Land Capability for Residential Development in the Erica-Rawson area

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Appendices

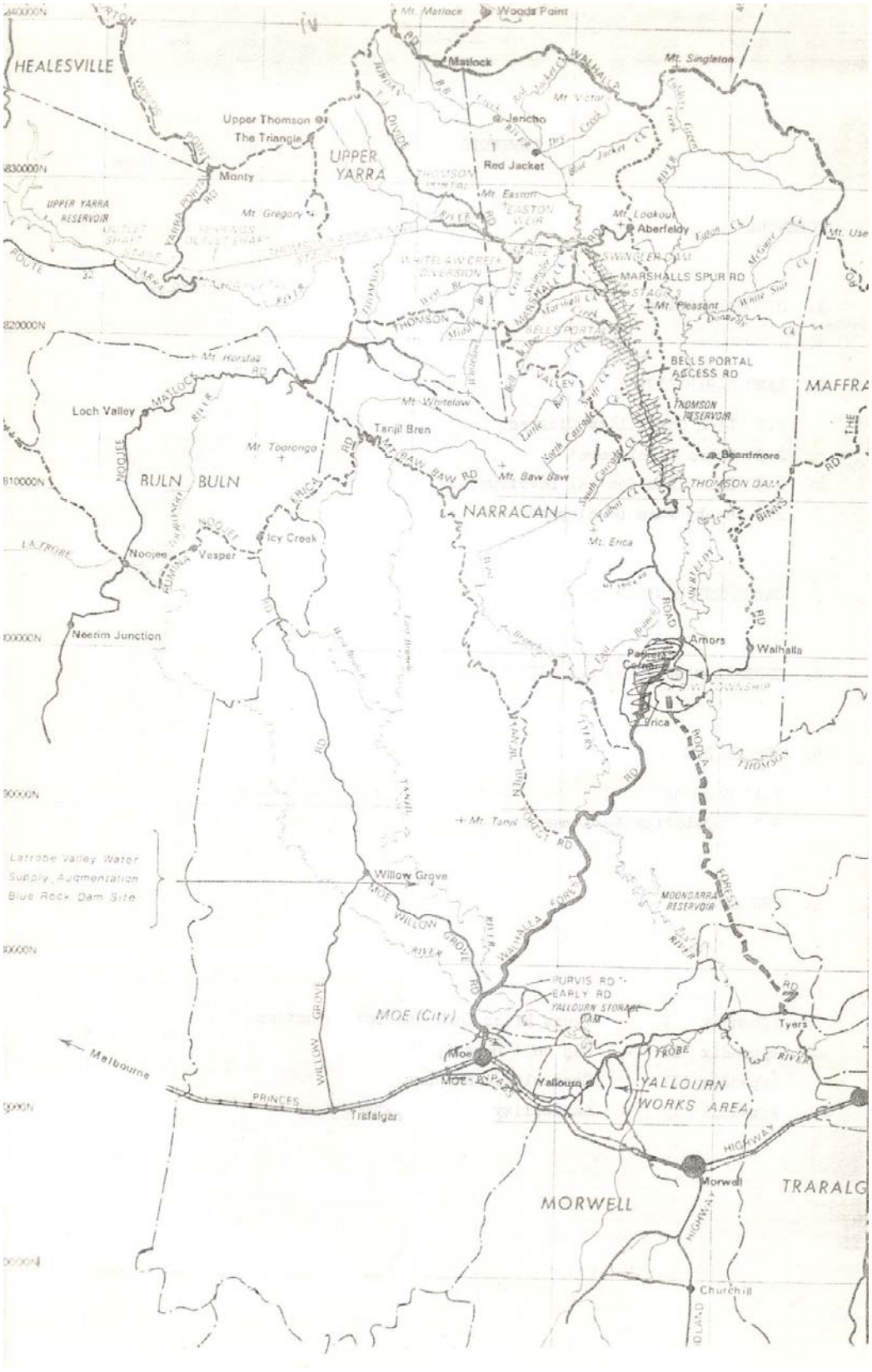

Figure 1 – Location of Study Area

Foreword

This report has been prepared at the request of the town and Country Planning Board to aid the planning of future use of land at Erica. Erica is a township on the Great Dividing Range, approximately 125 km due east of Melbourne (figure 1).

The Melbourne and Metropolitan Board of Works established the township of Rawson on freehold land just north of Erica to service the construction of the Thompson Dam. The Thompson project is now approaching completion and the T&CB, MMBW and the Shire of Narracan are considering the future planning and land use of the township of Rawson and Erica and surrounding freehold land.

This report considers the capability of the land to sustain various types of residential use without detriment to the land and to water quality in the catchment to the Tyers River (a Proclaimed Water Supply Catchment), and to the Lower Thompson River.

Various types of land are identified, mapped and described and each is assessed for its capability to sustain –

(a) close urban development (subdivision to 0.1 hectare house-blocks, sewered and fully serviced)

(b) rural residential development (subdivision to 0.4 – 2 hectare house-blocks, sewered or unsewered and with limited servicing.

(c) hobby farm development (subdivision to 10 – 15 hectare lots, each with a house and on-site effluent disposal and access tracks, but without small dams).

Specific limitations to the forms of land use on each type of land are identified and, where practical, generalised management guidelines are suggested.

1. Recommendations

As a result of both the capability analysis and consideration of requirements for maintenance of water quality in the Tyers River Catchment, it is recommended that:

(a) any close urban subdivision be limited to areas delineated as map units A and D and only where satisfactory arrangements for disposal of storm water can be made.

(b) rural residential development be limited to those areas delineated as map unit A and D. Map unit B is not recommended for rural residential development at this stage because of concern that extensive development will have significant adverse effects on water quality. Individual proposals for development would be considered on their merits by the Authority.

(c) hobby farm development be limited to those areas delineated as map units A, B, D and E. Map units C and F are not recommended for development, however they are suitable for inclusion into hobby farm allotments, provided individual allotment sizes reflect the nature of the land.

(d) appropriate conditions relating to:

i. stabilisation of disturbed soil

ii. design, location and installation of effluent absorption beds

iii. acceptable areas for intensive cultivation

iv. provision for a setback distance of 100 m from land delineated as G, for buildings, roadworks and other hard surfaced areas and effluent absorptions fields.

