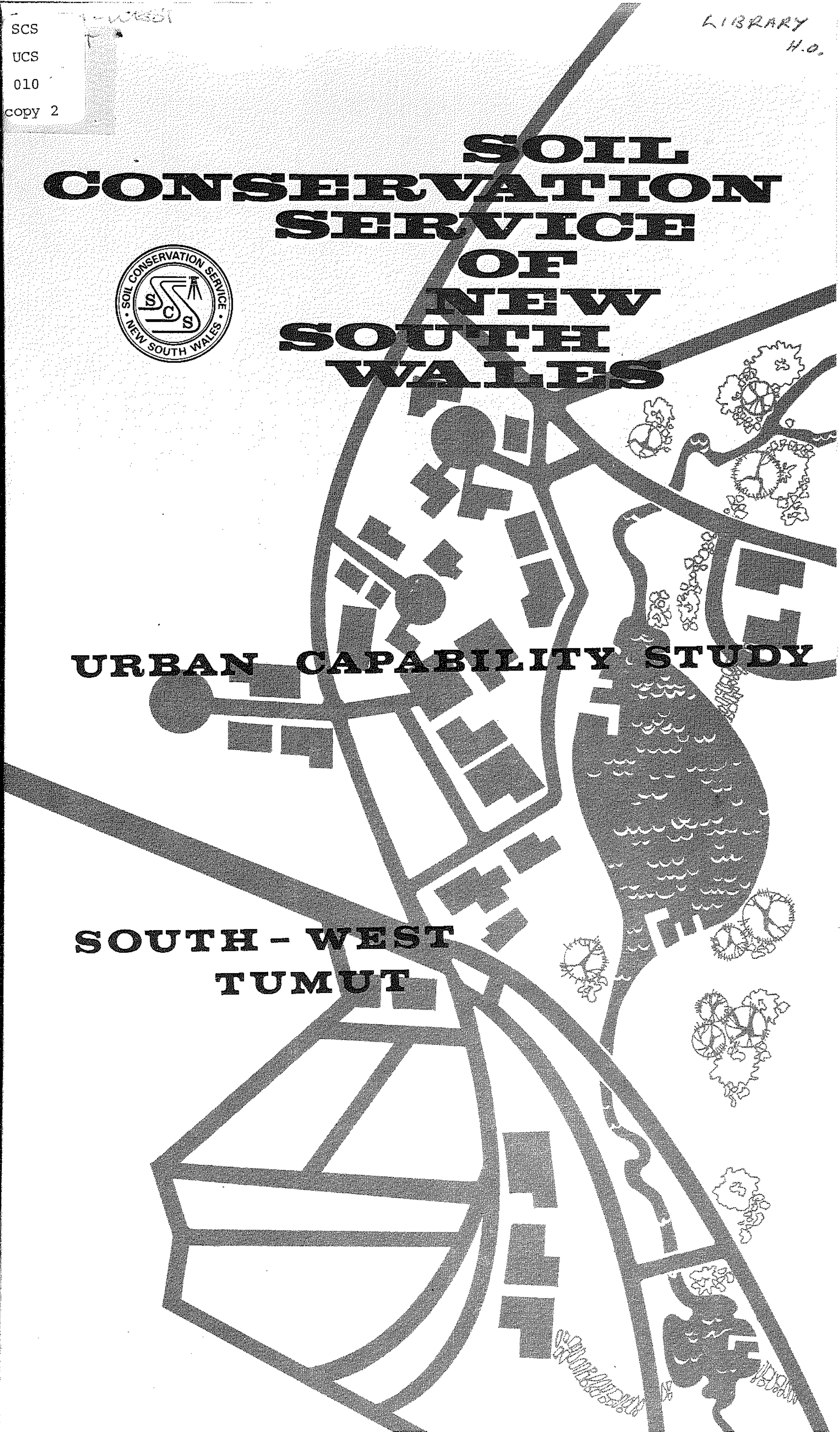
SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

URBAN CAPABILITY STUDY

SOUTH - WEST TUMUT



SOIL CONSERVATION SERVICE OF N S.W.

URBAN CAPABILITY STUDY:
SOUTH WEST TUMUT

MARCH, 1979.

Report prepared for Tumut
Shire Council.

