Soil Conservation Service of N.S.W.

URBAN CAPABILITY STUDY:

THURGOONA DEVELOPMENT AREA

ALBURY

October 1975

URBAN CAPABILITY STUDY
THURGOONA SUBDIVISION, ALBURY

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This report, and the original maps associated with it, have been scanned and stored on the custodian's intranet.

Original drafted maps have been scanned and named "UC_Thurgoona Subn_Albury_soils_sheet/scale.pdf"

S.J. Lucas April 2014

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INTRODUCTION

The Thurgoona Subdivision encompasses 1200 hectares of pastoral land in the north-eastern quarter of the Albury-Wodonga Growth Centre. This study is based on an investigation of the physical features of that area.

In the following report, particular emphasis is attached to the necessity for an approach to development which will maintain a stable landscape and will avoid contributing to problems of siltation and turbidity in the Murray River.

The study entailed preparation of an inventory of the physical features of the landscape - soils, slope, terrain and drainage pattern. This information has been interpreted to provide a landscape evaluation map and an assessment of the capability of the area for urban development in terms of erosion hazard and landscape stability.

Soils, landform and landscape evaluation maps have been prepared at a scale of 1:2500. The copies presented on pages 47, 48 and 49 of this report are, however, reduced to a smaller scale for convenience. Copies at the larger scale are available, on request, from the Soil Conservation Service.**

This report describes features of the soils and the landform, and the potential and limitations of the various classes defined on the landscape evaluation map are discussed. Soil survey details are presented in an appendix.

The information contained in the report is a guide to development based on soil conservation principles. To ensure the effective implementation of the recommendations that are made, consultations with local officers of the Soil Conservation Service are essential during the planning and the construction stages.

** Original maps drafted at 1:2,500 were catalogued SCS 10203 A-C, Sheets 1-5. Whole area maps at 1:10,000 were numbered SCS 10380, 10381 and 10382.

PHYSICAL FEATURES

Features of the environment which influence erosion hazard and the capability of the land for urban development include:

1. Climate
2. Terrain and Slope
3. Drainage
4. Geology and Soils

1. Climate

The average annual rainfall for the region is 690 millimetres. This tends towards winter dominance, but significant rainfall is also received in spring and autumn. Summers are relatively dry. The area experiences warm to hot summers. Very high temperatures are occasionally registered. Winters are cool, with mild to cold days and cold nights. Frosts occur on an average of 42 days each year, usually between mid-May and mid-September.

Long duration, low intensity rainfall in winter and early spring tends to saturate the soil. When such conditions persist, high rates of runoff may follow rains of only moderate intensity. Such rains are largely responsible for gully formation and migration. High intensity storms of short duration in summer generate severe sheet and rill erosion on bare areas.

During urban development, high levels of siltation will follow extensive stripping of vegetation if the bare soil is exposed for any length of time to rainfall and runoff.

2. Terrain and Slope

A central, well-rounded ridge runs north-south through the area. This rises to a height of approximately 35 metres above the floor of two broad valleys located on either side.

The general fall of the land is to the south, towards the flood plain of the Murray River.

Six slope classes have been mapped. They are:

a - 0 to 1% slope
b - 1 to 5% slope
c - 5 to 10% slope
d - 10 to 20% slope
e - 20 to 30% slope
f - > 30% slope

Gradients of the valley floors are less than 1%. Most of the hillslopes have gradients between 1 and 10%, with limited areas having gradients of 10 to 20%. Towards the southern extremity of the ridge is an isolated pocket where the gradient exceeds 20%.

The landform of the development area is low undulating terrain with convex hillslopes and broad convex footslopes. Ten terrain or slope facets have been mapped. They are:

2-0 convex slopes and crests with no easily defined individual slope facets.

2-1 convex upper slopes and crests.

2-2 convex crests.

2-3 convex upper slopes.

2-4 convex mid-slopes.

2-5 convex footslopes.

2-6 drainage plains. These are areas where water flows when stream channels overtop.

2-7 straight slopes.
2-8 flood plains.
2-9 Ox-Bow lakes. These are cut-off meanders, formed when the stream channel changes direction.

3. Drainage

Broad, shallow drainage lines extend from the valleys to the central ridge.

The major drainage lines along the valley floor carry large volumes of runoff from the steep hills surrounding the study area. This runoff has eroded gullies up to 2.5 metres in depth in the flow lines.

Lateral gully erosion to depths approaching one metre has occurred in watercourses which discharge into these major channels.

Within the Red Hill Catchment, natural drainage lines are well defined in upper sections and at lower levels adjacent to the Riverina Highway. In the mid-section of the catchment, however, the natural drainage line is not defined. This results in outflow of runoff which inundates an area of approximately 94 hectares, causing prolonged soil saturation.

4. Geology and Soils

The area consists of relatively level deposits of thick transported sediments, with ridges of moderately thick residual material.

The only rock outcrop on the area is one of micaceous schists near the northern boundary. Similar rock strata are found within a few centimetres of the surface on sites near the junctions of Correy's and St. John's Roads, and of Bowna and Thurgoona Roads.

The main erosion problem results from uncontrolled runoff from the steep catchment to the north of the area. This runoff has eroded gullies in the yellow solodic soils. Gullies up to 2.5 metres deep occur along the drainage lines and by roadsides. More serious gullies are found where the railway culverts have concentrated flows. Aside from these locations, erosion is not significant on the majority of the area.

Seven major soil units have been defined on the soils map. These are:

- Grey clays
- Brown clay - yellow solonetzic complex
- Red earth - red podzolic complex
- Yellow earth - yellow solodic complex
- Red and yellow podzolic soils
- Yellow solodic A
- Yellow solodic B

The boundaries between different soil types range from abrupt (1 to 2 metres between the red earths and the yellow solodics) to gradual (up to 200 metres between the yellow solodics and the brown clays).

There is a relationship between soil type and drainage. Drainage ranges from good on the red earths to very poor on the grey clays. Therefore abrupt changes in slope usually correspond with abrupt changes in soil type, while a gradual slope change produces a diffuse boundary between soil units.

Grey clays occur mainly in the low-lying area immediately north and west of Albury airport.

These soils have a high water table as a result of their location and their low profile permeability.

They are characterised by numerous gilgais on centres of about 20 metres, with approximately 60 centimetres relief between mounds and depressions. This feature is related to the high clay content and the high volume expansion of these soils.

The profile movement that has caused the gilgai formation will continue and may lead to distortion of earth-works, underground services and rigid structures.

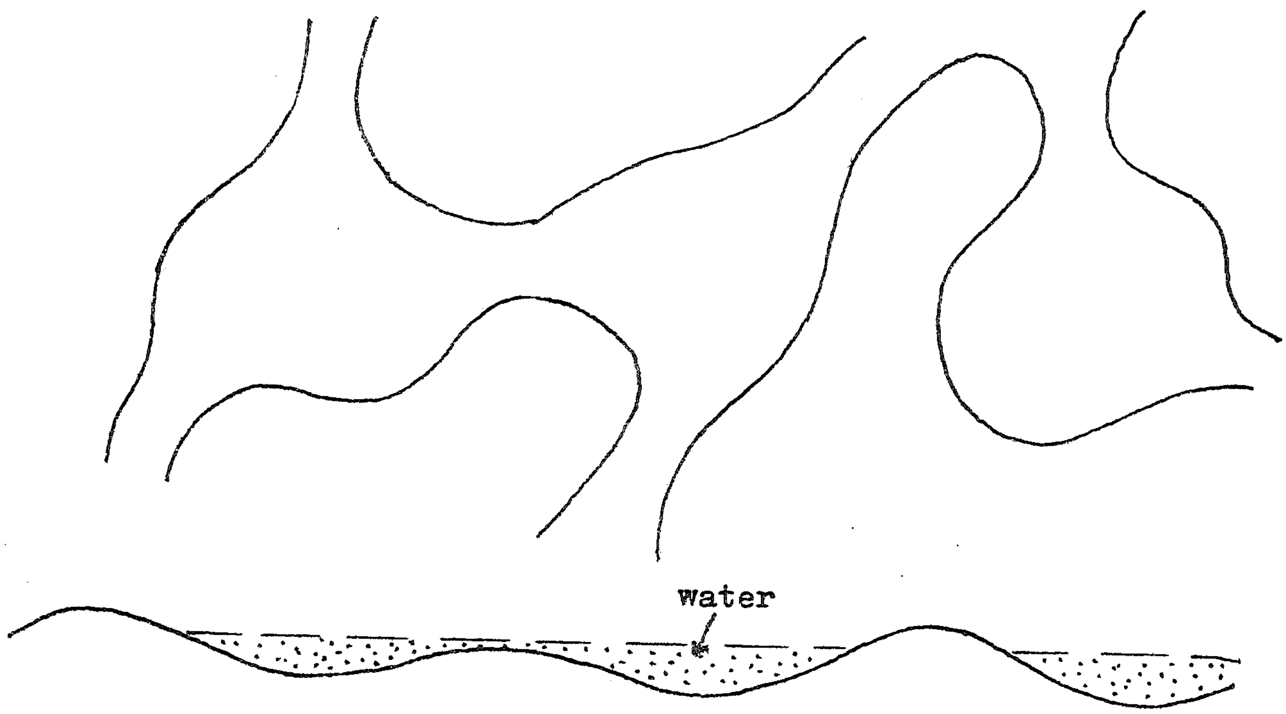
Profile permeability of this soil type is low. In addition, the low elevation of areas where the grey clay occurs is associated with a high water table. Site drainage is therefore poor. Surface drains have been moderately effective in countering this drainage problem.

A combination of brown clays and yellow solonetzic soils occupies the area immediately surrounding the grey clays and the central portion of the high terrace below Thurgoona Road.

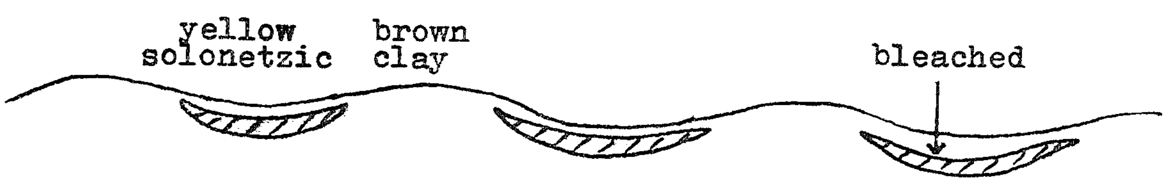
Drainage is impeded on these soils, although a permanent high water table is not evident.

The area is slightly gilgaied, with frequent small gilgais of 2 to 3 metres diameter and isolated larger ones. The location of the two soil types is related to drainage, with yellow solonetzic soils occurring in the depressions, while brown clays occur on the mounds of the gilgais.

Gilgai formation is not as severe as on the grey clays and soil shrinkage and expansion is not as great a problem. However, while laboratory analyses have not revealed a high



Typical gilgai pattern on the
grey clays.



Relative disposition of the brown clay and the yellow
solonetzic soil in gilgai formations.

volume expansion for the brown clay-yellow solonetzic complex, the existence of scattered gilgais indicates some potential for profile movement. This should be taken into account if building or roadway development is undertaken.

Although structural development is better in this soil unit than in the grey clay, profile drainage is still poor.

The red earth - red podzolic soil complex is confined to ridge crests. The two soil types are very similar. Both have a red, medium clay B horizon of variable depth. They are differentiated by the presence, in the red podzolic profile, of a non-bleached A2 horizon. This horizon, produced by impeded drainage, is moderately dispersible. The red podzolic soil is therefore more erodible than the red earth, though the erodibility of both is low.

The yellow earth - yellow solodic complex is similar to the red earth - red podzolic combination. It is found on slopes immediately below the latter. Drainage of these soils is moderate to good and they are slightly erodible.

Red and yellow podzolic soils are found on the ridge adjacent to the junction of Correy's and St. John's Roads.

At depths ranging from 35 centimetres to more than 200 centimetres these soils grade into micaceous schists and granite containing veins of quartz.

They are highly erodible and, to prevent erosion, will require rapid stabilization after disturbance.