(e) all areas of land delineated as map unit G be excluded from subdivision where possible, and excluded from soil disturbance except that associated with essential roading and approved dams.

(f) development be initially centered on those areas already provided with some service.

These recommendations indicate which areas are best able to support certain alternative potential land uses. They are based on the physical limitations to use imposed by the land and do not, except in a general fashion, take social, economic and other factors into account. They do not constitute a recommendation that the land be developed in a particular fashion.

Planning controls introduced under the appropriate planning Acts should be seen as complementary to rather than replacing the provisions of the Land Use Determination.

2. Land Capability

2.1 Land Capability Classes

Land Class	Degree of Limitation	General Description
1	None to very slight	Areas with a high capability for the proposed activity or use. The limitations of long term instability, engineering difficulties or erosion hazard do not occur or they are very slight. Standard designs and installation techniques, normal site preparation and/or management should be satisfactory to minimise the impact on the environment.
2	Minor	Areas capable of the proposed activity or use. Minor limitations are present in the form of engineering difficulties and/or erosion hazard. Careful planning and/or the use of standard specifications for site preparations, construction and follow-up management should minimise developmental impact on the land.
3	Significant	Areas with fair capability for the proposed activity or use. Significant engineering problems and/or high erosion hazard exist during construction. Specialised designs and techniques are required to minimise developmental impact on the environment.
4	Major	Areas with poor capability for the proposed activity or use. There are major engineering difficulties during development and/or a high erosion hazard exists during and after construction. Extensively modified design and installation techniques, exceptionally careful site preparation and/or management are necessary to minimise the impact on the environment.
5	Normally prohibitive	Areas with very poor capability for the proposed activity or use. Limitations, either long term instability hazards, erosion or engineering difficulties, cannot be satisfactorily overcome with current technology. Severe deterioration of the environment will probably occur if the activity or use is attempted in these areas.

The rating of a map unit for each of the types of development is derived from consideration of the ratings for relevant activities (Appendix III) and from consideration of the performance of the land under existing use.

2.2 Urban Development

- the subdivision of land into approximately 0.1 ha (0.25 ac) house block with full servicing* including reticulated sewerage and water supply, fully sealed and kerbed roading and storm water drainage.

Map Unit A: Class 2 with slope and shrink-swell potential as minor limitations. The only special management required is the stabilisation of any major cut or fill batters and the adoption of an appropriate plan of subdivision and minimise earthworks for roading and other services.

Map Unit B: Class 3 with slope as a significant limitation and shrink-swell potential as a minor limitation. It would be essential that any plan of subdivision take due cognizance of slope factors and

* (See Appendix III)

preferably avoid disturbance of steeper areas. Considerable care would be necessary to stabilise the cut and fill batters associated with both roading and benched house sites.

Map Unit C: Class 4 with slope as major limitation. Major design and construction techniques and maintenance would be required to develop the land. Certain areas would still be beyond satisfactory development due to slope. Significant soil loss could be expected during construction.

Map Unit D: Class 3 with slope and depth to seasonal watertable as significant limitations. Plans of subdivision should take slope into account and saving and respreading of topsoil on cut and fill batters as a basis for stabilisation is recommended. The shallow watertable may require installation of drainage prior to construction and/or limiting of work to the summer period.

Map Unit E: Class 3 with slop as a significant limitation and site drainage and shrink-swell potential as minor limitations. Plans of subdivision should take slope into account and endeavour to minimise cut and fill associated with roading and house sites. Saving and respreading to topsoil is an essential prerequisite to batter stabilisation. Significant soil loss could be expected during development.

Note: These areas are generally isolated from existing services.

Map Unit F: Class 4 with slope as the major limitation. Any plan of subdivision must acknowledge slope factors as a primary consideration. Extensive cut and fill would be necessary for servicing of allotments and benching of house sites impractical. Both mechanical stabilisation and topsoiling and revegetation of cut and fill batters would be required. Slope factors will effectively preclude some (unmapped) areas from development. Considerable soil loss could be expected during construction.

Note: These areas are generally isolated from existing services.

Map Unit G: As this unit consists of springs, swamps and drainage lines, it should not be considered for urban development.

2.3 Rural Residential Development

- subdivision of land into building allotments of between 0.4 ha (1 ac) and 2 ha (5 ac) with limited servicing* and with reticulated sewerage or on-site septic effluent disposal*, water supply either reticulated or from roof-fed storage tanks. Grassed areas may or may not be grazed by one or two pets (sheep or ponies for example), however no sheds are provided for animals.

General:
It is important that discharge from hard surfaces (roads, tracks, roof areas, etc) not interfere with effluent absorption fields. Absorption fields should not be located in areas which will be affected by such runoff as this would reduce their effectiveness in absorption and purification of effluent.

Map Unit A: Class 2 with slope and shrink-swell potential as minor limitations both to general construction activities and effluent disposal. Stabilisation of major earthworks, and subdivision to take advantage of gently sloping areas are desirable.

Map Unit B: Class 3 with slope as a significant limitation and shrink-swell potential as minor limitation. Subdivision plans and location and design of effluent absorption fields much take slope into account, taking advantage of gentler slopes and excluding the steeper areas from development where possible. Care would be necessary to stabilise the cut and fill batters associated with roading and levelling of house sites.

Map Unit C: Class 4 with slope a major limitation to both general construction activities and effluent disposal. Major design and construction techniques and maintenance would be required to develop the land. Certain areas would still be beyond satisfactory development due to slope of the land. Class attention to the design, location and installation of effluent absorption fields would be necessary; however, intermittent unsatisfactory disposal could still be expected. Significant soil loss could be expected during construction.

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* (See Appendix III)

Map Unit D: Class 4* with depth to seasonal watertable as a major limitation, slope and permeability being significant limitations, and site drainage and shrink-swell potential minor limitations.

(* If such development is sewered, the map unit is rated Class 3 with slope and depth to seasonal watertable as significant limitations.)

The shallow seasonal watertable and moderately slow permeability will require a considerable larger (and more costly) effluent absorption field than on other areas. Plans of subdivision should take slope into account and saving and respreading of topsoil on cut and fill batters as a basis for stabilisation is recommended.