This report, and the original maps associated with it, have been scanned and stored on the custodian's intranet.
Original maps drafted at 1:4,000 were catalogued SCS 12640/A -Z.
These full size maps have been scanned and named
"UC_South West Tumut_theme". S.J. Lucas Nov2014

Report compiled by:
P. D. Gillespie, Soil Conservationist,
R. J. Crouch, Soil Conservationist,
C. M. Adamson, Research Officer.

This report is a guide to development potential only in terms of erosion hazard and land stability. It indicates the capacity of the physical resources of the study area to sustain various intensities of urban use.

The maps are accurate at the scale at which they have been prepared and, as such, will assist in subdivision planning. It is important that information is not extracted from them at a scale larger than the scale of the originals.

Neither the maps nor the written report are a substitute for specific engineering and design investigations which may be required to more accurately define constraints in the location and design of roads, individual buildings, or recreation facilities.

The report does not constitute an overall recommendation for particular forms of use or development on specified areas, as no account has been taken of other town planning considerations. It forms a basis onto which these may be imposed to derive a development plan.

CONTENTS

			Page
SUMMARY			1
INTRODUCTION			4
INVENTORY OF PHYSICAL FEATURES			5
		Climate and Vegetation	5
		Landform	5
		Drainage Pattern and Soil Erosion	7
		Geology and Soils	8
URBAN CAPABILITY			12
		Sub-class A - 0	14
		Sub-class A - 3e	14
		Sub-class A - 3eh	14
		Sub-class A - 3v	15
		Sub-class B - 1	15
		Sub-class B - 1, 3e	16
		Sub-class B - 1, 3eh	16
		Sub-class C - 1, 3e	17
		Sub-class C - 1, 3eh	17
		Sub-class C - 4	17
		Sub-class D - 1, 3eh	18
		Sub-class D - 2	18
		Sub-class D - 2, 3v	19
		Sub-class E - 1, 3eh	19
		Sub-class E - 2	20
REFERENCES			21
APPENDIX I	-	Guidelines for Sediment and Erosion Control	22
APPENDIX II	-	Development of Grassed Drainage Reserves	26
	-	Storm Water Management	28
APPENDIX III	-	Laboratory Analysis of Soils	31
APPENDIX IV	-	Description of Typical Soil Profiles	33
APPENDIX V	-	Glossary of Terms	35

MAPS AND DIAGRAMS

Locality Diagram.

Landform Map.

Soils Map.

Soil Erosion and Drainage Pattern Map.

Urban Capability Map.

SUMMARY

This study covers an area of 140 hectares immediately southwest of the present town of Tumut.

The area comprises the foothills of rugged forest country. Landform varies from gently sloping country to steep slopes along the southwest border. The main drainage lines and creeks rise in the forest country and emerge onto broad flats.

The soils are derived from Blowering porphyry, Silurian sediments, and metamorphic rocks from the contact zone of these two geological groups. They have been mapped as four basic units. On the ridges the soils are derived from Silurian sediments, they are highly erodible and shallow. The drainage lines contain colluvial soils and one small area of heavy black soil of high plasticity. The soils formed on Blowering porphyry are deeper, red podsolic soils of moderate erodibility.

From an interpretation of the interaction between landform, soils, and drainage pattern, fifteen urban capability classes have been defined as described below:

Sub-class A-0 occurs as narrow strips on ridges in the east. No major erosion hazard should result from development of this land, which is suitable for all forms of residential development, extensive building complexes and active recreation.

Sub-class A-3e occupies gently sloping land with erodible soils. This land may be used for all forms of urban development, but erosion hazard is higher than on sub-class A-0 land.

Sub-class A-3eh occurs on gently sloping land with shallow erodible soils. It is similar to A-3e land, but the soil is shallow being generally less than 50 cm deep.

Sub-class A-3v occurs in a small area adjacent to one of the drainage lines. The soil has a high shrink/swell potential and this should be taken into account when designing foundations.

Sub-class B-1 occurs on gradients of 5 to 15%, on soils of moderate erodibility. This land is suitable for residential development.

Sub-class B-1, 3e. occurs on 5 to 10% gradients and is similar to sub-class B-1 land, but the soil is more erodible. The land is suitable for residential development, but the guidelines in Appendix I should be closely followed to minimise erosion problems during development.

Sub-class B-1, 3eh is similar to sub-class B-1, 3e land but with the added development constraint of shallow soil depth. This land is suitable for residential development.