The yellow solodic A is a moderately erodible soil occurring along the drainage lines, on the flood plain of 8-Mile Creek, and on foot slopes. It is characterised by a deep, strongly bleached A2 horizon overlying a mottled yellow/grey fine clay. It often contains a band of iron, manganese and quartz approximately 10 centimetres thick at a depth of 100 to 120 centimetres.

The A2 horizon is non-plastic and dispersible, so that it is highly erodible when exposed. Erosion is therefore a potential hazard for waterway development on these soils. Revegetation of any such waterways will be essential before flows are permitted to enter them.

This soil type has a low wet strength. When saturated it is a structureless quagmire which will not support heavy loads.

The yellow solodic B is the predominant soil type on the well drained colluvial slopes below the ridges.

Within this mapping unit the soils vary considerably. They may or may not have a bleached A2 horizon and the profile may or may not be mottled.

Where a bleached A2 horizon is present, it is less than 20 centimetres thick.

Where the B horizon is mottled, it is mottled bright red without the gleying that has occurred in the yellow solodic A soil.

A light to medium clay of moderate plasticity is located in the profile between 100 and 200 centimetres depth.

The erodibility of this soil type is moderate. It presents less problems for waterway development and for construction of flow detention structures than the yellow solodic A soil.

URBAN CAPABILITY

The landscape evaluation map has been developed from an interpretation of the interaction of the physical features of the area. On this map the area is divided into a number of classes according to landscape stability and, within this context, the assessed potential for urban development.

Four major classes are defined on the landscape evaluation map:

Class A - Areas of low erosion/instability hazard
Class B - Areas of moderate erosion/instability hazard
Class C - Areas of high erosion/instability hazard
Class D - Areas of very high erosion/instability hazard

Within these classes a number of sub-classes are defined relating to the dominant physical features which restrict development potential. Numbers used to define these restricting features are:

1 - Slope
2 - Flooding/Drainage
3 - Soil Type

The combination of two numerals indicates two physical features which interact to restrict development potential.

The major physical constraints to development on each sub-class are also itemised in the map legend.

The "capability" defined for each sub-class refers to the most intensive urban use which areas within that sub-class will tolerate without the occurrence of serious erosion and siltation in the short-term, and possible instability and drainage problems in the long-term. In assessing this "capability" no account is taken of development costs, social implications, aesthetics, or other factors relating to ecology and the environment. Development which is planned to minimise erosion hazard is, however, generally consistent with an aesthetically pleasing landscape and provides for savings in long-term repair and maintenance costs.

Capabilities as defined relate to the degree of surface disturbance involved in the various categories of urban development. "Extensive building complexes" refers to the development of shopping malls, industrial centres, or other structures which require large scale clearing and levelling for broad areas of floor space and for parking bays. Residential development infers a level of construction which provides roads, drainage and services to cater for 600 square metre housing blocks. Low density residential development infers construction to cater for 4000 to 8000 square metre housing blocks. The development of reserves, on the other hand, may require shaping and modification of the ground surface and vegetative improvement, but no building and minimal roadway construction is envisaged.

The definition of a site capability for residential development or for extensive building complexes does not necessarily imply the capacity of that site to support multi-storey units or other major structures. Before structural works of such magnitude are undertaken, a detailed analysis of the engineering characteristics of the soil, in particular bearing capacity and shear strength, is necessary on the specific development site.

In the text that follows general recommendations are made regarding stabilisation and revegetation techniques. Specific advice relating to these techniques (such aspects as seed and fertiliser mixtures and rates, cultivation measures, and batter slopes) should be sought from the local Soil Conservation office when subdivision work commences.

Specifications for revegetation and general stabilisation measures might be included in the terms of contracts let for development.

1. <u>General Recommendations</u>

A range of general recommendations, aimed at the control of erosion and siltation during development, applies to the total site. These recommendations are an integral part of the capability plan and adherence to them is critical to successful implementation of that plan.

(a) Development should be scheduled to minimise the area disturbed at any one time and to limit the period of surface exposure.

(b) Disturbance of vegetation and topsoil should be kept to the minimum practicable. This provision is most critical on steep slopes.

(c) Where development necessitates removal of topsoil, this soil should be stockpiled for later respreading. The stockpiles should not be deposited in drainage lines.

If the topsoil is to be stored for lengthy periods (six months or longer), vegetation should be established on the stockpiles to protect them against erosion.

(d) Areas that remain bare for lengthy periods during subdivision development should be afforded temporary protection by cover cropping with a suitable fast growing species (cereal rye or barley in autumn-winter, Japanese millet in spring-summer), or by treatment with a surface mulch of straw or a chemical stabiliser.

(e) Where appropriate, exposed areas such as construction sites should be protected by locating temporary banks and ditches upslope to contain and divert runoff. Simple drainage works will remove local water from construction sites.

(f) Where possible, development should be designed to minimise modification of the natural landscape.

(i) Cut and fill and general grading operations should be restricted to the minimum essential for development.

(ii) On steep slopes, roadways should, where possible, be aligned just off the contour. While such an alignment may require increased cut and fill, it provides improved control over surface drainage.

(g) All permanent drainage works should be provided as early as possible during subdivision construction.

(h) Vehicular traffic should be controlled during subdivision development, confining access, where possible, to proposed or existing road alignments. Temporary culverts or causeways should be provided across major drainage lines.

(i) Temporary tracks used during development should be graded to a crown and provided with effective surface drainage to prevent runoff eroding adjacent land.

(j) Permanent roads and parking bays should be paved as early as possible after their formation.

(k) Borrow areas should not be located on steep slopes or on highly erodible soils. Topsoil from borrow areas should be stockpiled, and erosion control earthworks provided to protect them from upslope runoff.

(l) Areas of fill should be thoroughly compacted before any construction takes place upon them.

(m) Cut and fill batters should be formed to a safe slope. On stable soils this will usually be no steeper than 1 in 2. On unstable soils it may be as low as 1 in 4.

Early stabilisation of the exposed soil of cut and fill batters is essential:

(i) Suitable seed mixtures include cereal rye, Wimmera rye grass and Woogenellup sub-clover. These should be sown at a heavy rate with a liberal dressing of fertiliser.

Specific recommendations on mixtures and application rates will be provided, on request, by the local Soil Conservation office.

(ii) Establishment of vegetation on batters is assisted by spreading topsoil over the surface.

(iii) Batters may be treated with a chemical or an organic mulch following sowing. This provides a measure of stability at an early stage.

(iv) Hydro-seeding is an alternative effective batter stabilisation technique. A mixture of seed, fertiliser, wood or paper pulp, and water is sprayed onto the batter through a specially designed applicator.

(v) Vegetation is best established in autumn. If seed is sown in spring, provision for watering may be required in the dry summer months.

(vi) Once vegetation is established on batters, regular topdressing with fertiliser is necessary.

(vii) Batters should be protected from upslope runoff by locating catch drains immediately above them. When the batters are more than six metres in height, berm drains should be located at intervals down the batter face to prevent the accumulation of erosive concentrations of local runoff.

(n) Following roadway construction and the installation of services, all disturbed ground which is not about to be paved or built upon should be revegetated:

(i) The surface should be scarified prior to return of topsoil.

(ii) Topsoil should not be respread while it is very wet or very dry.

(iii) Grasses and legumes should be sown into a prepared seed bed. The range of species which may be considered for general revegetation work includes phalaris, perennial and Wimmera rye grasses, couch, creeping and browntop bent grasses, Kentucky blue grass, white clover, Seaton Park sub-clover, and, in moist situations, paspalum and kikuyu. Seed of clover should be inoculated with Rhizobium and lime pelleted prior to sowing.

Autumn sowings will generally be the most successful for all species except kikuyu, which should be sown or planted in spring-summer. If spring sowing is necessary, irrigation may be required during the summer to ensure successful establishment.

(iv) All revegetation sites should receive an adequate dressing of fertiliser at sowing to assist vigorous establishment and growth.

Specific recommendations on seed and fertiliser mixtures and application rates will be provided, on request, by the local Soil Conservation office.

(o) Correct maintenance of all areas which are to remain under a permanent vegetative cover will ensure a persistent and uniform sward. Regular topdressing with fertiliser is necessary in the early years of establishment, while mowing will control weeds and promote a vigorous turf.

Within the broad framework outlined above, development constraints specific to each of the individual sub-classes must also be applied. These are described below.

2. Sub Class A-0: Low Hazard - No Major Constraints - Suitable for Extensive Building Complexes

Within this sub-class are widespread areas of ridge crests and hillslopes with gradients less than 3 per cent. Soils are mainly the yellow solodic B type as defined on the soil map. Erodibility of this soil type is moderate.

Common erosion problems which may arise from uncontrolled development on areas in this sub-class include sheet and rill erosion and resulting siltation.

(i) With careful management this area will tolerate the development of extensive shopping complexes and parking facilities, involving large scale ground disturbance and levelling, without serious erosion occurring. In the event of this form of development, particular attention should attach to provisions (j) (l) and(n) in the general recommendations.

(ii) If residential development takes place on this sub-class, the erosion hazard will not be significant provided the general recommendations are followed.

(iii) Few problems are associated with the use of this area as open space, although the development of such facilities as ovals will require care with cut and fill to ensure batters are stable and well vegetated.

3.1 Sub Class B-1: Moderate Hazard - Slope Constraint - Suitable for Residential Development.

Within this sub-class are widely scattered hill slopes with gradients ranging from 5 to 10 per cent.

Soils are largely the red earth - red podzolic complex, the yellow earth-yellow solodic complex, and the yellow solodic B. The erodibility of these soils is low to moderate.

Uncontrolled development on areas of B-1 will lead to sheet and rill erosion, minor gullying, and erosion of cut and fill batters.

(i) Commercial or industrial development requiring large scale levelling is not recommended on areas falling within this sub-class. The extent and depth of cut and fill which such development would require on these steeper slopes would generate a serious erosion hazard and may lead to high levels of siltation during construction. If, however, such development is undertaken on this sub-class, emphasis should attach to the early stabilisation of cut and fill batters and the effective compaction of fill. Particular attention should be paid to provisions (d), (e), (l), (m) and (n) in the general recommendations.

(ii) These areas will tolerate residential development without generating a severe erosion hazard. In the event of such development, particular attention should be paid to provisions (b), (d), (f), (j), (m) and (n) in the general recommendations.

(iii) Few problems are associated with passive recreation on this sub-class, provided a healthy cover of vegetation is maintained. The development of such active recreation facilities as ovals, requiring large scale cut and fill, will be subject to similar restrictions to those set out in (i) above.

These long, gentle slopes are typical of much of the land falling within Class A-0.

Gently sloping Class A land in the foreground grades into Class B-1 hillslopes in the background.

3.2 Sub Class B-2: Moderate Hazard - Drainage Constraint - Suitable for Extensive Building Complexes.

This sub-class covers areas of the drainage plain in the south-west quarter of the Thurgoona site, on the yellow solodic B soil. Slope gradients are less than 1 per cent.

These areas are poorly drained and are subject to overflow from the major drainage arteries which carry runoff through the development site. Without provision for this drainage problem, development on these areas will lead to surface erosion and siltation in the short-term, and problems of waterlogging and local flooding in the long-term.

Safe development of these areas hinges largely on the control and the effective disposal of runoff from the catchment upslope, and efficient site drainage to dispose of local stormwater. In this context, the development of drainage reserves along sub-classes D-2 and D-2, 3, as described later in this report, is critical. The location of roads upslope of these poorly drained sites will also assist in diverting flow away from them.