Map Unit E: Class 3 with slope and permeability as significant limitations, and site drainage, depth to rock and shrink-swell potential as minor limitations. Plans of subdivision should take slope into account and endeavour to minimise cut and fill associated with roading and levelling of house sites. Saving and respreading of topsoil is an essential prerequisite to batter stabilisation. Significant soil loss could be expected during development.

Note: These areas are generally isolated from existing services.

Map Unit F: Class 4 with slope as a major limitation, permeability a significant limitation (to effluent disposal) and shrink-swell potential as a minor limitation. Any plan of subdivision must acknowledge slope as a primary constraint. Extensive cut and fill would be necessary for servicing of allotments and benching of level house sites impractical. Considerable care should be taken in the design, location and installation of effluent absorption fields. Slope factors will effectively preclude some (unmapped) areas form development. Considerable soil loss can be expected during development.

Note: These areas are generally isolated from existing services.

Map Unit G: As this unit consists of springs, swamps and drainage lines, it should not be considered for development.

2.4 Hobby Farm Development

- subdivision of land into allotments of 4 ha (10 ac) to 10 ha (25 ac) each with a house site[*], on-site effluent disposal*, limited servicing, water supply either reticulated or from roofed tanks (dams are impractical for most of the land – see below or Appendix III – Capability Analyses), grazing of grassed areas on a semi-commercial basis (not just pet animals) and possibly cultivation*.

Map Unit A: Class 2 with slope and shrink-swell potential minor limitations. Stabilisation of major cut and fill batters and adoption of an appropriate plan of subdivision to minimise earthworks associated with roading is desirable. There are no problems associated with intensive cropping (Class 1) or with grazing, however earthen dams are unlikely to be satisfactory due to low runoff and a high leakage rate.

Map Unit B: Class 3 with slope as a significant limitation and shrink-swell as minor limitation. Plans of subdivision and the siting and design of effluent absorption fields must take slope into account, taking advantage of gentler slopes and excluding steeper areas where possible. Care should be taken to stabilise any cut and fill batter associated with roading and levelling of house sites.

There are no problems associated with grazing and slope/soil[*] structure is a minor limitation to intensive cropping (Class 2), however earthen dams are unlikely to be satisfactory due to low runoff and a high leakage rate.

Map Unit C: Class 4 with slope as a major limitation and shrink-swell potential a minor limitation. Major design and construction techniques and maintenance would be required for general building activities. Certain areas would still be beyond satisfactory development due to slope of the land. Close attention to the design, location and installation of effluent absorption fields would be necessary;

[*] (See Appendix III)

[*] (See Appendix IV – Land Capability Rating for Intensive Cultivation)

however, intermittent unsatisfactory operation could still be expected (although this would be a largely aesthetic problem due to the larger size of allotments – containment of effluent within the allotment would not be difficult despite some surface leakage). Significant soil loss could be expected from construction sites.

Overgrazing of land may result in some intermittent sheet erosion, although the tolerance of soil loss by the land is high. Slope/soil structure* is a significant limitation to intensive cultivation (Class 3) while the limitations of slope and permeability are normally prohibitive of successful dam construction (Cass 5).

Map Unit D: Class 4 with depth to seasonal watertable a major limitation, slope a significant limitation to both effluent disposal and construction activities, and permeability a significant limitation to effluent disposal. The shallow seasonal watertable and moderately slow permeability require a larger (and more costly) effluent absorption field than do other areas. Saving and respreading of topsoil on cut and fill batters as a basis for stabilisation is recommended.

There are no problems associated with grazing, while depth to seasonal watertable and rooting depth are significant limitation to intensive cultivation. There are only minor problems with dam construction although catchment area is severely limited.

Map Unit E: Class 3 with slope and permeability as significant limitations and site drainage, depth to rock and shrink-swell potential as minor limitations. Plans of subdivision should take slope into account and endeavour to minimise cut and fill associated with roading and take advantage of gentler slopes. Saving and respreading of topsoil is an essential prerequisite to stabilisation of cut and fill batters. Significant soil loss could be expected during construction.

Overgrazing could result in significant sheet erosion while the limitation of shallow rooting depth is normally prohibitive of intensive cultivation (Class 5) – slope/soil structure*, profile drainage and the aggregate stability of the A horizon are significant limitations. Depth to rock is a major limitation, and slope, unified soil group of construction material and a moderately high leakage rate are significant limitations to dam construction.

Map Unit F: Class 4 with slope as a major limitation to both effluent disposal and construction activities. Permeability of the soil is a significant limitation to effluent disposal. Any plan of subdivision must acknowledge slope as a primary constraint and benching of house sites would be impractical. Considerable care should be taken in the design, location and installation of effluent absorption fields. Slope factors will effectively preclude some (unmapped) areas from development. Considerable soil loss can be expected during development.

The land would be prone to significant sheet erosion following overgrazing while the limitations (slope/soil structure* and rooting depth) to intensive cultivation are normally prohibitive (Class 5). Slope is a major to normally prohibitive limitation (Class 5) to dam construction and a high leakage rate, shallow layer of construction material and unfavourable Unified Soil Group are significant limitations.

Map Unit G: As this unit consists of springs, swamps and drainage lines, it should not be considered for this type of development, except that some areas may be suitable for dam construction.

* (See Appendix IV – Land Capability Rating for Intensive Cultivation)

3. Catchment Management

The majority of the land (54%) is within a Proclaimed Domestic Water Supply Catchment – the Tyers River Water Supply Catchment, which comprises the lands of the catchment to the pump station on the Tyers River near its confluence with the Latrobe River, and including the Moondarra Reservoir. The water from the catchment is used for both domestic and industrial purposes in the Yallourn-Morwell area.

The constraints on land use in a catchment imposed by the requirement of maintenance of water quality are often greater than the constraints imposed by the land itself. What may be an acceptable level of soil erosion or frequency of failure or effluent disposal systems from a land utilisation viewpoint may not be acceptable in terms of its effect on water quality.

Therefore, the requirements of water supply protection should also be taken into account. While the Soil Conservation Authority has made a Land Use Determination for the catchment detailing acceptable land uses for specific areas, (see Appendix I) this has not specifically considered residential development. Instead, it relies upon the general provision – "Prior Soil Conservation Authority approval is necessary before any development associated with residential use …….. is carried out in the catchment".