Sub-class C-1, 3e occurs on gradients of 10 to 15% and is similar to sub-class B-1, 3e land but, due to the steeper gradients, more care in erosion control will be needed during development. This land is suitable for residential development.

Sub-class C-1, 3eh is land similar to sub-class B-1, 3eh land, but occurs on steeper gradients (10 to 20%). Control of runoff from slopes above and within this sub-class will be essential to prevent soil erosion during development.

Sub-class C-4 consists of a quarry. It is suitable for residential development if levelled and filled. Servicing would be difficult due to the presence of rock at or near the surface.

Sub-class D-1, 3eh is very steep land with shallow soils. Due to a high erosion hazard and the presence of rock near the surface, the most intensive use suggested for this land is as reserves, passive recreation areas or yard space.

Sub-class D-2 comprises most of the drainage lines in the area. A system of vegetated drainage reserves with retarding basins has been proposed for stormwater management.

Sub-class D-2, 3v is a specific area of a drainage line with soil having a high shrink/swell potential. It is recommended this land be used in a similar way to D-2 land.

Sub-class E-1, 3eh is very steeply sloping land. Development is not recommended due to the high erosion hazard. It is recommended the land be left in its natural state with existing vegetation retained.

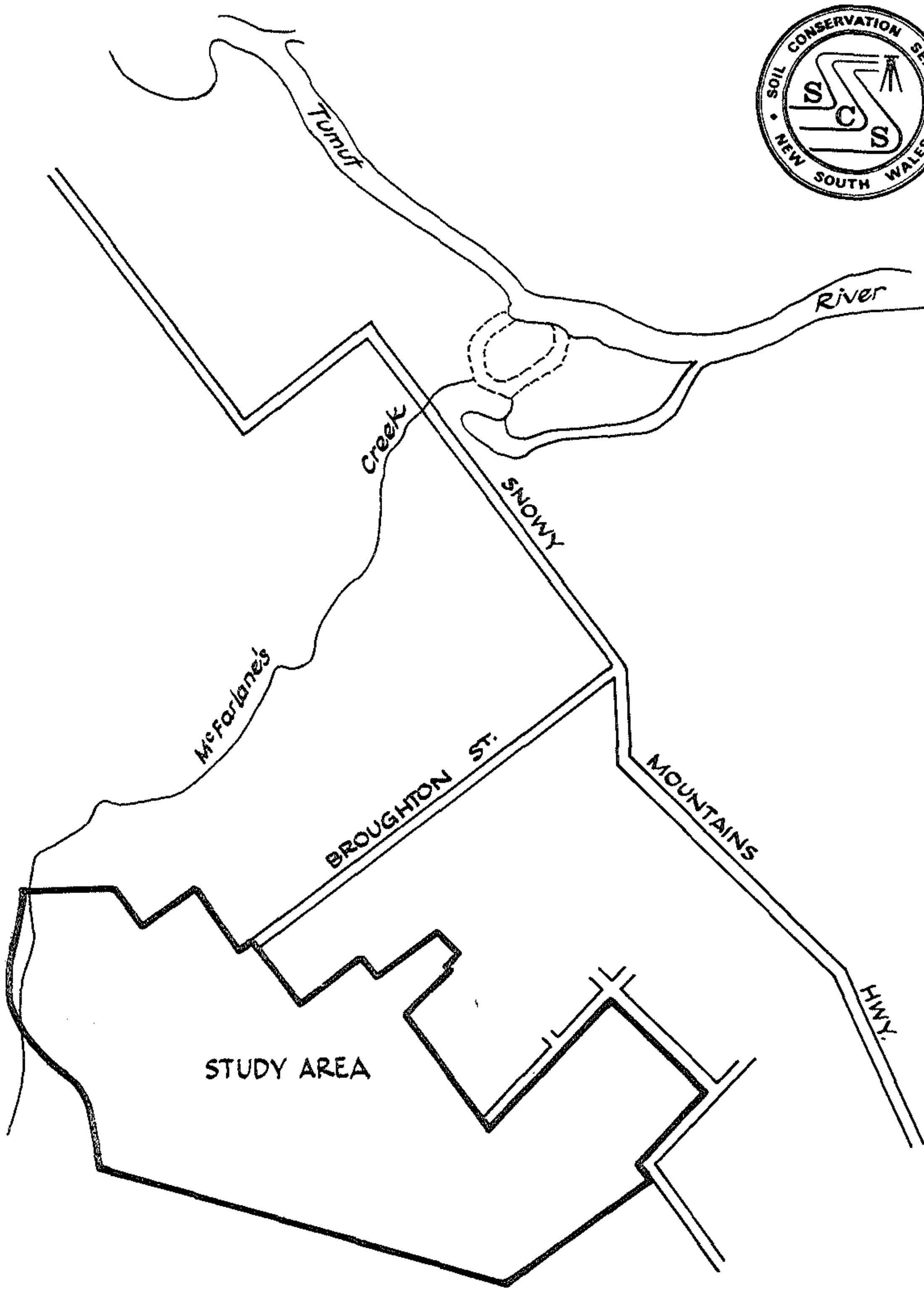
Sub-class E-2 occurs along McFarlane's Creek. It is subject to high flows of water, and soils are highly erodible. Due to the extreme erosion hazard development is not recommended. The land should remain in its natural state with a protective vegetative cover maintained.

