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 the land, or to 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 Appendix F).

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 which 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 to 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, 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, for details).

vi) The permeability of the soil profile is measured when the soils are 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 (1:25000), 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 an improved capability class exceeding that of the overall map unit. An opportunity may therefore exist to distinguish and utilize land with fewer constraints for a chosen development. This is most likely where allotment sizes exceed five ha. Detailed site inspection is required under these circumstances

2.4 Land capability rating tables

Each land capability rating table (refer Tables 2.3, 2.4, 2.5, 2.6 and 2.7) 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 1 to 5 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 usable 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 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 minimise 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(μs/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) e.g. the ‘ideal’ prime agricultural areas would be denoted by C_1 T_1 S_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_2 S_4 The overall Land Capability Class of this latter land would be 4; with soil factors being the major limiting features.

* 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 > K_{sat} *	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 l/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 (Ksat 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)	E1, 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	E1
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