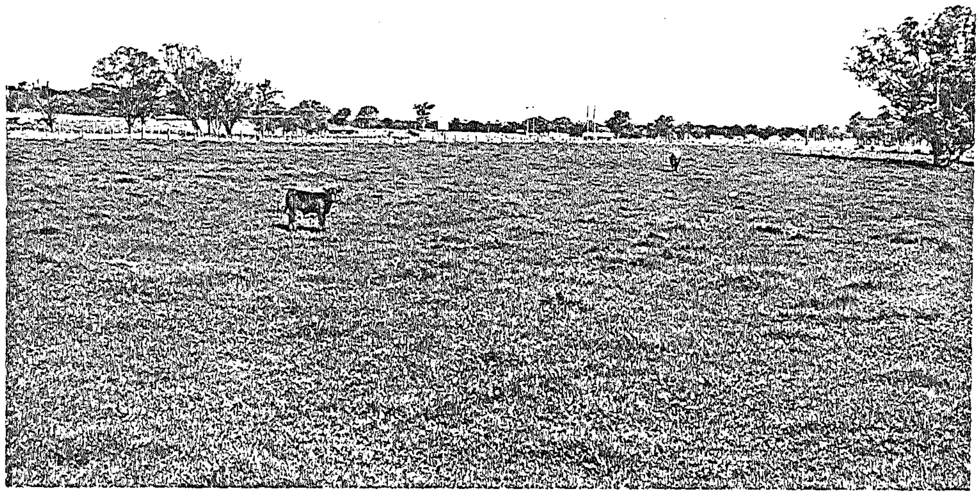
With such provisions for drainage and attention to the general recommendations, particularly items (e), (g) and (n), areas of this sub-class can be safely developed for extensive commercial or industrial complexes, for residential subdivisions, or for recreation.

3.3 Sub Class B-2, 3: Moderate Hazard - Drainage/Swelling Clay Constraints - Suitable for Extensive Building Complexes.

Within this sub-class are areas of the drainage plain and the footslopes between Gerogery and St. John's Roads. Slopes are generally less than 3 per cent.

The main difference between this sub-class and B-2 is the soil type. This is a brown clay - yellow solonetzic complex. Associated with this soil are problems of poor drainage and, in some locations, possible problems of profile shrinkage and expansion.

Like B-2, this sub-class is suitable for the development of extensive commercial or industrial complexes, for residential subdivision or for recreational use. Efficient drainage is



Land typical of the lower lying areas which fall within Classes B-2 and B-2, 3 is illustrated in the two photographs above.

critical to prevent possible flooding and waterlogging, and the attention of developers should be drawn to possible shrinkage and swelling of the soil, particularly in areas where gilgais are evident.

4.1 Sub Class C-1: High Hazard - Slope Constraint - Suitable for Residential Development.

Only a few isolated slopes with gradients of 10 to 20 per cent on the red earth - red podzolic soil complex fall in this sub-class.

As a result of the steep gradient, the erosion hazard is more severe on these slopes than on those of sub class B-1. Uncontrolled development may lead to more serious rilling and gully erosion, siltation, and the erosion of cut and fill batters.

(i) These slopes are not recommended for the development of extensive commercial or industrial complexes for the same reasons which preclude similar development on sub-class B-1. The hazards of such development are even greater on this sub-class.

(ii) These areas are suitable for residential development without posing a serious erosion hazard, provided the general recommendations are followed, particularly items (a), (b), (d), (f), (j), (k), (m) and (n).

(iii) Passive recreation on this sub-class presents no problems, although a good vegetative cover should be maintained. Active recreation is not recommended where it will require substantial cut and fill to provide expanses of level ground.

4.2 Sub Class C-1, 3: High Hazard - Slope/Erodible Soil Constraint - Suitable for Low Density Residential Development.

Slopes with gradients of 10 to 20 per cent, on highly erodible red and yellow podzolic soils in the south-eastern quarter of the study area, fall within this sub-class. The terrain is essentially similar to that of C-1, but the erodible nature of the soil on this sub-class poses a more serious erosion hazard.

(i) Like Sub-Class C-1, this area is not recommended for large scale commercial or industrial development.

(ii) The area will tolerate residential development. If possible, it should be developed with only low density housing (4000 to 8000 square metre blocks). Such development should aim at locating roads and houses towards the top or the bottom of the slope, with yard space running onto steep sections to minimise the disturbance of the most hazardous areas. In the event of such development, particular attention should be paid to items (a), (b), (d), (e), (f), (j), (k), (m) and (n) of the general recommendations.

(iii) Passive recreation presents no problems, provided a good vegetative cover is maintained. Active recreation is not recommended where it will require substantial disturbance to provide large areas of level ground.

4.3 Sub Class C-2, 3: High Hazard - Drainage/Puddling Soil Constraint - Suitable for Low Density Residential Development.

Within this sub-class are the footslopes adjoining the flood plain of 8-Mile Creek. Gradients of these slopes range up to 5 per cent. The soils are the yellow solodic A which are highly erodible and have a low wet strength.

With uncontrolled development on this sub-class, there is a hazard of serious rill and gully erosion. There may be problems of long term surface instability as a result of the low wet strength of the soil. Any urban development should take account of this soil limitation.

(i) The area is not considered suitable for large scale commercial or industrial centres. Major disturbance of the yellow solodic soil will generate a serious erosion hazard. In addition, severe constraints attach to roadway and building design on this soil to mitigate the instability hazard associated with its poor wet strength.

(ii) The area is suitable for low density housing on blocks of 4000 to 8000 square metres. In the event of such development, the design should take account of the puddling problem associated with the yellow solodic soil and should aim, where possible, to locate roadways and buildings on well drained sites, utilising the bulk of the area as yard space. Particular attention should be paid to items (e), (g) and (n) in the general recommendations.

(iii) The area is suitable for recreation usage, provided a stable vegetative cover is maintained. Efficient drainage will be required if this usage is to be intensive.

4.4 Sub Class D-1,3: Very High Hazard - Slope/Erodible Soil Constraint - Suitable for Reserve.

A small area of hill slopes with a gradient exceeding 20 per cent, situated in the south-western corner of the study area, falls in this sub-class. The soils are highly erodible red and yellow podzolics.

Because of the high erodibility of the soil and the steep gradient, this sub-class is not recommended for commercial, industrial or residential development. A very severe erosion hazard would be generated by any disturbance of the area. As far as possible it should remain undisturbed, utilising it as yard space or as a recreation reserve.

4.5 Sub Class D-2: Very High Hazard - Drainage Constraint - Suitable for Reserve.

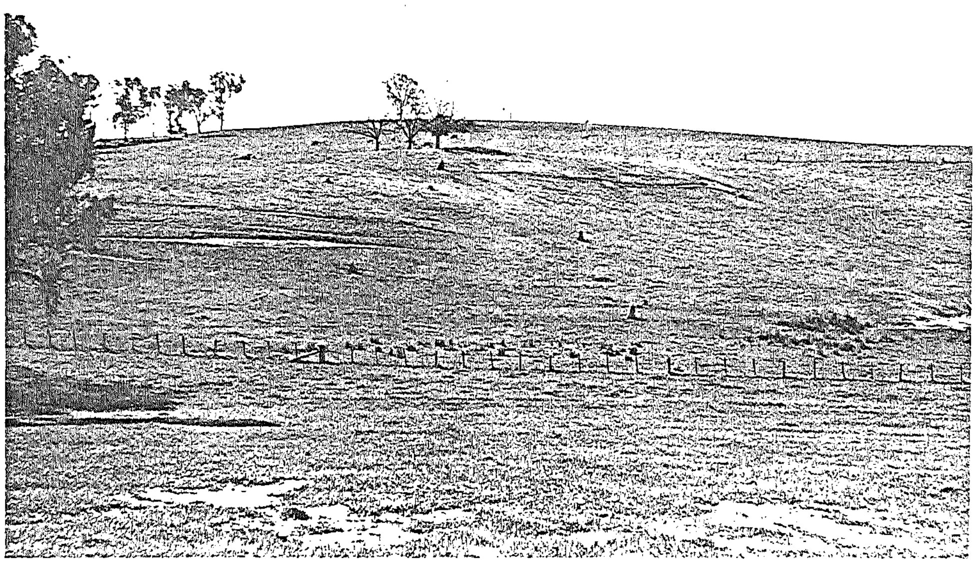
Sub Class D-2,3: Very High Hazard - Drainage/Puddling Soil Constraint - Suitable for Reserve.

These two sub-classes comprise the major drainage lines on the study area and the flood plain of 8-Mile Creek. Slopes are generally less than 1 per cent.

The yellow solodic B soil unit occurs on D-2, while the yellow solodic A is found on D-2,3. The former is relatively stable, while the latter presents a greater hazard because of its low wet strength.

These areas are subject to regular flooding and remain in a saturated condition through the winter and early spring months.

Class B-1 grading into steeper Class C-1 slopes.



Steep hillslopes in the south-eastern corner of the area fall within Class D-1,3.

Uncontrolled development on these areas will lead to serious gully erosion and siltation in the short-term, and problems of waterlogging, flooding, undermining of development works and, on the yellow solodic A soil, possible mass movement in the long-term.

(i) & (ii) Development of extensive building complexes or of houses is not recommended on these sites because of the hazards indicated above. However, in the event of such development, very efficient control of runoff from the catchment upslope and from the adjacent hillsides is essential.

Filling and effective site drainage will be necessary to overcome recurring floods and frequent waterlogging.

Very large underground pipes, box culverts or concrete stormwater channels will be required to carry stormwater safely from the subdivision. Sufficient capacity is necessary to carry not only runoff from the development area but also that from the catchment upslope of this area.

Even with these provisions, periodic flooding and the associated damage to buildings, undermining of roadways, upheaval of stormwater drains, and localised waterlogging is likely after heavy rain.

Frequent saturation will accentuate the puddling problem on the yellow solodic A soil, increasing the instability hazard.

(iii) To minimise erosion and long-term instability problems, the most suitable use for the central drainage arteries delineated by D-2 and D-2,3 is as a drainage reserve. With minor modification of channel shape and subsequent vegetative improvement, these reserves can be developed to carry all stormwater from the subdivision, as well as runoff from the catchment upslope of the development area, safely and efficiently to the Murray River. In this development, particular attention should be paid to items (g), (h) and (o) of the general recommendations.

The existing incised flow lines should be levelled, and wide, shallow, trapezoidal or parabolic waterways formed in their place. These waterways should have sufficient cross-section to allow them to carry expected flows at a velocity not exceeding 2.5 metres per second. Flows exceeding this velocity will scour vegetated channels, and concrete lining is then required.

Reserves of the width shown on the landscape evaluation map will cater for all but the most extreme flood flows. In delineating these reserves, allowance has been made for the catchment outside the subdivision site, west of the railway line, and the possible future development of this external catchment. If, however, this area is to be retained for agricultural or pastoral pursuits, careful management should be adopted to control silt movement into the drainage reserves on the urban area down-slope.

Once the drainage channels have been formed and shaped, they should be stabilised with introduced grasses and legumes. Kikuyu, couch, paspalum, perennial ryegrass and Seaton Park sub-clover are suitable species for waterway stabilisation in the Albury region.

Best results will be achieved if these areas are sown in autumn, though kikuyu may require a spring sowing. A heavy dressing of fertiliser should be applied at sowing, and follow-up applications of fertiliser may be necessary. Topsoiling is desirable on those portions of the reserves where gully erosion is at present active.

Stabilisation will be assisted if a surface binding agent such as jute mesh and bitumen, straw and bitumen, or another suitable chemical or organic mulch is applied at sowing. This will impart temporary surface stability until vegetation is established. It is a particularly desirable measure where reserves are developed after subdivision works commence.

If possible, however, all drainage reserves on the area should be formed and stabilised before any major development work commences. This is a critical requirement on the yellow podzolic A soil of D-2,3. As this is a highly erodible soil, it will be subject to severe erosion by flows unless it is well vegetated.

Trickle flows in the drainage reserve may be catered for by providing an underground pipe with sufficient capacity to handle the one in one year or the one in five year flow, or by locating a half pipe, a concrete V-invert, or a footpath along the centre of the reserve. Without this provision, continuous trickle flows may erode the floor of the waterway, while rushes, sedge and other water-loving species will proliferate along the trickle path. The general appeal of the reserves for passive recreation will suffer as a result.

Where roadways cross the drainage reserves, floodways or culverts should be provided. To minimise erosion, culvert outlets should be located at ground level. Rock grouting, hay and wire netting, jute mesh and bitumen, or structural energy dissipators should be used below outlets to alleviate erosion problems.