The major features of these fifteen urban capability classes are summarised in Table 1.

TABLE 1. - Summary of Urban Capability Class Characteristics, South West Tumut, Urban Area.

Urban Capability Class	Erosion/ Instability Hazard	Area (ha)	% of Total Area	Limitations	Capability ⊕
A-0	Low	3.4	2.4	Nil	E.B.C.
A-3e	Low	13.8	9.8	Erodible soil	E.B.C.
A-3eh	Low	13.7	9.7	Shallow, erodible soil	E.B.C.
A-3v	Low	0.7	0.5	Shrink-swell soil	E.B.C.
B-1	Moderate	16.6	11.8	Slope	Residential
B-1, 3e	Moderate	10.6	7.6	Slope/erodible soil	Residential
B-1,3eh	Moderate	5.5	3.9	Slope/shallow, erodible soil	Residential
C-1,3e	High	12.1	8.6	Slope/erodible soil	Residential
C-1,3eh	High	15.4	11.0	Slope/shallow erodible soil	Residential
C-4	High	1.6	1.1	Quarry	Residential
D-1, 3eh	Very high	15.3	10.9	Slope/shallow, erodible soil	Reserve
D-2	Very high	12.2	8.7	Drainage/flooding	Reserve
D-2, 3v	Very high	4.1	2.9	Drainage/flooding/ shrink-swell soil	Reserve
E-1, 3eh	Extreme	14.5	10.4	Slope/shallow, erodible soil	No Development
E-2	Extreme	0.9	0.6	Flooding/erodible soil	No Development
		140	99.9		

⊕ E.B.C. = Extensive Building Complexes.



LOCALITY DIAGRAM
for
SOUTH WEST TUMUT

INTRODUCTION

The study area, of 140 hectares, lies immediately southwest of Tumut. It includes part of Tumut State Forest and the Tumut town common. It comprises foothills of timbered country and is bounded by McFarlane's Creek, Sydney Street, Maroo Avenue, Yarall Street, Lambie Street, Forest Street, Quandong Street, Simpson Street, and Currawong Street. A power transmission line follows the southwest boundary.

This study is based on an investigation of the physical features of the site. These features have been assessed in terms of their effect on erosion hazard and general land stability.

The study entailed an inventory of soils, slope, terrain, drainage pattern and erosion. This information has been interpreted to give an urban capability assessment of the land in terms of stability and erosion hazard.

Soils have been field surveyed and mapped onto a 1:4,000 base plan. Soil characteristics relating to profile stability and erodibility have been assessed. Laboratory analyses are presented in Appendix III.

Terrain, slopes and drainage pattern have been studied by aerial photograph interpretation and detailed field checking. These features have also been mapped on 1:4,000 scale base plan.

While originals of the landform, soils and urban capability maps have been prepared at the scale indicated above, copies included in this report have been reduced for convenience of presentation. The larger scale copies are available, on request, from the Soil Conservation Service.

The information in this report is a guide to development of the site based on soil conservation principles. To ensure the effective implementation of the recommendations, consultation with Soil Conservation Service officers is essential during both the planning and the construction stages of development.

INVENTORY OF PHYSICAL FEATURES.