Various forms of land use may affect water quality in the following ways:

(i) sediment and/or turbidity reaching surface waters

(ii) chemical contamination of the stream (particularly by phosphates and nitrates from incompletely treated septic effluent and from fertilizer applications)

(iii) contamination of the streams with pathogenic organisms (generally from incompletely treated septic effluent and animal manure)

Sediment is a physical obstruction to the flow and storage of water while turbidity affects aesthetic aspects of water quality. Suspended soil particles may carry other contaminants such as phosphate into the stream.

Contaminants from incompletely treated septic effluent may reach the stream by surface leakage or subsurface flow. This latter aspect is of some concern on the red soils, for while surface leakage is quite obvious (odour, wetness of disposal area), subsurface leakage can only be identified by a reduction in water quality some distance away. Identification of failing system(s) is therefore almost impossible.

Current option within the Soil Conservation Authority is that a maximum density of septic effluent absorption fields of one per hectare on the red soils (Map Units A, B and C) should not adversely affect water quality – given suitable design (based on permeability), location (away from culverts, drainage depressions, etc) and installation (shallow distribution trenches).

Development of any area for close urban subdivision should be subject to satisfactory provision for discharge of storm water. (It should be noted that some overseas studies have indicated that urban runoff has similar characteristics to secondary septic effluent for a number of parameters.) Alternatives for safe discharge of storm water may include disposal outside the water supply catchment, on-site disposal through permeable drains, and ponding and settling followed by controlled discharge.

It is desirable that a referral system be developed to allow early Authority comment and/or assistance on planned developments.

Map Unit A: Extensive soil disturbance and effluent disposal on this land should not be a matter of major concern provided appropriate setbacks from drainage depressions are observed.

Map Unit B: Sediment control is desirable on gentler slopes and essential on steeper slopes during construction. Extensive soil disturbance associated either with cropping or with construction is not

desirable on the steeper slopes. Tight control over the design, location and installation of effluent absorption fields will be necessary to minimise adverse effects on water quality.

Map Unit C: Extensive soil disturbance of this land should be strongly discouraged. Limited construction may be acceptable where alternative house sites on flatter land are not available, subject to satisfactory design, location and management, and suitable access and effluent disposal sites being available.

Map Unit D: Development should not adversely affect water quality, given satisfactory design of effluent disposal system.

Map Unit E: This land should not be subjected to extensive soil disturbance or a high density of effluent absorption fields. Revegetation procedures to stabilise disturbed soil would be required to minimise the impact on the environment.

Map Unit F: Extensive soil disturbance associated with intensive cultivation, tree clearing or construction sites should be strongly discouraged.

Map Unit G: Soil disturbance, effluent disposal or free access by stock to this unit will result in reduced water quality. Further disturbance of this land other than that associated with essential roading and, in some cases, dam construction, is undesirable.

4. General Management Considerations

The following tables indicate some of the means by which the limitations to use may be overcome. The tables are for:

(i) General construction activities

(ii) On-site septic effluent disposal

(iii) Intensive cropping

(iv) Earthen dams

Each table lists those land features which impose physical limitations in the study area, the manner in which each limitation may affect land use and one or more ways of overcoming the limitation without indicating what is the ‘best’ means, or combination of means. In each case it is implicit that not using the subject land for the specified activity is always an alternative.

Table 4.1 – General Construction Activities

Limitations	Potential effects on Land Use	Means of overcoming the limitations
1. Slope	(a) Increased area of soil disturbance involved in site levelling and road construction.	Use of designs which minimise soil disturbance (stump foundations, pile foundations); close attention to stabilisation of disturbed soil (saving and respreading of topsoil over disturbed areas), revegetation of disturbed areas; careful selection of building site to allow use of and access via flatter areas.
	(b) Increased hazard of erosion of bared soil due to faster water movement and concentration of water.	Installation of appropriate drainage before construction begins; use or sedimentation devices during construction; stabilisation of disturbed soil.
2. Shrink-swell potential	(a) Risk of movement of foundation with wetting and drying of soil.	Use of appropriate foundation design.
3. Depth to seasonal watertable	(a) Interferes with the excavation and stability of level house sites and trenches for services and foundations on restricts access over excavated sites.	Installation of subsurface drainage prior to commencement of excavation and construction; limitation of construction work to the drier months.

Table 4.2 – On-site Septic effluent disposal

Limitations	Potential effects on Land Use	Means of overcoming the limitations
1. Slope	(a) Increased hazard of surface leakage which is aesthetically undesirable and may be a health hazard.	Adoption of a suitable design and attention to location of the absorption field
2. Shrink-swell potential	(a) Indicates a soil which is likely to undergo considerable changes in ability to transmit water depending upon the moisture status of the soil – systems designed on the basis of the permeability of dry soil are unlikely to operate satisfactorily when the soil is moist.	Adoption of appropriate design specifications based on permeability of the pre-wetted soil.
3. Permeability	(a) Rapid transmission of effluent through the soil limits the purification of it and may result in contamination of groundwater. (b) Low permeability soils have a limited acceptance rate for effluent disposal and purification.	Adoption of appropriate design specifications based on the likely long-term acceptance rate of the soil.
4. Depth to seasonal watertable	(a) A shallow seasonal watertable will limit the rate at which soil can accept and purify effluent, a high seasonal watertable may result in intermittent surface leakage of effluent.	Extend the length of distribution trench and area devoted to absorption.

Table 4.4 – Earthen Dams

Limitations	Potential effects on Land Use	Means of overcoming the limitations
1. Slope	(a) Excessive slope reduces the storage to excavation ratio (thereby increasing costs).	Avoid steeper sites.
	(b) Excessive slope makes it difficult to ensure the excavation is below full supply level.	Topsoil and stabilise exposed cut areas.
	(c) Steep sites are more prone to spillway failure.	Use of additional design and construction inputs.
2. Unified Soil Group	(a) Some sol groups are not well suited to embankment construction because of low mechanical strength, difficulty in compaction and working or because of permeability.	Allow for at design and construction stage – use of non-homogenous embankment. Input more suitable material.
3. Shrink-swell potential	(a) The cheapest source of construction material is usually from a borrow pit which will be below fully supply level. An insufficient thickness of material suitable for forming the embankment requires considerable double handling of material or importing suitable material, adding considerably to costs.	Allow for at design and construction stage – use of non-homogenous embankment. Input more suitable material.
4. Depth to seasonal watertable	(a) Permeable soils, either in the embankment or in the excavation will leak water, resulting in reduced effective storage capacity of the dam.	Line the excavation and embankment with a suitable impermeable material. Modify the existing material with chemical conditioners.