The establishment of drainage reserves along the lines described above will provide inexpensive, safe, efficient, and aesthetically pleasing central drainage arteries. These will be capable of carrying all storm runoff from the subdivision and adjacent catchment areas, with minimal risk to roadways or buildings. The probability of flooding of adjacent low-lying areas (sub classes B-2 and B-2,3) will be greatly reduced.

There is potential within this drainage design for the development of flow detention structures. Such structures would have a significant influence in attenuating flow peaks in the drainage reserves. Possible sites are located both on drainage lines within the development area and in the foothills above the area. Specific locations can be identified and assistance provided with design of the structures by the local Soil Conservationist.

In any event, the existing dams along the drainage lines should be retained, at least while development is in progress. They will perform a useful function as silt traps during the period of development. Their effectiveness in this respect can be increased by equipping them with trickle pipe outlets to empty stored water between storms.

The flood plain of 8-Mile Creek, which falls within Sub class D-2,3, is subject to inundation. The soils of the flood plain have a low wet strength and become a structureless quagmire when wet. Building and roadway construction should, therefore, be avoided on the area, and it might be set aside as a recreation reserve.

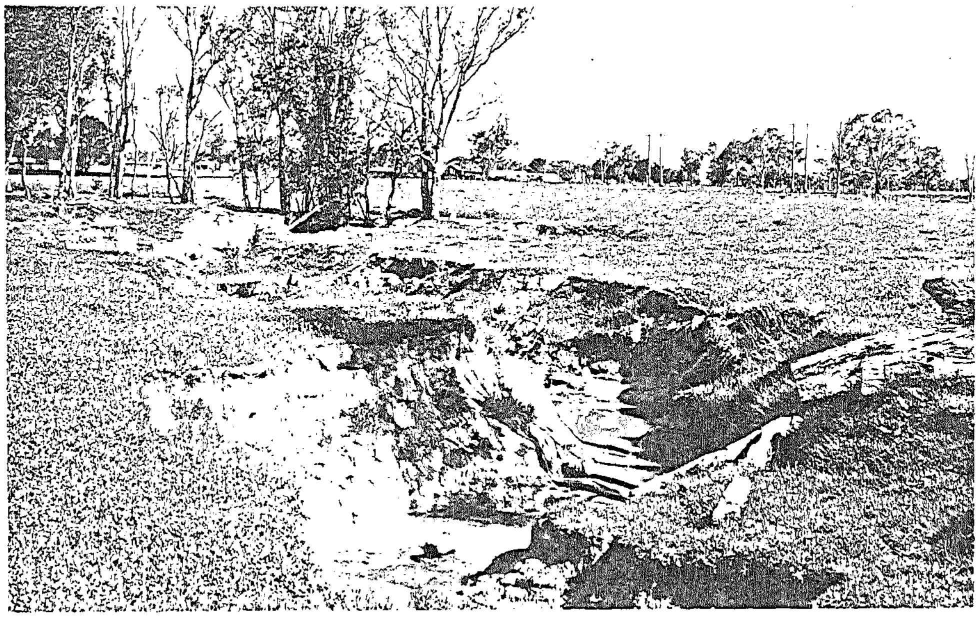
4.6 Sub Class D-3: Very High Hazard - Swelling Clay Constraint - Suitable for Reserve.

This sub-class comprises an area of gilgaied grey clay soils on the drainage plain just north of the Riverina Highway.

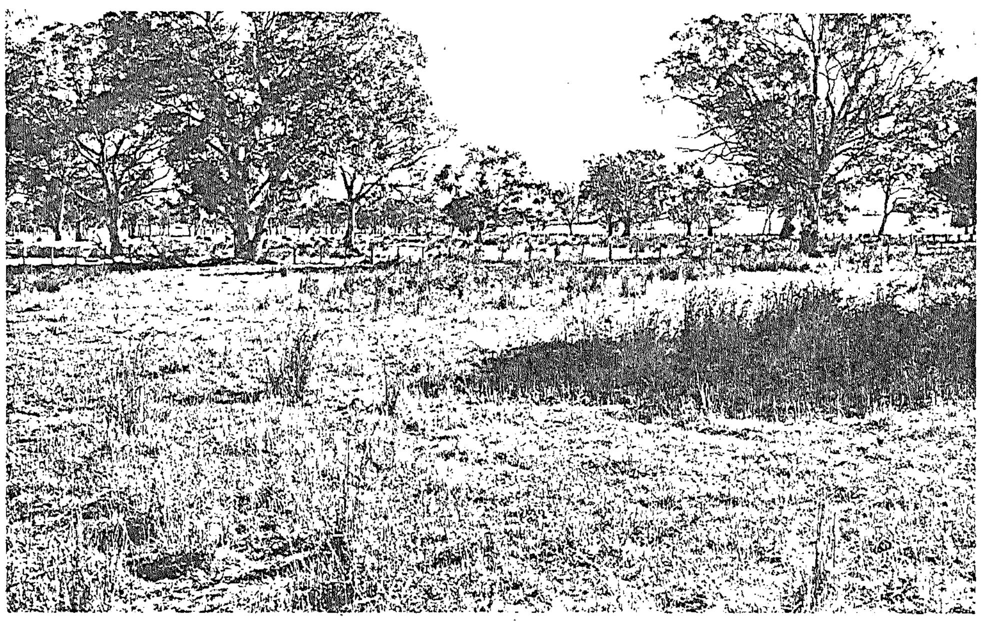
The site is almost level, has a high water table, is poorly drained, and is subject to flooding and waterlogging. The soil has a high volume expansion and is subject to gilgai formation.

Because of these shortcomings, building and roadway development is not recommended on this sub-class. If such development takes place, elaborate precautions will be required to minimise the hazards associated with profile movement and with the poor site drainage. Even with such precautions, it will be difficult to ensure long-term stability of the area.

The site would be best retained for passive recreation. Surface drainage and the development of a good vegetative cover will assist in maintaining surface stability. It is not considered suitable for ovals or for other active recreation facilities owing to the pronounced gilgai development and the poor site drainage.



This drainage line falls within Classes D-2 and D-2,3. Development requires filling of the gully and shaping to form a major waterway.



Poorly drained Class D-3 land is characterised by deep gilgais on which such water-loving species as sedge and rushes are growing.

APPENDIX

SOIL SURVEY : THURGOONA SUBDIVISION

1. Survey and Mapping Method

The soils have been mapped at a scale of 1:2500. Map units were delineated initially in terms of erodibility and Great Soil Grouping, and units so defined have been classified using Northcote's Factual Key. Boundaries between units have been determined by detailed field reconnaissance.

A two inch hand auger was used to sample 20 centimetres into the B horizon. This enabled classification to sub-class level using the Northcote Key.

Sampling for detailed description and classification was done with a four inch Jarret Auger up to site 22, and with an "Atlas Copco" sampler on subsequent sites. The auger extracted cores of 4.5 centimetre diameter to a depth of 150 centimetres. Sampling sites were selected to provide a reasonable cross-section of the area, covering all anticipated soil types.

Soil classification and description was carried out at the sampling sites and included an assessment of erodibility and drainage characteristics.

Each horizon was classified in terms of the Unified Soil Classification System and Hamilton's Erodibility Index.

Samples were collected for laboratory analysis from profiles exceeding 30 centimetres in depth.

2. Map Units: Description of Typical Profiles

2.1 Grey Clay (Ug 5.23 - Ug 6.2)

Ten centimetres of medium clay, rich in organic material, is underlain by at least 100 centimetres of heavy grey clay. In situations where the grey clay is less than 150 centimetres deep, it is underlain by a heavy brown clay with similar properties.

2.2.1 Brown Clay (Ug 3.3 - Ug 5.23)

Fifteen centimetres of a silty clay overlies a brown, medium clay. This grades into a lighter brown, highly plastic, alkaline heavy clay at about 100 centimetres.

2.2.2 Yellow Solonetzic Soil (Db 1.33 - Dy 2.33)

Fifteen centimetres of a silty clay, rich in organic matter, overlies a bleached, dispersible, silty clay 15 to 20 centimetres deep. This changes abruptly to a well-structured, yellow, heavy clay which is underlain by the same light brown, plastic, alkaline heavy clay as the brown clays.

The bleached layer has been produced by periodic inundation.

No evidence was found of iron or manganese, or of calcium carbonate nodules.

2.3 Red Earth - Red Podzolic Soil (Gn 2.12 - Dr 2.21)

Both soil types consist of a loamy, organically rich A horizon with a red tinge. In the red podzolic soil this is separated from a red, earthy, friable, light to medium clay B horizon by an unbleached A_2 horizon. In the red earths this A_2 horizon is absent. Near the ridge tops the B horizon lies directly on weathered granite country rock. Downslope it lies on a yellow, plastic clay.

2.4 Yellow Earth - Yellow Solodic Soil (Dy 3.22)

These soils consist of a loamy organic A horizon which grades, in the yellow earth, into a friable, yellow, medium clay B horizon. In the yellow podzolic soil, the organic A horizon is separated from the B by a non-bleached A_2 horizon 10 to 20 centimetres deep.

2.5.1 Red Podzolic Soil (Dr 2.21)

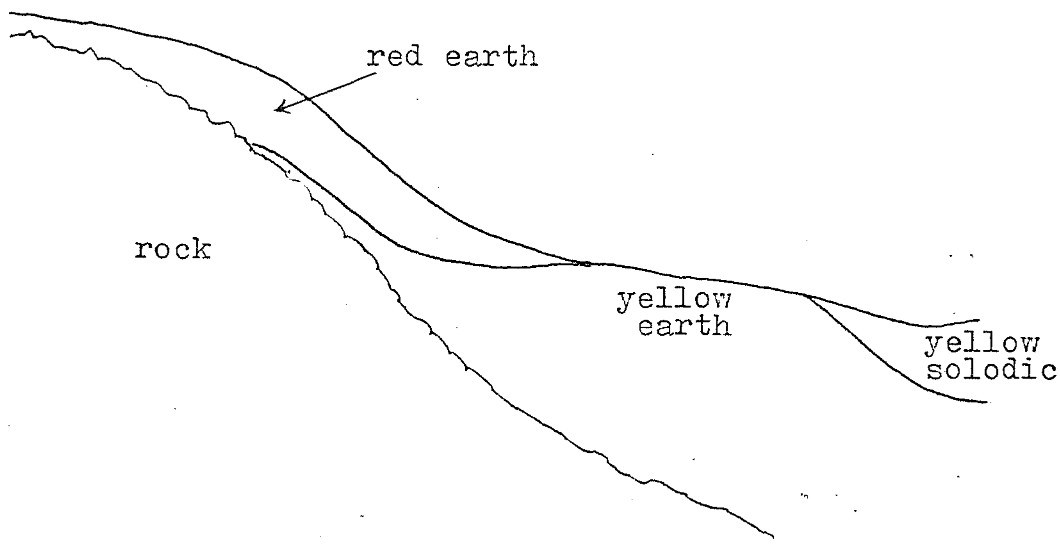
Fifteen centimetres of a silty clay loam overlies a slightly bleached layer 10 to 20 centimetres deep. This grades abruptly into a red sandy clay that becomes more yellow with depth. pH ranges from 5.5 in the A horizon to 6.0 in the deep B horizon. If this soil is exposed, it is highly erodible.