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

1. Climate and vegetation.
2. Landform.
3. Drainage and soil erosion.
4. Geology and soils.

1. Climate and Vegetation.

The climate is characterised by hot dry summers and cool moist winters.

The median annual rainfall for the Tumut Plains meteorological station is 906 mm. Highest monthly median rainfall is 95 mm in October and the lowest is 38 mm in February. Most rain falls between May and October, with August and October being the wettest months.

Mean daily temperatures range from a maximum of 30.1°C in February to a minimum of 0.1°C in July. On average the temperature rises above 34.4°C one day per week in February and falls below -3.9°C one day per week in June and July.

High intensity rain storms in summer cause sheet and rill erosion on bare areas, while protracted rainfall during winter may saturate the soil, cause local flooding and mass movement of soil on unstable hillsides.

The native vegetation adapted to these climatic conditions comprises dry sclerophyll forest communities. In the study area considerable clearing and regrowth has taken place. The town common area has a sparse cover of eucalypt trees, whilst other areas have been cleared and planted with *Pinus radiata.*

2. Landform.

Slope and terrain data were collected by stereoscopic interpretation of aerial photographs (scale approximately 1:16,000), verified by field survey, and drafted onto 1:4,000 scale orthophoto maps.

The following slope and terrain facets are defined on the landform map:

Slope (percent)	Code
0 - 1	1
1 - 5	2
5 - 10	3
10 - 15	4
15 - 20	5
20 - 25	6
25 - 30	7
> 30	8

Terrain Component	Code
1. Hillcrest and ridge	1
2. Sideslope	2
3. Footslope	3
4. Drainage plain	4
5. Incised drainage channel	5
6. Flood plain	6
7. Disturbed terrain	7
8. Escarpment	8

Hillcrest and ridges

Ridges are sharp and narrow between drainage lines, with gradients ranging from 1 to 25%. Fire trails occur on most of the ridges especially in the northwest All ridges are well drained.

Sideslopes

Gradients of sideslopes on the area vary from 5% to greater than 30%. In northeast they are generally flatter, while in the west and southwest they are steeper. The sideslopes are generally well drained.

Footslopes

Gradients of footslopes on the site vary from 1 to 10%. They occur in the northeast Degree of drainage falls as their gradient decreases.

Incised drainage channels and Drainage plains.

Gradients on these two terrain units are generally between 1 and 5%, although the area along McFarlane's Creek has sideslopes of 20 to 25% gradient. Surface runoff concentrates in the drainage plains and this has caused some channel incision. In wet periods they are poorly drained and surface water is common. All present soil erosion on the site occurs on these terrain components.

Distrubed terrain.

This consists of a quarry area with low slope gradients.

3. Drainage Pattern and Soil Erosion.

There are approximately nine drainage lines arising in, or flowing through, the study area. The two major drainage lines are McFarlane's Creek in the northwest corner, and an unnamed creek which flows across Lambie Street between Forest and Grant Streets and discharges onto a flood plain near Sydney Street.

The most serious gully erosion occurs on the unnamed creek with minor gullying on other drainage lines.

The drainage lines are a major development constraint and due allowance must be made for external catchment areas.

The Drainage Pattern and Erosion map shows the natural drainage pattern and the occurrence of gully erosion.

Stream order as shown on the map was determined as follows: A first order stream runs from the point of origin to its junction with another stream. Where two first order streams join, a second order stream begins. This continues until a junction is formed with another second order stream to produce a third order stream, and so on.

This classification relates to the runoff different streams carry. The higher the (numerical) stream order, the greater is its capacity, and the greater also is the likelihood overtopping of the drainage channel will occur.

The capacity of the unnamed fourth order stream is not adequate to carry the increased runoff which will result from a change to urban land use. Such increased runoff will increase both erosion and flood hazard and adversely affect future development unless special allowance is made.

A system of stormwater management to offset the impact of development on stream flows is recommended. This is discussed in the Urban Capability section of this report.