5. Procedures

5.1 Mapping

A number of different types of land have been identified, mapped and described.

These types of land, or 'map units', were identified with stereo interpretation of 1:25 000 aerial photographs, checked and described by field inspection and delineated on a 1:10 000 topographic map. Each map unit is identified by a single letter. Individual letters have no significance in themselves.

Map units are an attempt to simplify the landscape and there is seldom a rapid change from one unit to another – the line on the map does not necessarily represent an abrupt change from one land type to another.

5.2 Capability Assessment

A limited number of parameters usually determine the capability of a parcel of land to sustain a specified use without deterioration of the land.

Rating tables developed by the Soil Conservation Authority identify these parameters and indicate the extent of the effect of each parameter on sustained use.

Relevant parameters from the map unit description are then compared with the class limits in the rating tables for a specified use and the capability of the land for that use determined by the most limiting land feature. Management strategies can be then designed to overcome the limitations to sustained use so identified, or alternatively, a decision made not to use the land in that fashion.

6. The Land

The study land is the freehold land of the immediate surrounds of the township of Erica. The area is approximately 1,200 hectares, of which 180 ha is in the Parish of Walhalla and 1,020 ha is in the Parish of Telbit, all within the Shire of Narracan (see Figure 1).

Physiography:

Most of the land consists of basaltic cap overlying an older land surfaced formed on sedimentary rocks. Clearing has generally not extended beyond the basalt. In some areas drainage lines have cut through the basalt and exposed underlying Devonian sediments. In one or two places, it appears that some basalt has been naturally eroded to expose higher points in the underlying sedimentary landscape (for example, map unit D).

Slopes on the basaltic area range from 5% on the centre of the cap to in excess of 25% where streams have cut into the basalt. The land derived from sedimentary rocks is somewhat steeper, commonly ranging from 10% to 30%.

Climate:

(a) *Temperature*

Average mean temperature varies from 17.20^{o}C (January) to 9.5^{o}C (July). The average maximum temperature varies from 23^{o}C (January) to 10.5^{o}C (July), while the average minimum temperature varies from 11.7^{o}C (February) to 3.9^{o}C (July).

Plant growth is therefore likely to be limited by low temperature in the winter months, June to September.

(b) *Rainfall*

The average annual rainfall is 1,174 mm, with all months receiving, on average, in excess of 75 mm. January and February have only about 60 – 7-% probability of receiving sufficient rainfall to sustain growth of annual plants and there is a likely excess of moisture in July, August and September.

Soils

Red friable soils (Krasnozems) with depths of at least 120 cm have developed on the basaltic area, while the soils of the sedimentary land are variable, generally a gradational yellow earth.

Appendix I – Tyers River Land Use Determination

The majority (84%) of the land is in the Tyers River Water Supply Catchment and is subject to a Land Use Determination made by the Soil Conservation Authority pursuant to Section 23(1) of the *Soil Conservation and Land Utilization Act* 1958. The Determination was gazetted in the Victoria Government Gazette No. 33, dated 7th May, 1975.

This land falls into categories 1, 4, 5 and 6 of the Land Use Determination.

The provision of individual land use categories are set out below and should be read in conjunction with the Determination plan.

General Provisions Applying to all Categories

Prior Soil Conservation Authority approval is necessary before any development associated with residential use or recreation is carried out in the catchment.

Prior Soil Conservation Authority approval is necessary before any earthworks, including roadworks and mining, are carried out within the catchment.

From time to time the Soil Conservation Authority may require that existing roads in the catchment be upgraded.

Subdivision of land requires Soil Conservation Authority approval.

Category Number	**Land Category**	**Provisions of Category**
1	Land to be retained in an undisturbed state for the protection of watercourses, streams and reservoirs. Covers land- * Within 200 m of Moondarra Reservoir foreshore; * Within 200 m of the Erica Waterworks Trust Diversion Weir; * Within 40 m of the Tyers River up to the Tyers Junction and Jacob's Creek to the Walhalla Road; * Within 20 m of all other streams and specified drainage lines.	A. No further clearing, cultivation, earthworks, buildings or construction of stream crossings will be permitted without the specific approval of the Soil Conservation Authority. B. Improvements in the location of and design of existing stream crossings may be required by the Soil Conservation Authority.
4.	Land primarily suitable for forest operations – parts of which may be suitable for development for grazing or cropping purposes.	A. Forestry operations may be carried out only in accordance with forest management conditions approved by the Soil Conservation Authority. B. Soil Conservation Authority approval required before any part of this category is developed for grazing or agriculture. C. Soil conservation practices will be specified when necessary.
5.	Land suitable for grazing (low intensity agriculture)	Cultivation of pasture establishment and maintenance will be permitted subject to conditions which may include the length of the rotation and soil conservation practices where necessary.
6.	Land suitable for cropping (high intensity agriculture) and other intensive uses as approved.	From time to time, conditions may be imposed and may include specifications of length of rotation and soil conservation practices where necessary.

Appendix II – Map Unit Descriptions

In this section, the map units which represent the different types of land are described in generalised terms built up from observation of the land in a number of sites in the study area. While some parameters can be measured directly (for example – slope) others have to be inferred (for example – profile drainage).

The map units are marked onto a 1:10 000 topographic map, enclosed inside the back cover of this report.