2.5.2 Yellow Podzolic Soil (Dy 3.41)

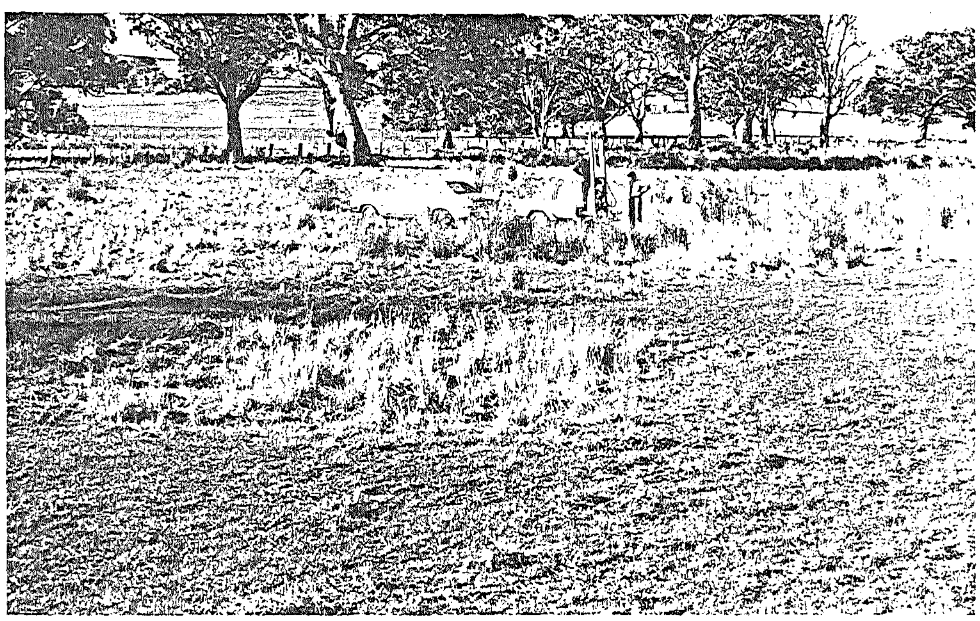
Twenty centimetres of a silty clay loam overlies a strongly bleached, non-plastic layer 15 to 20 centimetres deep. This grades abruptly into a yellow clayey sand to sandy clay. The profile is slightly acid throughout.

2.6 Yellow Solodic A Soil (Dy 3.42)

An acid, loamy A horizon of variable depth grades into a deep (80 centimetres), silty, strongly bleached A_2 horizon.



Ridge cross-section to show the relative distribution of red and yellow earths.



The grey clay soil - deeply gilgaied and poorly drained.

TABLE I . PROPERTIES OF MAJOR SOIL TYPES - THURGOONA SUBDIVISION

Map Unit	A				B			C	
	Grey Clay				Brown Clay - Yellow Solonetzic			Yellow Solodic A	
Northcote Coding	Ug5. 23-6/3/25		Ug6. 2-6/3/10		Dy5. 43-3/0/15	Ug3. 3-5/2/10		Dy3. 42-3/1/20	
Great Soil Group	Grey clay		Grey clay		Yellow Solonetic	Brown clay		Yellow Solonetzic	
Underlying Material	-		-		-	-		-	
Depth to bedrock (cm)	-		-		-	-		-	
Profile Drainage	Poor		Poor		Poor	Poor		Poor	
Texture B Horizon	Heavy clay		Heavy clay		Heavy clay	Heavy clay		Heavy clay	
Sample depth (cm)	25-105	105-125	10-90	90-180	50-150	10-30	30-150	30-100	100-150
Liquid limit (%)	34. 3	46. 4	65. 1	61. 5	49. 6	29. 9	45. 8	57. 3	52. 4
Plastic limit (%)	14. 4	17. 0	21. 8	20. 3	19. 6	11. 7	16. 5	18. 3	20. 7
Plasticity Index	19. 9	29. 4	43. 3	41. 2	30. 0	18. 2	29. 3	39. 0	31. 7
U.S.C. Code	CL	CL	CH	CH	CL-CH	CL	CL+CH	CH	CH
Optimum M.C. (%)	17	17	25	25	22	17	22	25	25
Volume expansion (%)		16. 5 to 33. 5	34. 8	19. 3	6. 4	5	16. 3	21. 3	30. 2
Dispersal Index	4. 5	3. 0	9. 8	4. 2	2. 1	2. 1	1. 4	2. 0	2. 7
Emerson Class	3	2	3	3	1	1	1	3	3
Erodibility	Low	Low	Low	Low	High	Mod.	Mod.	High	High
Hamilton's E.I.	1. 15	1. 63	1. 63	1. 63	3. 6	4. 9	4. 9	3. 46	4. 62
Suitability for ponds	Good		Good		Mod.		Good		Mod.
Topsoil Quality	Mod.		Mod.		Mod.		Mod.		Mod.
Ease of revegetation	Mod.		Mod.		Mod.		Mod.		Mod.
Special features	High water table		High water table		Periodic High Water table			Periodic High water table	

TABLE I (Continued)

Map Unit	D Yellow Solodic B			E Yellow Earth - Yellow Solodic	F Red Earth - Red Podzolic	G Red and Yellow Podzolic	
Northcote Coding	Dy2.42-3/1/20			Dy3.22-3/0/25	Gn2.12-3/1/15	Dy3.41-4/0/35	
Great Soil Group	Yellow Solodic			Yellow Podzolic	Red Earth	Yellow Solodic	
Underlying Material	-			-	Granite	Schists	
Depth to Bedrock (cm)	-			-	50 +	10 +	
Profile Drainage	Mod.			Mod.	Good	Mod.	
Texture B Horizon	Light-medium clay			Medium clay	Medium clay	Loamy sand	
Sample depth (cm)	21-45	45-120	120-160	25-140	15-150	20-35	35-150
Liquid Limit (%)	27.0	17.6	33.4	38.3	40.4		35.8
Plastic Limit (%)	15.2	NP	15.8	16.0	21.5		17.4
Plasticity Index	11.8	NP	17.6	22.3	18.9	NP	18.4
U.S.C. Code	CL	CL	CL	CL	CL	ML	CL
Optimum M.C. (%)	17	17	17	17	17	19	17
Volume Expansion (%)	10.8	9.1	15.1	11.9	15.5	shrinks	14
Dispersal Index	6.5	4.5	4.5	13	30	2.7	9.5
Emerson Class	3	3	3	3	3	2	3
Erodibility	Mod.	Mod.	Mod.	Low	Low	High	High
Hamilton's E.I.	2.83	4.6	2.3	0.61	0.61	6.19	5.00
Suitability for ponds			Good	Good	Poor		Poor
Topsoil Quality			Mod.	Mod.	Good		Poor
Ease of revegetation			Mod.	Mod.	Good		Poor
Special Features					Rock close to surface		

This is separated by an abrupt boundary from a mottled yellow/grey, heavy clay B horizon. At a depth of 120 centimetres plus, the B horizon grades into a brown, plastic clay. A band of iron, manganese and quartz 10 centimetres thick often occurs at 100 to 120 centimetres depth.

2.7 Yellow Solodic B Soil (Dy 2.42)

A loamy A horizon 15 to 20 centimetres deep overlies an A_2 horizon less than 20 centimetres deep which may or may not be bleached. This is separated abruptly from the yellow B horizon. Within this unit, the B horizon may be either whole coloured or it may contain bright red mottles. This is usually underlain by a yellow/brown, plastic, medium clay.

3. Definition of Terms used in Table I

Northcote Coding

From Northcote, K.A. - "A Factual Key for the Recognition of Australian Soils". Rellim Technical Publications, Edition 4 (1974).

Soil Conservation Service Addendum to this coding (last three numbers) refers to surface texture, surface structure, and depth of the A horizon in centimetres. Texture classes range from 1 to 6 (from sand to heavy clay). Structure classes range from 0 to 3 (from structureless to strongly developed structure).

Great Soil Group

The equivalent Great Soil Group correlating with the Northcote code. From Stace et al (1968) - "A Handbook of Australian Soils". Rellim Technical Publications.

Underlying Material

Indicated as country rock if encountered above 180 centimetres.

Depth of Bedrock

Indicated if encountered above 180 centimetres. Also indicates minimum depth of soil.

Profile Drainage

Estimated from site characteristics and soil appearance. Possible classes - poor, moderate, good.

Texture B Horizon

Field assessment of a moist bolus as described by Northcote (1974).

Liquid Limit

The moisture content at which the soil passes from the liquid to the plastic state.

Plastic Limit

Minimum moisture content at which the soil is plastic - i.e. can be rolled into a thread 3.5 millimetres thick and 25 millimetres long without crumbling. 'NP' indicates non-plastic soil.

Plasticity Index

Difference between the liquid and the plastic limits. Toughness and dry strength are proportional to the plasticity index. 'NP' indicates non-plastic soil.

U.S.C. Code

Unified Soil Classification System: Foundation and Construction Materials - "Design of Small Earth Dams". U.S.D.I. (1961). Engineering properties can be estimated from this coding.

'ML' refers to inorganic silts and very fine sand, and silty or clayed fine sands of low plasticity.

'CL' refers to inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays and lean clays.

'CH' refers to inorganic clays of high plasticity, and expanding clays.

Optimum Moisture Content

The moisture content for Proctor maximum density. Derived from U.S.C. Code.

Volume Expansion

Free swell determination using Keen Rackzowski test.

$<$ 5%	Very low
5-10%	Low
10-20%	Moderate
20-40%	High
$>$ 40%	Very high

Dispersal Index

Method used by the Soil Conservation Service as described by Ritchie, J.S. (1963) - "Earthwork Tunnelling and the Application of Soil Testing Procedure". Journal of the Soil Conservation Service of New South Wales, Volume 19.

1-2	Highly dispersible
2-3	Moderately dispersible
>3	Slightly dispersible

Emerson Class

Classes derived from Emerson Crumb Test on undisturbed soil crumb as described by Emerson, W.W. (1967) - "A Classification of Soil Aggregates Based on their Coherence in Water". Australian Journal of Soil Research, Volume 5.

1. Highly dispersible
2. Moderately dispersible
3. Slightly dispersible

>3 Not dispersible

Erodibility

Assessed in the field. Possible classes - low, moderate, high.

Hamilton's E.I.

Hamilton's Erodibility Index is based on determinations of infiltration rate, internal drainage, infiltration capacity, dispersibility, texture and structure. Possible classes are:

0-1	Very slightly erodible
1-2	Slightly erodible
2-3	Moderately erodible
3-4	Highly erodible
>4	Very highly erodible

Suitability for Ponds

Determination based on grading analysis, dispersibility, Unified Soil Coding, and an assessment of the water-holding characteristic of the soil. Intended as a guide to suitability for runoff detention basins. Possible classes - poor, moderate, good.

Topsoil Quality

Relates to fertility as assessed in the field. Possible classes - poor, moderate, good.

Ease of Revegetation

Based on texture, tilth and salinity determinations. Possible classes - poor, moderate, good.

Special Features

Additional features considered to be of importance.

TABLE II: Field Description and Classification of Soils – Thurgoona Subdivision

Site	Classification	Depth (cm)	pH	Colour (when moist)	Texture	Structure	Drainage	Erodibility
19	Dr2.21 4/1/25	15	5½	10YR5/4	SCL	1	Good	High
		25	5½	7.5YR7/6	SL	1	Mod.	
		60	5½	5YR4/6	SC	3		
		200+	6	7.5YR5/8	SC	3		
20	Dy3.41 4/0/35	20	6	10YR5/4	SCL	0	Mod.	High
		35	5½	10YR7/4	S	0	Poor	
		150+	5	10YR5/6 20%5YR4/6	LS	3		
21	Gn2.22 3/1/20	20	6	5YR4/3	Lfsy	1	Good	Low
		50	6½	5YR5/6	LMC	2	Good	
		75	6½	5YR4/6	MC	2		
		120	6½	7.5YR5/6	MC	2		
		170+	6½	10YR5/6	MC	2		
22	Dy3.22 3/0/25	15	6	7.5YR4/4	L	0	Good	Mod.
		25	6	7.5YR4/4	SiL	0	Mod.	
		140	6	10YR5/6	MC	2		
		180+	6	10YR5/6 (mottles 10YR5/6 increasing with depth)	MC	2		
23	Ug5.2 6/3/25	25	5½	2.5Y5/2	MC	3	Poor	Low
		105	6	2.5Y6/2	HC	3		Mod.
		125	7	10YR4/1	HC	3		Low
		170+	7½	2.5Y5/4 (Fe & Mn mottles throughout)	HC	3		Low
24	Ug6.2 6/3/10	10	6	2.5Y3/2	MC	3	Poor	Low
		180+	6	5Y5/2	HC	3		Low
25	Dbl.33 5/2/15	15	5½	7.5YR4/2	SiC	2	Poor	Mod.
		20	5½		SiC	3		Mod.
		90	8	10YR4/3	HC	3		Mod.
		155+	8	5YR4/6	HC	3		Low
26	Dy2.42	21	6	7.5YR5/4	Lfsy	1	Good	Mod.
		46	6½	10YR7/4	SL	0		High
		120	6	10YR6/8	FSCL	2		Mod.
		156	7½	2.5Y5/4	LMC	2		Low
27	Dy2.32 3/1/15	15	6	10YR5/3	Lfsy	1	Good	Mod.
		35	6	10YR6/4	FSCL	0		High
		60	6½	5YR5/6	MC	2		Mod.
		90	7	2.5YR4/6	LMC	2		Low
		150+	6½	50%10YR6/4	MC	3		Low
28	Ug5.16 5/2/12	12	6	5Y2/1	LC	2		Low
		100	7	2.5Y3/0	MC	3		Low
		150	8	2.5Y5/0	MC	3		Low
29	Ug5.25 5/2/25	25	5½	2.5Y4/2	LC	2		Low
		150	6½	10YR4/2	HC	3		Low
		170+	8½	10Y4/3 (Fe Mn $CaCO_3$ earth. Smooth faced peds.)	HC	3		Low
30	Ug3.3 5/2/25	25	5½	5YR5/6 (Sporadically bleached A2)	SiC		Poor	Mod.