LANDFORM

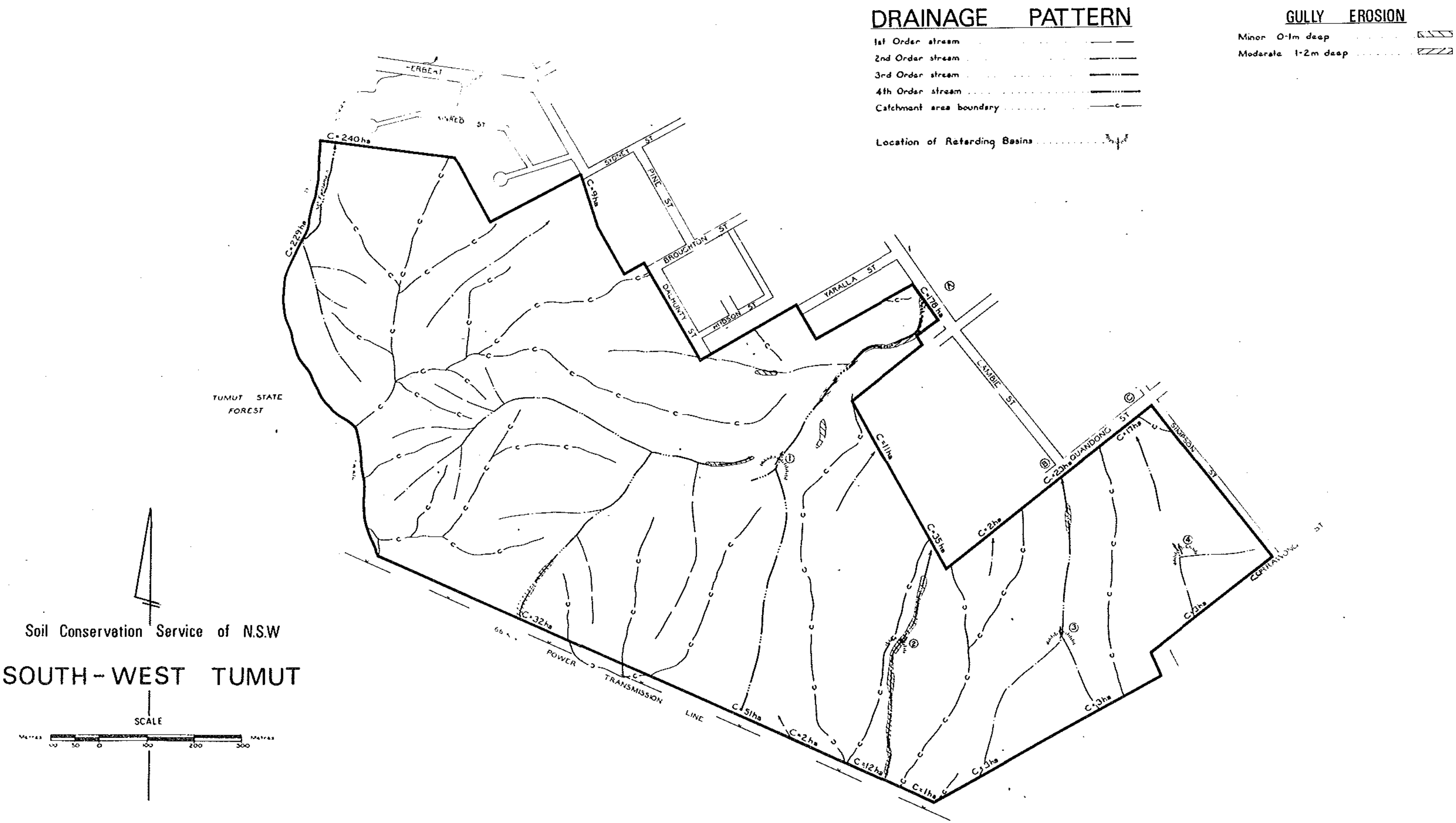
SLOPE (first numeral) Percent	Code	TERRAIN (second numeral) Component	Code
0 - 1	1	Hillcrest or Ridge	1
1 - 5	2	Sideslope	2
5 - 10	3	Footslope	3
10 - 15	4	Drainage plain	4
15 - 20	5	Incised drainage channel	5
20 - 25	6	Flood plain	6
25 - 30	7	Disturbed terrain	7
>30	8	Escarpment	8