MAP UNIT	A
PHYSIOGRAPHY	
Landform	Crests and gently undulating plain with no well defined drainage lines, no evidence of landslips.
Slope	Ranges from 0% to 10%, commonly 6%.
Geology	Tertiary older volcanics – olivine basalt
SOILS	
Type	Red friable clay soil (Krasnozems)
Factual Key	Gn 4.11
Profile	Red, strongly structured loam to silty loam topsoil to a depth of 30 cm, over a red brown strongly structured silty clay loam to silty clay subsoil. Subsoil overlies decomposed parent material.
Soil Depth	Ranges from 120 cm to in excess of 500 cm over short distances and without surface indications.
Unified Soil Group	MH over CL
Shrink-swell Potential	Moderate (<12%)
Dispersion	Subsoil slakes readily
Permeability	Rapid
DRAINAGE	
Profile	Well to excessively well drained, no watertable.
Site	Sheds runoff* moderately freely, no flood risk * does not produce copious runoff due to very permeable nature of the soil
EROSION HAZARD ON BARED SOIL	
Topsoil	Low, however soil aggregates are likely to be moved short distances by runoff
Subsoil	Exposed batters may slump when wet and ‘fret’ away when dry

MAP UNIT	B
PHYSIOGRAPHY	
Landform	Hillslopes, generally upper and mid-slopes, sometimes with a drainage line at the bottom of the slope; no evidence of landslips.
Slope	Ranges from 8% to 25%, with 15-20% common.
Geology	Tertiary older volcanics – olivine basalt.
SOILS	
Type	Friable red clay soil (Krasnozem)
Factual Key	Gn 4.11
Profile	Brown strongly structured clay loam topsoil to a depth of 20 cm, over a red brown strongly structured silty clay loam to 40 cm, over a red strongly structured silty clay. Subsoil overlies decomposed parent material.
Soil Depth	Ranges from 120 cm to in excess of 500 cm over short distances and without surface indications.
Unified Soil Group	MH over CL
Shrink-swell Potential	Moderate (<12%)
Dispersion	Subsoil slakes readily.
Permeability	Rapid
DRAINAGE	
Profile	Well to excessively well drained, no water table.
Site	Sheds runoff* freely, no flood risk * does not produce copious runoff due to permeable nature of the soil.
EROSION HAZARD ON BARED SOIL	
Topsoil	Low, but subject to moderate fallow wash on steeper slopes when cultivated.
Subsoil	Exposed batters may slump when wet and ‘fret’ away when dry.

MAP UNIT	C
PHYSIOGRAPHY	
Landform	Narrow crests and hillslopes – sometimes mid- and lower-slopes steepened by the incision of drainage lines, no evidence of land slips.
Slope	In excess of 20%, 25% common.
Geology	Tertiary older volcanics – olivine basalt.
SOILS	
Type	Friable red clay soil (Krasnozem)
Factual Key	Gn 4.11
Profile	Dark brown strongly structured loam topsoil to a depth of 10 cm, over a red brown silty loam to silty clay loam to 25 cm, over a red strongly structured silty clay.
Soil Depth	Usually in excess of 150 cm.
Unified Soil Group	ML over CL
Shrink-swell Potential	Moderate (<12%)
Dispersion	Subsoil slakes rapidly.
Permeability	Rapid.
DRAINAGE	
Profile	Well to excessively well drained, no water table.
Site	Sheds runoff* freely, no flood risk.
	* does not produce copious runoff due to the permeable nature of the soil.
EROSION HAZARD ON BARED SOIL	
Topsoil	Moderate, but subject to significant fallow when wash cultivated.
Subsoil	Exposed batters slump when wet and ‘fret’ away when dry.

MAP UNIT	D
PHYSIOGRAPHY	
Landform	Crest
Slope	Range from 5% to 12% with 10% common.
	Mixed Tertiary older volcanics – olivine basalt, and Devonian sandstone, siltstone and claystone.
Note: This unit appears to be a 'window' through the basalt mantle which has exposed the underlying Devonian sediments. The soil appears to have developed with contributions from both materials.	
SOILS	
Type	Gradational yellow brown earth
Factual Key	Gn 4.31
Profile	Grey brown strongly structured loam topsoil to a depth of 15 cm, over a dark brown strongly structured silty loam to silty clay loam to 30 cm, over a yellow brown mottled clay loam subsoil.
Soil Depth	Exceeds 150 cm
Unified Soil Group	ML/CL over CL/CH
Shrink-swell Potential	Moderate (<12%)
Dispersion	Subsoil slakes readily and disperses slowly.
Permeability	Moderately slow.
DRAINAGE	
Profile	Imperfectly drained, perched seasonal watertable at 75 cm.
Site	Sheds runoff moderately freely, no flood risk
EROSION HAZARD ON BARED SOIL	
Topsoil	Low
Subsoil	Low

MAP UNIT	E
PHYSIOGRAPHY	
Landform	Upper slopes and crests
Slope	Less than 15%, 10% common
Geology	Devonian sandstone, siltstone and claystone.
SOILS	
Type	Gradational yellow structured earth.
Factual Key	Gn 4.21
Profile	Dark grey structureless sandy loam topsoil to a depth of 10 cm, over a weakly structured, mottled yellowish brown sandy loam to 50 cm, over a moderately structured brownish yellow sandy clay loam with up to 30% stones of parent material, the proportion of stones increasing with depth and giving way to fractured rock at depth.
Soil Depth	Generally exceeds 100 cm
Unified Soil Group	SM over CL
Shrink-swell Potential	Low
Dispersion	Subsoil disperses slowly
Permeability	Moderately slow
DRAINAGE	
Profile	Imperfectly drained, no apparent watertable.
Site	Sheds runoff moderately freely, no flood risk.
EROSION HAZARD ON BARED SOIL	
Topsoil	Moderate
Subsoil	Moderate – road surface will erode readily if not adequately drained.

MAP UNIT	F
PHYSIOGRAPHY	
Landform	Hillslopes, mainly mid- and upper-slopes.
Slope	Ranges from 10% to in excess of 30% commonly 15% and 25%.
Geology	Devonian sandstone, siltstone and claystone.
SOILS	
Type	Gradational yellow structured earth.
Factual Key	Gn 4.31
Profile	Grey structureless sandy loam topsoil to a depth of 10 cm, over a pale yellow structureless sandy clay loam to 60 m, over a mottled moderately structured yellow clay.
Note: The upper layer (topsoil) may be absent in areas which have suffered extensive soil disturbance.	
Soil Depth	Exceeds 150 cm
Unified Soil Group	ML over CL
Shrink-swell Potential	Low to moderate
Dispersion	Subsoil disperses slowly
Permeability	Moderately slow
DRAINAGE	
Profile	Imperfectly drained, no apparent watertable.
Site	Sheds runoff freely, no flood risk.
EROSION HAZARD ON BARED SOIL	
Topsoil	Low to moderate, depending upon slope.
Subsoil	Moderate, roadside batters erode and slump readily.