TABLE II (Contd)

Site	Classification	Depth (cm)	pH	Colour (when moist)	Texture	Structure	Drainage	Erodibility
	Ug3.3	65	6	10YR5/6 (Fe Mn Concretions)	MC	3		Mod.
		175+	8	10YR5/6 (No Fe Mn)	HC	3		Mod.
31	Ug3.2 5/2/10	10	5½	5YR5/2	SiC	2	Poor	Mod.
		30	6	2.5Y7/4	LC	3		High
		150	6½	2.5Y5/4	HC	3		Mod.
		150+	8½	2.5Y4/2	HC	3		Mod.
32	Ug5.24 5/2/5	5	5½	7.5YR3/2	LC	2		Low
		45	5½	10YR5/1	HC	3		Low
		120+	7½	2.5Y3/0	HC	3		Low
33	Db4.42 3/1/20	20	6½	7.5YR5/4	L	1	Mod.	Mod.
		30	6½	7.5YR5/6	SiC	0		Mod.
		70	6½	10YR6/4	LC	2		Mod.
		170+	7	10YR5/6	LC	2		Mod.
34	Dy2.33	20	6½	2.5Y5/2	Si		Good	Mod.
		40	6½	10YR6/3	SiC			Mod.
		100	6½	10YR5/6	LMC			Mod.
		150+	8	2.5Y6/2 30%7.5YR5/8	MC			Mod.
35	Dy5.43 3/1/15	15	6½	7.5YR4/2	Si	1	Mod.	Mod.
		20	6½	10YR7/2	L	0		High
		80	7	10YR6/8 10%2.5Y6/2	LC	2		Mod.
		150+	8	10YR5/6 50%2.5Y6/2	MC	3		Mod.
36	Dy5.43	15	6	10YR4/2	Si		Mod.	Mod.
		50	6½	10YR7/3	LS			High
		110	7	10YR6/8 30%2.5Y7/4	LC			High
		150+	8	10YR6/8	MC			High
37	Dy5.43	10	6	10YR3/2	Si		Good	Mod.
		30	6½	10YR7/4	SiC			High
		150	7	10YR6/8 20%2.5YR5/6	MC			High
38	Dy5.43	10	5½	10YR6/3	L		Poor	Mod.
		30	6	10YR7/2 (Fe & Mg)	SC			High
								High
		150	6½	40%10YR7/1 60%10YR6/8	MC			High
39	Dy2.42	6	6	7.5YR5/2	SL		Good	Mod.
		40	6	10YR7/2	SC			Mod.
		150	6½	10YR5/8 (Rock fragments)	SC			Mod.
40	Dy2.42	6	5½	10YR6/2	Si		Good	Mod.
		30	6	10YR8/4	SC			High
		80	6	10YR6/8	MC			Mod.
41	Ug5.2	10	6		L		Poor	Low
		20	6½		Si			Low
		150+	6		MC			Low
42	Dy2.43	6	6	7.5YR4/2	L		Good	Mod.
		16	6½	10YR7/3	SiCL			High
		46	6½	5YR5/8	LC			Low
		66	7	10YR8/4	LC			Low
		150	7	10YR7/8	MC			Low

TABLE II (Contd.)

Site	Classi-fication	Depth (cm)	pH	Colour (When moist)	Texture	Struc-ture	Drain-age	Erodi-bility
43	Dy2.43	10	6	7.5YR5/4	L		Good	Mod.
		25	6	10YR6/4	Si			Mod.
		105	$6\frac{1}{2}$	10YR6/8	MC			Mod.
		150	8	10YR6/8	HC			Mod.
44	Dy2.23	20	6	7.5YR2/5	L		Good	Mod.
		45	7	7.5YR6/4	SC			Good
		110	7	10YR6/8	MC			Mod.
		150	8	10YR6/4	HC			Mod.
45	Dr2.12 3/1/15	15	6	5YR4/3	L	1	Good	Low
		50	6	5YR5/8	SC	2		Low
		115	6	10YR5/8	MC	3		Low
		150+	$5\frac{1}{2}$	5Y6/4	HC	3		Low
				30%5.5YR4/8				
46	Dy3.42 3/1/25	25	6	7.5YR4/2	L	1		Mod.
		40	6	10YR7/2	LS	0		High
		150+	6	2.5Y7/2	MC	2		Mod.
			$5\frac{1}{2}$	30% 10Y5/6				Mod.
47	Dy3.42 3/1/20	20	6	10YR5/3	CL	1	Poor	Mod.
		30	6	10YR7/3	FSCL	0		High
				(Fine gravel)				
		150	6	7.5YR4/8				High
				50% 5Y5/2	HC	3		
		200	$6\frac{1}{2}$	2.5Y5/4	HC	3		Mod.
48	Dy3.23	20	6	7.5YR5/4	L		Good	Mod.
		90	7	10YR7/6	SiCL			High
				(5 cm Bleach at 90 cm)				
		150+		80%10YR6/6	MC			Mod.
				(Mottled) 20%10YR7/2				
49	Gn4.15	15	6	10YR4/4	L		Good	Mod.
		20	6	7.5YR5/6	SiCL			Low
		60	7	5YR5/8	LC			Low
		100	7	7.5YR6/8	MC			Low
		150	7	10YR5/6	HC			Mod.
50	Dy5.42 3/0/15	15	$6\frac{1}{2}$	10YR5/3	L	0		Mod.
		35	6	10YR7/2	SiC	0		High
		85	6	50% 10YR7/6	MC	2		High
				50% 10YR7/3				
		150+	$6\frac{1}{2}$	10YR6/6				Mod.
				50% 10YR7/1	HC	3		
51	Dy5.43 3/0/15	15	$5\frac{1}{2}$	10YR5/3	L	0		Mod.
		20	6	5Y7/2	SiC	0		High
		95	$6\frac{1}{2}$	10YR5/8	HC	3		High
		150+	8	2.5Y5/6				Mod.
52	Dy2.43	6	$5\frac{1}{2}$	7.5YR6/4	L			Mod.
		16	6	7.5YR8/2	Si			High
		75	6	10YR7/2	MC			Mod.
		150	8	2.5Y6/2	HC			Mod.
53	Dy3.42	20	$5\frac{1}{2}$	7.5YR5/6	CL			Mod.
		70	6	50%7.5YR6/8	MC			High
				50%7.5YR5/8				
		105	7	30%7.5YR7/2	MC			High
				70%7.5YR7/0				
		115		Fe Mn Qtz Gravel				
		150+	8	10YR6/4	HC			Mod.

TABLE II (Contd.)

Site	Classi-fication	Depth (cm)	pH	Colour (when moist)	Texture	Struc-ture	Drain-age	Erodi-bility
54	Dy2.42	30	5½	7.5YR5/2	CL			Mod.
		130	5½	2.5Y6/8	MC			Mod.
		150+	7½	10YR5/6	HC			Mod.
55	Dy3.42 3/0/25	25	6	10YR6/2	L	0		Mod.
		55	6	70% 10YR8/1 30% 10YR8/8	LC	2		High
		110	6	50% 10YR7/4 50% 10YR7/2 Fe Mn Qtz	MC	3		High
		150+	6	70% 10YR8/3 30% 10YR7/6	HC	3		Mod.
56	Dy3.42	24	5	2.5Y5/2	L			Mod.
		27	5½	2.5Y7/2	CL			High
		75	6	7.5Y5/8	HC			Mod.
		150	6	50%2.5Y6/2 2.5Y5/4	HC			Mod.
57	Dy3.12	15	6	7.5YR5/4	L		Good	Mod.
		80	6	70% 10YR6/8 30% 5YR5/8	MC			Mod.
		150	6	60% 10YR6/8 40% 10YR7/1	HC			Mod.
58	Ug5.31 3/1/15	15	6	10YR6/3	SiC	1	Poor	Low
		150	8½	2.5Y6/4 $CaCO_3$ at 120	HC	3		Low
59	Dy3.23	15	6	7.5YR5/4	CL			Mod.
		30	5½	7.5YR6/2	SiC			Mod.
		110	7	90%2.5Y7/4 10% 10YR6/6	MC			Mod.
		150	8	10YR7/8	HC			Mod.
60	Dy3.42	15	6	7.5YR5/4	L	1	Poor	Mod.
		35	6	10YR7/4	CL	0		High
		105	6	10YR7/6 50%2.5Y7/6	MC	2		High
		150+	6	10YR7/8	HC	3		Mod.
61	Ug3.3 5/1/15	15	6	2.5Y4/2	SiC	1	Poor	Low
		20	6	5Y6/1	SiC	1		Mod.
		100	6½	10YR4/3	MC	3		Low
		150+	8	2.5Y5/4	HC	3		Low
62	Ug5.35 5/2/10	10	6	2.5Y4/2	SiC	2	Poor	Low
		35	6	10YR5/6	MC	3		Low
		150	8	2.5Y5/4	HC	3		Low
63	Ug3.3 5/1/25	25	6	10YR4/2	SiC	1	Poor	Low
		35	6	2.5Y6/2	SiC	1		Mod.
		150	6	2.5Y5/4	MC	3		Low
64	Ug5.23 5/2/25	25	5½	10YR4/1	SiC	2		Low
		80	6	5Y4/1	MC	3		Low
		150+	8½	2.5Y5/4	MC	3		Low
65	Ug5.23	5	6½	5YR6/1	SiC			Low
		30	6½	5YR6/1	HC			Low
		150	8	10YR6/4	HC			Low
66	Dy2.33 3/1/10	10	6	10YR4/2	L	1		Mod.
		12	6	10YR7/2	LC	1		High
		90	6	2.5YR5/4	MC	3		Mod.
		150+	8	5Y6/3	HC	3		Mod.

TABLE II (Contd.)

