and Freedman – 1944, Skene and Poutsma – 1962), while CSIRO produced information for the Dookie area while developing the ecological survey approach (Downes, 1949). The Soil Conservation Authority has surveyed the catchment of the Broken River at land systems level (rundle and Rowe, 1974) and also have produced reconnaissance level land systems information of the remainder of the Shire.

Soil engineering parameters so not appear to have been collected on a systematic basis across the area. Traditionally, engineering data is gathered only for specific sites such as along a highway alignment, major water conducting channel or dam wall.

The aim of this study, therefore, was to characterise the land in terms of a number of engineering parameter so that information on certain aspects of land performance could be presented.

The availability of soil maps of most of the Shire has considerably influenced procedure of the study.

At the outset, a hypothesis was proposed that a relationship would exist between the existing defined soil types in the map units and the engineering properties of linear shrinkage and hydraulic conductivity. On the basis of this hypothesis, the available soil maps were used as the basis for soil sampling and data collection.

The relationship was subsequently proved correct, allowing the existing soil maps to be used to convey the information of location and extent of particular soil conditions. The results are shown on Map 3.

In all, 126 profiles were examined and sampled for determination of the engineering parameters. The same samples were also analysed for pH (a measure of acidity), electric conductivity (indication the concentration of electrolytes in the soil), and chloride concentration carried out on material at a depth of 45 to 50 cm or else 10 cm into the tope of the B horizon (i.e. Subsoil clay, where present). Analyses were carried out at the Soil Conservation Authority soils laboratory and although no significant problems of soil salinity were detected in the samples, copies of the results can be obtained upon request. A further 52 “in situ” hydraulic conductivity determinations were made, using equipment assembled after designs by Talsma and Hallam (1980) and the results are shown on Map 4.

The sampling program was designed to provide data on a wide range of the more significant soil types. A higher sampling intensity was allowed in areas where there were the demand for rural subdivision.

REFERENCES

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Skene, J. K. M. and Poutsma, T. J. (1962) – Soils and Land Use in Part of the Goulburn Valley. Technical Bulletin No. 14, Department of Agriculture, Melbourne, Victoria, Australia.

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APPENDIX A - LAND SYSTEMS DESCRIPTIONS

(Read in conjunction with Map No. 1)

Land System	313139 12.8% of Shire				24213 0.1% of Shire
Erosion Risk Class	2	3	4	5	
Location	Dookie Hills				West of Cosgrove
Landform & Average Elevation	Hills with Alluvial apron – 210 m				Low hills – 135 m
Rainfall/Slope	500 – 625 mm 4 – 40%				375 – 500 mm 6 – 18%
Geology	Cambrian greenstone, diabase, tuff, chert				Tertiary basalt
Soils	Loam and clay loam over medium clay; loam over clay loam; uniform stony loam.				Loam over clay loam; clay loam over light clay.
Native Vegetation	Woodland of yellow box and murray pine. Mostly cleared.				Woodland of grey box, red gum. Cleared.
Constraints	Problems of water holding ability, dam construction and building foundations may exist due to the presence of shrink/swell clays (which crack open when dry). Shallow soils over rock on the upper slopes present problems for dam construction. Generally stable soils which may erode if mismanaged.				The ability of soils to hold water is variable and unpredictable unless tested. Generally stable soils which may erode if mismanaged.

Land System	253113 4.2% of Shire	253113 54.0% of Shire
Erosion Risk Class	1	1
Location	Goulburn river flood plain north of Shepparton.	Plains north and east of Shepparton.
Landform & Average Elevation	Flood plain – 110 m	Riverine plain – 115 m
Rainfall/Slope	375 – 500 mm 0 – 4%	375 – 500 mm 2 – 4%
Geology	Recent alluvial sediments.	Quaternary fluvial sediments.
Soils	Silty clay loam over loam; loamy sand over sand; uniform loams and sands.	Loam over clay loam; fine sandy loam over clay; clay loam over clay; uniform clay.
Native Vegetation	Woodland of red gum. Partly cleared.	Woodland of Murray pine, grey box, yellow box, buloke and red gum. Mostly cleared.
Constraints	Sand seams make storage of water variable and unpredictable unless tested.	Water can be stored throughout most of this unit in earthen tanks and dams. Deep sand leads may be encountered near rivers and streams.
	Some of the area is subject to flooding caused by river and stream outflow & some flat areas are subject to long periods of inundation. These unit are not erosion prone except in watercourses and depressions. Salting is present in some depressions which in itself is a restraint on development and may lead to acceleration of erosion. Septic effluent disposal may be hazardous in some of the soils due to the high percolation rate of alluvial soils near streams, and the low permeability of some of the soils.	

Land System	353115 2.3% of Shire	
Erosion Risk Class	1	
Location	Flood plains of Broken and Goulburn river south of Shepparton	
Landform & Average Elevation	Flood plain – 120 m	
Rainfall/Slope	500 – 625 mm 0 – 4%	
Geology	Recent alluvial sediments.	
Soils	Clay loam over sandy and medium clay; uniform sands and loams.	
Native Vegetation	Woodland of red gum. Partly cleared.	
Constraints	Water storage is generally favourable, but deep sand leads may be found near streams. Most of the area is subject to flooding caused by stream outflow and flat areas are subject to inundation over prolonged periods. This unit is not erosion prone in water courses and depressions. Septic effluent disposal may be hazardous in some of the soils due to the high percolation rate of alluvial soils near streams.	

APPENDIX B - DETAILS OF SOIL TESTS

Soil Type	No. of Sites	Liquid Limit	Plastic Limit %	Plasticity Index %	Unified Soil Group of Sub-soil	Linear Shrinkage %	Hydraulic Conductivity (liters/square metres per day)
Caniambo loam	2	58	18	40	CH	13	
Carrawa loam	2	58	14	44	CH	17	60
Cashel clay loam	4	81	19	62	CH	19	5
Congupna loam	2	35	15	20	CL	9	
Congupna clay loam	10	52	16	36	CL-CH	14	12
Congupna clay	10	48	14	4	CL-CH	19	7
Dookie clay loam	2	64	14	50	CH	19	6
Goorambat sandy loam	2	50	16	34	CL-CH	13	
Goorambat loam	2	57	16	41	CH	16	
Goulburn loam	2	43	15	28	CL	13	
Goulburn clay loam	2	48	12	36	CL-CH	13	
Gupna fine sandy loam	2	33	13	20	CL	9	50
Gupna loam	2	42	16	26	CL	13	30
Gowangardie loam	2	47	13	34	CL	15	
Koonda fine sandy loam	2	42	13	29	CL	14	
Lemnos loam	2	41	13	28	CL	12	28
Lemnos fine sandy loam	2	43	13	30	CL	14	
Lemnos sandy loam	2	50	14	36	CL-CH	14	12
Major clay loam	4	62	18	44	CH	17	20
Nalinga loam	2	41	14	27	CL	10	
Orvale fine sandy loam	2	48	14	34	CL-CH	15	
Orvale loam	2	25	14	11	CL-ML	6	5
Orvale sandy loam	2	36	14	22	CL	12	2
Shepparton fine sandy loam	2	52	14	38	CL-CH	14	120
Shepparton sand loam	2	41	15	26	CL	12	23
Shepparton loam	2	40	17	23	CL	12	
East Shepparton fine sandy loam	2	31	14	17	CL	14	210
East Shepparton sandy loam	2	45	16	29	CL	14	23
Type A	2	84	23	61	CH	18	
Upotipotpon clay	5	56	16	40	CH	14	
Zeerust fine sandy clay	2	36	13	23	CL	9	260