MAP UNIT	G
PHYSIOGRAPHY	
Landform	Well defined drainage lines consisting of perennial and intermittent streams, springs and swampy areas.
Slope	Bed grade of perennial streams – commonly 2% bed, grade of intermittent streams – commonly 5%.
Geology	Either Tertiary older volcanics – olivine basalt, or Devonian sandstone, siltstone and claystones.
SOILS	
Profile	Variable, reflecting the parent materials of the catchment areas.
DRAINAGE	Very poorly drained, subject to extended periods of inundation.

This unit has been excluded from the capability analysis. However, it can be regarded as having a Class 5 capability for all uses excepting small earthen dams (some of the higher reaches of the unit may have Class 3 or 4 capability).

Appendix III – Capability Analyses

The following tables detail those land features which affect a specified land use (from the Capability Rating Systems – Appendix IV); the extent to which the specified uses are affected and a capability rating for each of the specified land uses for each map unit (excluding map unit G).

Figures 3, 4, 5 and 6 are capability maps of the area for each of:

(i) General construction activities
(ii) On-site effluent disposal
(iii) Intensive cultivation
(iv) Earthen dams

Map Unit A: Capability Analysis

	General construction activities	Effluent disposal	Intensive cropping	Earthen dams
Slope or slope/structure	2	2	1	2
Profile drainage			1	
Site drainage	2	2		
Depth to seasonal watertable	1	1		
Depth to permanent watertable	1			
Flooding return period	1	1	1	1
Depth to hard rock	1	1		1
Unified soil group	2			3
Shrink-swell potential	2	2		2
Thickness of construction material				2
Depth of topsoil				2
Rooting depth			1	
Texture of A horizon			1	
Aggregate stability of A horizon			1	
Permeability		1		4
Gravel and stones	1	1	1	1
Boulders and rock outcrop	1	1	1	1
Capability class	2	2	1	4
Main limitation(s)	Slope, shrink-swell potential	Slope, shrink-swell potential	-	Permeability, USG of soil

Map Unit B: Capability Analysis

	General construction activities	Effluent disposal	Intensive cropping	Earthen dams
Slope or slope/structure	3	3	2	3.4
Profile drainage			1	
Site drainage	1	1		
Depth to seasonal watertable	1	1		
Depth to permanent watertable	1			
Flooding return period	1	1	1	1
Depth to hard rock	1	1		1
Unified soil group	2			
Shrink-swell potential	2	2		2
Thickness of construction material				2
Depth of topsoil				1
Rooting depth			1	
Texture of A horizon			1	
Aggregate stability of A horizon			1	
Permeability		2		4
Gravel and stones	1	1	1	1
Boulders and rock outcrop	1	1	1	1
Capability class	3	3	2	4
Main limitation(s)	Slope, shrink-swell potential	Slope, shrink-swell potential	Slope/structure	Permeability, slope

Map Unit C: Capability Analysis

	General construction activities	Effluent disposal	Intensive cropping	Earthen dams
Slope or slope/structure	4	4	3	5
Profile drainage			1	
Site drainage	1	1		
Depth to seasonal watertable	1	1		
Depth to permanent watertable	1			
Flooding return period	1	1	1	1
Depth to hard rock	1	1		1
Unified soil group	2			2
Shrink-swell potential	2	2		2
Thickness of construction material				2
Depth of topsoil				1
Rooting depth			1	
Texture of A horizon			1	
Aggregate stability of A horizon			1	
Permeability		2		4
Gravel and stones	1	1	1	1
Boulders and rock outcrop	1	1	1	1
Capability class	4	4	3	5
Main limitation(s)	Slope	Slope	Slope/soil structure	Slope, permeability

Map Unit D: Capability Analysis

	General construction activities	Effluent disposal	Intensive cropping	Earthen dams
Slope or slope/structure	3	3	1	2
Profile drainage			3	
Site drainage	2	2		
Depth to seasonal watertable	3	4		
Depth to permanent watertable	1			
Flooding return period	1	1	1	1
Depth to hard rock	1	1		1
Unified soil group	2			2
Shrink-swell potential	2	2		2
Thickness of construction material				1
Depth of topsoil				1
Rooting depth			3	
Texture of A horizon			1	
Aggregate stability of A horizon			2	
Permeability		3		2
Gravel and stones	1	1	1	1
Boulders and rock outcrop	1	1	1	1
Capability class	3	4	3	2
Main limitation(s)	Slope, depth to seasonal watertable	Depth to seasonal watertable, slope permeability	Profile drained, rooting depth	Slope, permeability USG shrink-swell potential

Map Unit E: Capability Analysis

	General construction activities	Effluent disposal	Intensive cropping	Earthen dams
Slope or slope/structure	3	3	3	3
Profile drainage			3	
Site drainage	2	2		
Depth to seasonal watertable	1	1		
Depth to permanent watertable	1			
Flooding return period	1	1	1	1
Depth to hard rock	1	2		4
Unified soil group	2			3
Shrink-swell potential	2	2		2
Thickness of construction material				2
Depth of topsoil				1
Rooting depth			5	
Texture of A horizon			1	
Aggregate stability of A horizon			3	
Permeability		3		3
Gravel and stones	1	1	1	1
Boulders and rock outcrop	1	1	1	1
Capability class	3	3	5	4
Main limitation(s)	Slope	Slope, permeability	Rooting depth, slope/soil structure profile drainage, Ag. Stability	Depth to rock, slope, permeability, USG.

Map Unit F: Capability Analysis

	General construction activities	Effluent disposal	Intensive cropping	Earthen dams
Slope or slope/structure	4	4	4.5	4.5
Profile drainage			3	
Site drainage	1	1		
Depth to seasonal watertable	1	1		
Depth to permanent watertable	1			
Flooding return period	1	1	1	1
Depth to hard rock	1	1		2
Unified soil group	2			3
Shrink-swell potential	2	2		2
Thickness of construction material				3
Depth of topsoil				1
Rooting depth			5	
Texture of A horizon			1	
Aggregate stability of A horizon			4	
Permeability		3		3
Gravel and stones	1	1	1	1
Boulders and rock outcrop	1	1	1	1
Capability class	4	4	5	5
Main limitation(s)	Slope	Slope, permeability	Slope/soil structure, rooting depth	Slope, permeability

Appendix IV – Capability Rating Systems

The Soil Conservation Authority has developed Capability Rating Systems for a variety of uses. The following tables are based on those presented in “Land Capability for Urban and Related Uses in the Berwick-Pakenham Area and the Shire of Hastings” by D. F. Howe, R. T. Costello and L. D. Russell. (Soil Conservation Authority, 1979).