Site	Classification	Depth (cm)	pH	Colour (when moist)	Texture	Structure	Drainage	Erodibility
67	Ug3.2 5/2/15	15	5½	10YR4/2	SiC	2		Mod.
		20	6	10YR6/1	LC	2		Mod.
		150+	8½	2.5Y5/4	MC	3		Mod.
68	Dy3.43 3/0/10	10	6	10YR6/4	L	0		Mod.
		25	6	10YR7/2	SiC	0		High
		115	6	10YR5/8				Mod.
				30%2.5YR6/2	MC	1		
		150+	8½	2.5Y5/4	MC	3		Mod.
69	Dy2.22 3/1/15	15	6	7.5YR4/4	L	1	Good	Low
		35	5½	7.5YR6/6	SiC	0		Mod.
		110	5½	10YR5/8	LC	2		Low
				10% 5Y5/8	MC	3		Low
		150	7	20% 5Y5/3				
70	Gn2.12 3/1/15	15	6	5YR4/4	L	1	Good	Low
		100	6	2.5YR4/8	MC	2		Low
				2.5Y4/8	MC	2		Low
		150+	6	(with 10YR5/8 increasing with depth)				
71	Gn2.22 3/1/10	10	6	5YR4/4	L	1	Good	Low
		20	5½	2.5YR4/8	LC	2		Low
		90	6	10YR5/8	LC	2		Low
		150	6	5YR4/8	MC	3		Low
		Schist fragments (2.5Y2/4 inc with depth)			Mn Qtz to 3 cm dia.			
72	Dy2.42 5/1/10	10	6	5YR5/2	SiC	1	Mod.	Low
		30	5½	7.5YR7/2	SiC	0		Mod.
		110	6	10YR5/8	MC	2		Low
		150	6	2.5YR5/4	HC	3		Low
73	Dy2.32	15	6	10YR6/3	SCL		Poor	Mod.
		30	6	2.5Y7/2	LC			High
			6	30%2.5Y6/6				
		150+	8½	2.5YR5/4	MC			Low
74	Ug3.3 5/0/15	15	6	10YR5/3 (Sporadically bleached)	SiC	0	Mod.	Mod.
		50	6	10YR5/8 50%2.5Y6/6 Qtz gravel	MC	2		Low
		150+	8½	2.5Y5/4	HC	3		Low
75	Ug5.23 5/2/10	10	5	5Y4/1	SiC	2	Poor	Low
		110	6	10YR4/1	HC	3		Low
		150+	8½	2.5Y5/2	HC	3		Low

TABLE III: Laboratory Analyses - Soils of the Thurgoona Subdivision

Site & Northcote Coding	Depth (cm)	Particle Size Analysis Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	LL (%)	PI	USCS	D.I.	V.E. (%)	Emerson Class	Sticky Point Test
19	25	40	9	22	19	9	1	43.9	25.3	CL	6.5	16.5	3	H
	200+	29	11	29	24	7	0	35.3	18.3	CL	6.0	10.7	3	H
20	35	12	8	30	36	14	1	-	NP	ML	2.7	sh	2	H
	150+	26	7	17	24	22	3	35.8	18.4	CL	9.5	14.9	3	ND
21	75	44	10	32	8	5	0	37.9	21.0	CL	13.5	10.5	3	ND
	120	45	10	25	8	12	1	43.1	24.7	CL	30.0	15.3	3	ND
22	140	40	12	36	5	6	1	38.3	22.3		13.0	11.9	3	ND
23	105	38	20	17	4	15	6	34.3	19.9	CL	4.5		3	H
Ug5.2-6/3/25	125	54	19	20	4	1	2	46.4	29.4	CL	3.0	16.5	2	H
24	90	57	9	9	2	16	7	65.3	43.3	CH	9.8	34.8	3	H
Ug6.2	180	61	12	15	1	4	8	61.5	41.2	CH	4.2	19.3	3	ND
25	90	58	14	10	0	9	9	57.9	35.7	CH	2.6	28.3	1	H
Dbl.33	150	67	11	5	0	8	7	62.7	39.7	CH	2.6	35.6	2	H
26	46	20	9	37	26	6	1	27.0	11.8	CL	6.5	10.8	3	ND
Dy2.42-3/1/20	120	13	8	33	30	14	1	17.6	NP	ML	4.5	9.1	3	H
	156	28	23	26	18	4	1	33.4	17.6	CL	4.5	15.1	3	ND
27	60	42	17	20	9	9	2				9		3	L
Dy2.32	90	41	14	23	22	0	0				11.5		3	M
	150	62	21	5	0	6	6				9.5		3	H
28	100	62	11	16	2	4	5	56.6	35.1	MH	6.3		3	H
Ug5.16	150	49	19	25	4	2	2	42.0	26.0	MH	6.0	33.5	3	H
29	150	60	9	18	2	6	6				4.4		3	H
Ug5.25	170	52	4	11	2	16	15				39	38.7	>3	ND

TABLE III (Contd.)

Site & Northcote Coding	Depth (cm)	Particle Size Analysis: Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	LL (%)	PI	USCS	D.I.	V.E. (%)	Emerson Class	Sticky Point Test
30	65	25	17	35	8	12	3				1.5		1	H
Ug3.3	150	50	16	25	3	4	2				2.7		1	M
31	30	33	14	34	8	6	6	29.9	18.2	CL	2.1	5	1	H
Ug3.2	150	54	17	22	4	1	2	45.8	29.3	MH	1.4	16.3	1	M
32	45	38	26	9	4	18	4				4.7		3	H
Ug5.24	120	47	18	14	1	5	15				1.8		1	H
33	30	33	19	38	7	3	0				19	16.1	3	H
Db4.42	70	55	13	25	3	3	1				15	21.7	3	L
	170	35	17	37	5	3	4	39.7	20.4	CL	2	19.4	1	H
34	40	25	23	40	2	5	4				5.7		3	H
Dy2.33	100	41	22	36	1	0	0				10.5		3	H
	150	36	21	28	2	10	4				7.7		3	L
35	20	14	21	52	11	3	0				4.5		3	H
Dy5.43	80	45	13	22	4	6	9				5.6		3	H
	150	50	15	28	5	0	2				1.4		1	H
36	50	11	17	53	12	6	2				2		20	H
Dy5.43	110	45	14	22	6	11	2				9.7		>3	ND
	150	51	11	24	5	4	3				1.9		1	H
37	30	11	22	47	12	6	0				2.5		3	H
Dy5.43	150	45	13	20	40	16	2				6.0		1	H
38	30	7	22	53	11	6	0				2.3		3	H
Dy5.43	150	49	12	23	3	5	7				1.4		2	H
39	40	14	18	26	32	7	3				1.8		1	H
Dy2.42	150	25	11	23	19	20	2				2.5		1	H
40	30	14	14	32	37	2	1	NP		ML	2.0	sh	1	H
Dy2.42	150	40	11	18	19	10	1				2.6		1	H
41	150	41	23	26	5	4	2				2.0		1	H
Ug5.2														
42	44	32	20	40	8	0	0				20.0	15.4	3	H
Dy2.43	66	28	17	34	8	11	2				6.0		2	L
	150	50	11	15	5	17	3	52.1	33.9		6.8	21.7	1	H

TABLE III (Contd.)

Site & Northcote Coding	Depth (cm)	Particle Size Analysis Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	LL (%)	PI	USCS	D.I.	V.E (%)	Emerson Class	Sticky Point Test
43	25	31	18	36	13	2	0				6.0		3	L
Dy2.43	105	42	13	19	9	15	1						>3	ND
	150	48	10	12	3	21	6				2.0		1	H
44	110	41	12	23	7	16	1				9.0		2	H
Dy2.23	150	60	7	13	4	13	3				2.8		1	H
45	50	43	8	21	10	17	1				15		3	H
Dr2.12	115	45	7	10	6	30	2				15		>3	ND
	150	54	13	12	14	6	1				6.4		3	H
46	40	12	24	47	16	2	0				1.8		2	H
Dy3.42	150	32	15	24	13	16	0				3.7		2	H
47	100	51	12	16	6	10	4	57.3	39.0	MH	2.0	21.3	3	H
Dy3.42	150	53	14	14	7	8	5	52.4	31.7	MH	2.7	30.2	3	H
48	90	51	11	21	9	8	1				10.0		>3	ND
Dy3.23	150	61	12	14	13	0	10				4.8		1	H
49	60	60	10	21	6	4	0				16.5		3	M
Gr4.15	100	53	13	14	4	7	8				1.9		1	H
	150	66	11	15	4	1	1				12.0		>3	ND
50	85	38	13	35	9	5	0				7.3		3	H
Dy5.42	150	53	13	25	5	3	1				5.8		2	H
51	95	53	15	16	2	6	8				2.2		3	H
Dy5.43	150	50	13	18	3	10	6				2.3		1	H
52	75	39	13	18	3	20	7				2.9		1	H
Dy2.43	150	46	18	24	4	6	3				1.9		1	H
53	70	50	19	27	2	2	0				13.5		>3	ND
Dy3.42	105	44	14	32	9	1	0				8.3		3	H
	150	45	12	16	4	10	13				3.1		1	H
54	130	49	13	27	4	5	2				14		>3	ND
Dy2.42	150	41	14	22	3	4	16				2.7		1	H
55	55	21	27	42	7	3	0	20.4	NP	ML	2.6		3	H
Dy3.42	110	42	13	32	6	4	3	43.1	27.0	CL	8.3	23.3	>3	ND
	150	33	16	34	6	8	3	35.5	20.2	CL	3.5	15.5	1	H

Table III (Contd)

Site & Northcote Coding	Depth (cm)	Particle Size Analysis						LL (%)	PI	USCS	D.I	V.E. (%)	Emerson Class	Sticky Point Test
		Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones							
56	75	46	11	22	4	10	7				3.6		1	H
Dy3.42	150	44	14	26	5	7	4				1.3		1	H
57	80	57	11	21	3	7	1				16.5		3	H
Dy3.12	150	43	20	26	7	2	6				1.7		1	H
58	50	36	12	19	3	19	12				3.2		1	H
Ug5.31														
59	110	50	15	26	5	4	0				15		3	H
Dy3.23	150	58	13	21	5	2	2				3.3		1	H
60	105	50	13	22	6	8	0	46.0	25.3	MH	10.3	21.7	>3	ND
Dy3.42	150	42	13	24	5	8	9				1.9	12.6	1	H
61	100	38	15	16	3	23	5				3.1		1	H
Ug3.3	150	50	24	17	3	4	1				6.4		1	H
62	150	35	7	4	1	35	17				5.1		3	H
Ug5.35														
63	150	40	17	3	1	13	27				4.3		3	H
Ug3.3														
64	80	56	21	10	3	0	9				4.0		3	H
Ug5.23	150	64	18	7	2	5	5				4.0		3	H
65	150	31	13	7	0	22	25				3.6		3	H
Ug5.23														
66	90	39	15	15	2	22	8				4.0		3	H
Dy2.33	150	51	24	23	2	0	0				2.4		2	H
67	150	35	11	10	2	27	16				2.4		2	H
Ug3.2														
68	115	32	11	37	16	3	0				2.2		1	H
Dy3.43	150	46	10	22	9	12	1				1.1		1	H
69	110	51	14	28	7	0	0				4.5		>3	ND
Dy2.22	150	50	13	26	8	0	2				4.0		2	H
70	150	54	12	27	6	0	1	40.4	18.9	CL	30	15.5	>3	ND
Gn2.12														

TABLE III (Contd.)