Land capability rating for general construction activities (building foundations, secondary roads, shallow excavations)

	Capability class				
Land feature affecting use	1	2	3	4	5
Slope	5%	5-8%	8-15%	15-35%	30%
Site drainage	Excessively well drained. Well drained.	Moderately well drained.	Imperfectly drained.	Poorly drained.	Very poorly drained.
Flooding	Nil			Less than 1 per 100 years	Greater than 1 per 100 years
Depth to hard rock	Greater than 120 cm	120 to 80 cm	80 to 40 cm	40 to 15 cm	Less than 15 cm
Stones	Less than 10%	10 to 15%	15 to 35%	Greater than 35%	
Boulders, rock outcrop	Less than 0.1%	0.1 to 0.5%	0.5 to 5%	5 to 30%	Greater than 30%
Unified Soil Group	GW GC GM GP SW SC	SP SM CL	MH CH	OH OL ML	Pt
Shrink-swell potential	Less than 4%	4 to 12%	12 to 20%	Greater than 12%	
Depth to					
(i) seasonal	Greater than 150 cm	90 to 150 cm	60 to 90 cm	30 to 60 cm	Less than 30 cm
(ii) permanent watertable	Greater than 200 cm	150 to 200 cm	120 to 150 cm	90 to 120 cm	Less than 90 cm

Land capability rating for on-site effluent disposal (areas capable of being used for on-site absorption of all-waste septic tank effluent from a single family dwelling.

	Capability class				
Land feature affecting use	1	2	3	4	5
Slope	0 to 5%	5 to 8%	8 to 15%	15 to 30%	More than 30%
Site drainage	Excessively well drained. Well drained.	Moderately well drained.	Imperfectly drained.	Poorly drained.	Very poorly drained.
Flooding return period	None	-	-	Less than 1 in 25 years	More than 1 in 25 years
Depth to seasonal watertable	More than 150 cm	150 to 120 cm	120 to 90 cm	90 to 60 cm	Less than 60 cm
Permeability	Rapid*	Moderately rapid	Moderately slow	Slow	Very slow
Depth to rock or impervious layer	More than 200 cm	200 to 150 cm	150 to 100 cm	100 to 75 cm	Less than 75 cm
Gravel and stones	Less than 5%	5 to 20%	20 to 40%	40 to 75%	More than 75%
Boulders, rock outcrop	Less than 0.02%	0.02 to 0.2%	0.2 to 2%	2 to 10%	More than 10%
Shrink-swell potential	Less than 4%	4 to 12%	12 to 20%	More than 20%	-

* Possibility of contamination of groundwater should be considered.

This table is being revised and sizing curves are being prepared by Dr R. van de Graaff of the Soil Conservation Authority for consideration by the Interdepartment Committee on Household Waste Treatment.

Land capability rating for intensive cultivation (areas capable of being used for intensive cropping – potatoes, berry crop and crucifers; management includes adequate fertilizer application, clean cultivation for weed control and availability of supplementary water

	Capability class				
*** Soil structure**					
Apedal, weal	0-4%	4 to 8$	8 to 15%	15 to 20%	More than 20%
Slope moderate, S. gr.	0-8%	8-15%	15-20%	20-35%	More than 35%
Strong	0-15%	15-20%	20-35%	35-50%	More than 50%
Flooding return period	More than 1 in 20 years	1 in 20 to 10 years	1 in 10 to 5 years	1 in 5 to 1 year	More than once per year
Profile drainage class	Well drained. Moderately well drained.	Excessively well drained.	Imperfectly drained.	Poorly drained.	Very poorly drained.
Rooting depth	More than 50 cm	50 to 30 cm	30 to 20 cm	20 to 15 cm	Less than 15 cm
Texture of A Horizon	L SL C	SCL LS S	C	-	-
Aggregate stability of A Horizon	1 (stable)	2	3	4 5 (dispersing)	-
Gravel and stones	Less than 4%	4 to 10%	10 to 20%	20 to 30%	More than 30%
Boulders and rock outcrop	Less than 0.01%	0.01 to 0.05%	0.05 to 1%	1 to 10%	More than 10%

* This is used as a general guide to the likelihood of the land generating runoff and the likelihood of land being eroded by runoff. It is based on the observation that strongly structured soils are more permeable than less structured soils and therefore less likely to generate runoff during a given storm. Soils on steeper land are more likely to be eroded by runoff than when on gentler slopes. There is also a slope factor which limits the usefulness of machines.

Land capability rating for earthen dams (Areas capable of being used fro the construction of small water storages with earthen embankments

	Capability class				
Land features affecting use	1	2	3	4	5
Slope: gully dam	2 to 4%	4 to 8%	0-2; 8 to 12%	12 to 15%	More than 15%
Slope: hillside dam	2 to 5%	5 to 10%	0-3%; 10 to 15%	15 to 20%	More than 20%
Flooding return period	None	-	-	Less than 1 in 25 years	More than 1 in 25 years
Unified Soil Group	GC GM SC	SM CL (PI <15)	ML CH CL (PI >15)	CL MH OH	Pt
Thickness of construction material	More than 200 cm	200 to 100 cm	100 to 75 cm	75 to 30 cm	Less than 30 cm
Stones	Less than 5%	5 to 20%	20 to 50%	50 to 75%	More than 75%
Boulders and rock outcrop	Less than 0.05%	0.05 to 0.1%	0.1 to 1%	1 to 5%	More than 5%
Permeability	Very slow	Slow	Moderately slow	Moderate to very rapid	-
Shrink-swell potential	Less than 4%	4 to 12%	12 to 20%	More than 20%	-
Depth to hard rock	More than 300 cm	300 to 200 cm	200 to 150 cm	150 to 80 cm	Less than 80 cm
Dispersible clay	2 to 6%	6 to 10%	10 to 16%	More than 16% Less than 2%	-
Depth of topsoil	10 to 25 cm	25 to 50 cm	50 to 100 cm 0 to 10 cm	100 to 200 cm	More than 200 cm