Site & Northcote Coding	Depth (cm)	Particle Size Analysis: Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	LL (%)	PI	USCS	D.I.	V.E. (%)	Emerson Class	Sticky Point Test
71	150	30	9	34	13	9	4	41.7	22.2	CL	3.8	18.4	3	H
72	110	62	11	15	5	4	3	65.4	41.2	CH	8.7	22.2	>3	ND
Dy 2.42	180	51	10	22	4	7	5	58.0	38.7	MH	2.8	13.1	3	H
73 Dy 2.32	150	47	16	25	4	4	4				1.3		1	H
74	150	41	11	25	0	6	17	49.6	30.0	CL	2.1	6.4	1	H
75	110	47	10	7	2	3	30				3.9		3	H
Ug 5.23	150	39	6	6	1	13	34				3.6		2	H

4. Definition of Additional Terms Used in Tables II and III

Texture

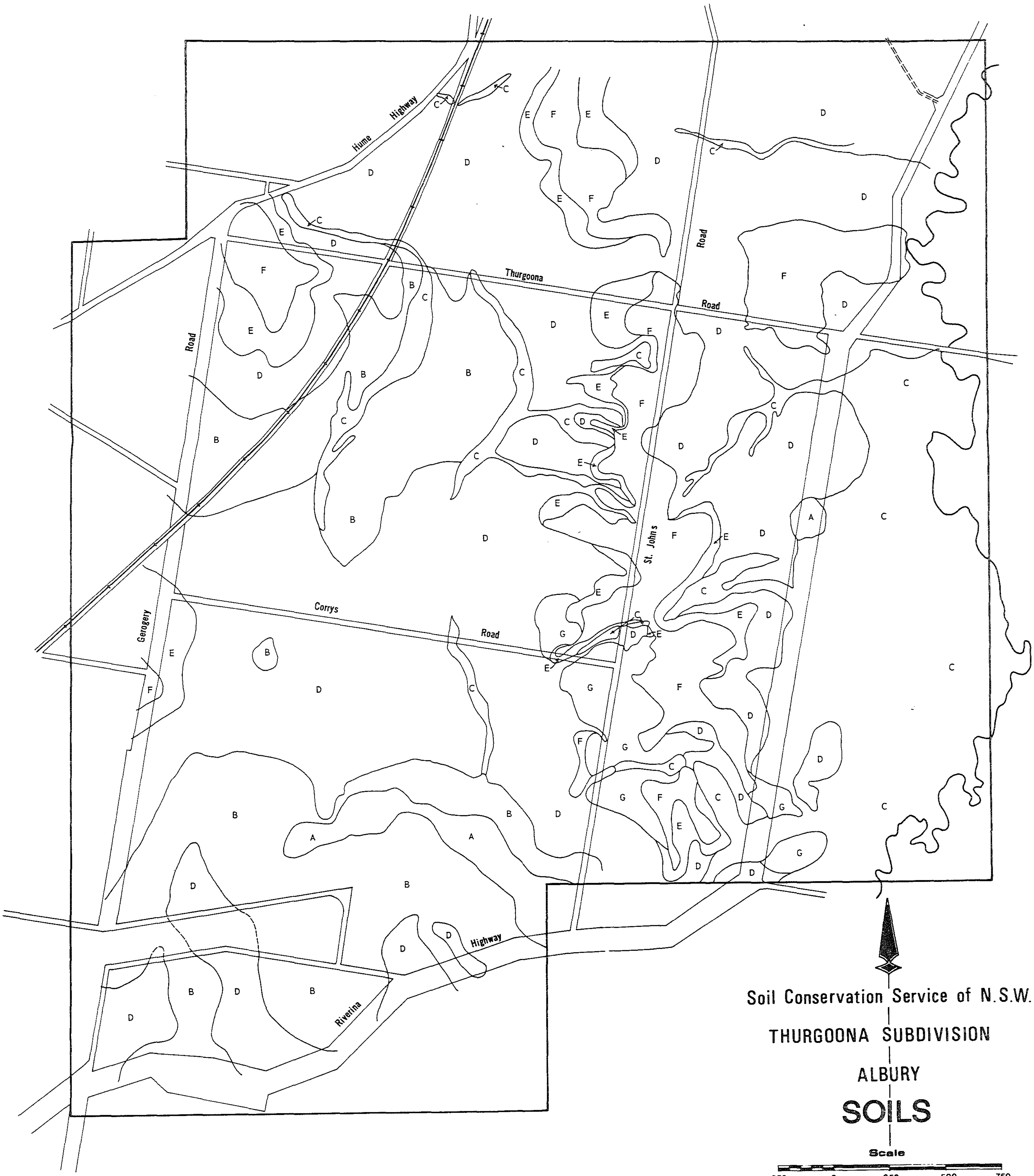
The grades of texture are described in detail by Northcote (1974). The symbols used in Table II have the following meaning.

F	-	Fine
M	-	Medium
H	-	Heavy
C	-	Clay
L	-	Loam
Si	-	Silt
S	-	Sand
LC	-	Light clay
Lfsy	-	Loam, fine sandy
LMC	-	Light medium clay

Sticky Point Test

Field test of dispersibility. A soil aggregate is moulded at the moisture content equivalent to sticky point (soil just adheres to the fingers), dropped into water, and the soil is placed in one of the following classes on the basis of the time taken for dispersion:

N.D.	-	Non-dispersible
L	-	Low dispersibility
M	-	Moderate dispersibility
H	-	High dispersibility



Soil Conservation Service of N.S.W.

THURGOONA SUBDIVISION

ALBURY

SOILS

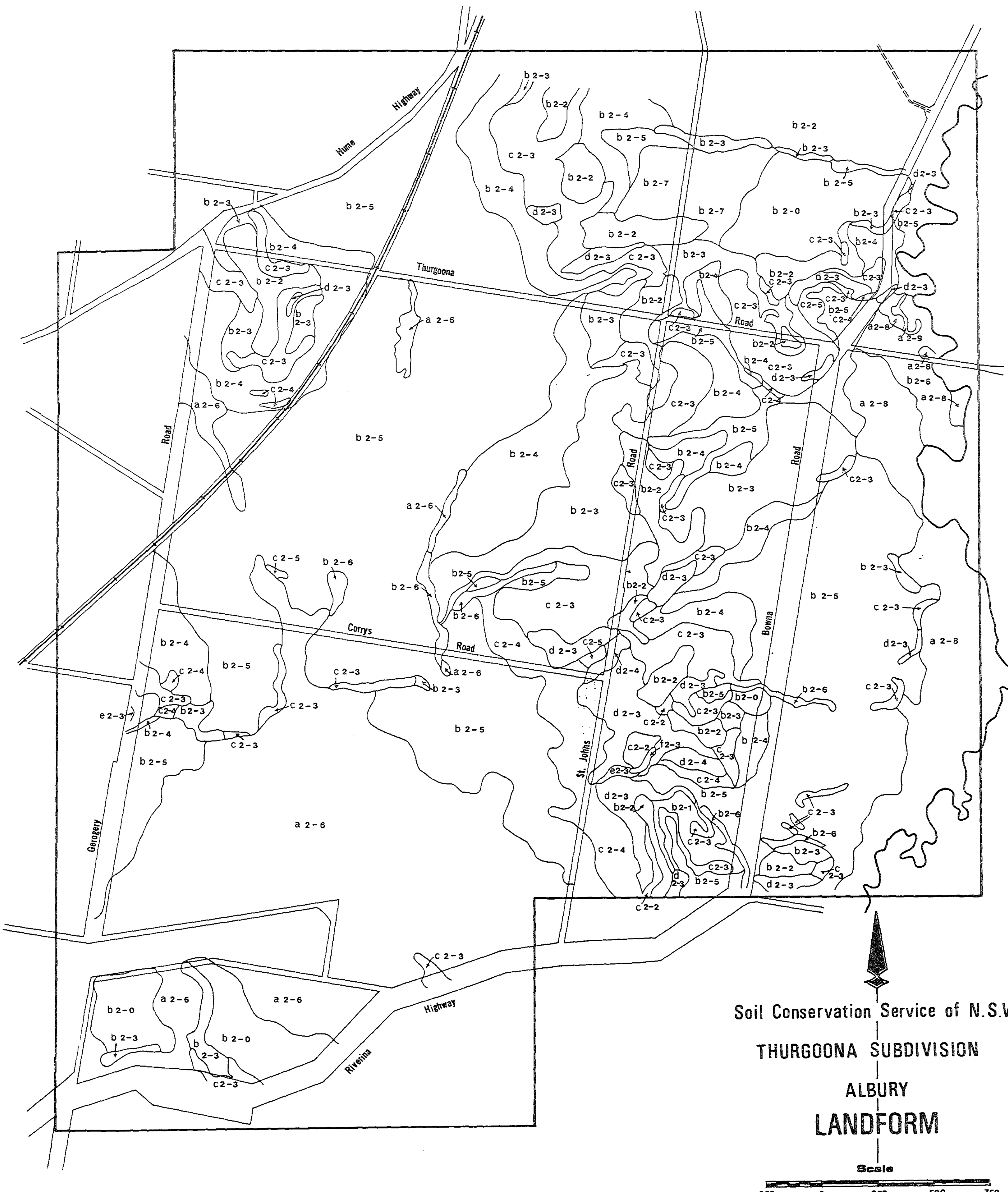
Scale

250 0 250 500 750

metres

G.N.

S C S 10380



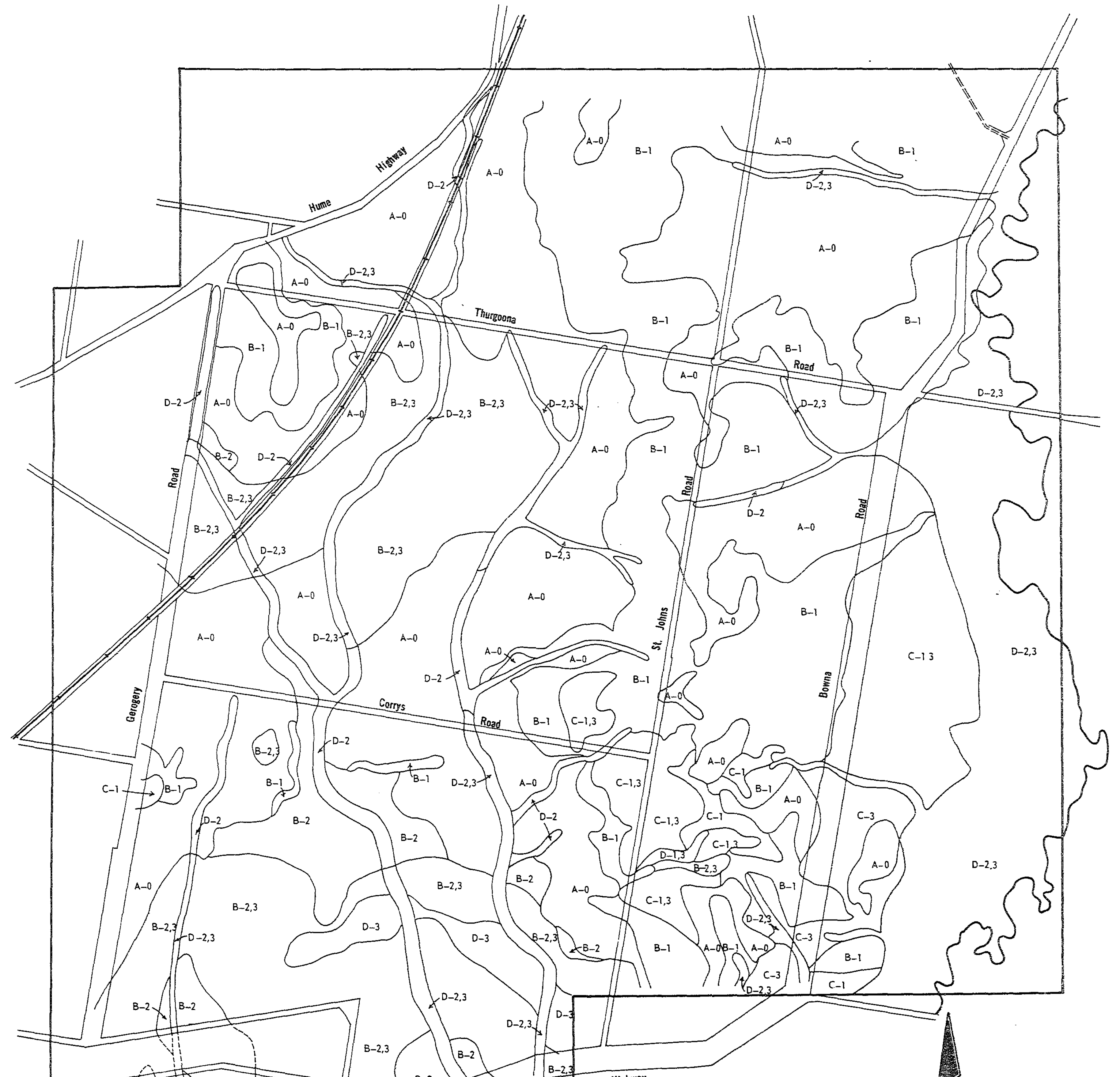
Soil Conservation Service of N.S.W.

THURGOONA SUBDIVISION

ALBURY

LANDFORM

S C S 10381



Soil Conservation Service of N S W

THURGOONA SUBDIVISION

ALBURY

LANDSCAPE EVALUATION FOR URBAN USE

Scale

250 0 250 500 750

metres

GIN

S C S 10382