Soil Conservation Service of N.S.W

SOUTH-WEST TUMUT

SCALE

Metres 100 50 0 100 200 300 Metres


DRAINAGE PATTERN
1st Order stream
2nd Order stream
3rd Order stream
4th Order stream
Catchment area boundary
Location of Retarding Basins
GULLY EROSION
Minor 0-1m deep
Moderate 1-2m deep
Soil Conservation Service of N.S.W
SOUTH - WEST TUMUT
SCALE
Metres
TUMUT STATE FOREST
SIDNEY ST
PINE ST
BROUGHTON ST
DALHUNTY ST
HUDSON ST
YARALLA ST
LAMBIE ST
QUANDONG ST
SIMPSON ST
POWER TRANSMISSION LINE
C=240ha
C=229ha
C=9ha
C=178ha
C=11ha
C=35ha
C=2ha
C=23ha
C=17ha
C=32ha
C=51ha
C=12ha
C=1ha
C=3ha

4. Geology and Soils.

The soils have developed on two major rock types, Blowering porphyry, and Silurian sediments. The present town is situated on the porphyry. These intrude into the study area in the east in the form of low hills of red soil with patches of gravel.

The sediments occur as steep hills in the west. Along the contact zone between the sediments and porphyrys, the sediments have been metamorphosed giving both hard and soft rocks. The hard rocks have been quarried for aggregate.

The soils vary according to topography and parent material.

Soils were mapped onto 1:4,000 orthophotomaps supplied by Tumut Shire Council. The survey was carried out by field reconnaissance followed by soil classification and sampling for laboratory analyses.

Results of laboratory analyses are summarised in Table 2 and are presented in full in Appendix III. Typical soil profiles for each map unit are described in Appendix IV.

Soil Erodibility.

The soils in the study area are rated either highly or moderately erodible. This is because of a high soil dispersibility which is a consequence of parent material being sedimentary.

Soil on the steeper slopes are most dispersible and hence most erodible.

There is a substantial erosion hazard associated with urban development on these steep areas of erodible soils. To prevent erosion and the subsequent siltation of drainage installations in the present urban areas of Tumut, it is essential that the guidelines in Appendix I be followed.

Description of Soil Map Units.

MAP UNIT A (Dy 2.32, Uc 1.22, Dr 2.32)

Map unit A consists of shallow soil on steep slopes in the west of the area. The soil is very shallow (less than 50 cm) and has formed directly on sedimentary and metamorphic rocks. It is very stoney, up to 80% of the soil being made up of stones greater than 6 mm in diameter.

The soil consists of a hard, stoney grey, sandy loam topsoil (A horizon) over a shallow silty clay subsoil (B horizon). A narrow bleached layer is often present between the A and B horizons. The B horizon consists of a pale yellow silty clay between rock fragments which grades gradually into solid rock at about 50 cm.

The B horizon has low plasticity and low shrink/swell potential, but due to the high level of dispersion and high stone content, it is rated highly erodible.

Main constraints to development are the steep gradients and the shallow soil depth.

MAP UNIT B (Dy 3.42)

Map unit B comprises soil deposited in the drainage lines and on lower slopes. It is colluvial in origin, the parent material having been washed from the adjacent hills.

There is considerable soil variation in this unit. Small patches of clay soil similar to the soil of map unit D and extensive areas of colluvial gravel occur along with the typical soil described below.

The typical soil has a yellow medium clay B horizon below a moderately deep (50 cm) bleached A_2 horizon and a loam A_1 horizon. The B horizon is usually dispersible with low plasticity and low shrink/swell potential. In the lower topographic positions and in the higher basin areas the clay becomes more plastic and has moderate shrink/swell potential.

Most of this unit is underlain by colluvial gravels.

The soil erodibility rating is high.

The only constraints to development of this land result from its topographic situation. It receives large amounts of run-on water and provision for disposal of this water must be made when planning urban development.

Some erosion will occur on the steeper land if the soil is left bare.

MAP UNIT C (Dr 2.21, Dr 3.21 with patches of Gn 2.14 and Dy 3.21)

Map unit C occurs in the eastern half of the area on very strongly metamorphosed and porphrytic rocks. Soil types are very strongly related to topographic situation. They consist of quartz gravel on the ridge crests, red clay on the upper slopes, usually under a layer of gravel, and red and yellow mottled clay on the mid and lower slopes. (Figure 1.)

The gravel layer is usually about 30 to 50 cm deep and consists of about 20% quartz gravel, 40% sand and 40% clay and silt. This layer overlies rock on the crests and red clay on the lower slopes. In some areas this gravel has been excavated.

The red clay has moderate to high plasticity and moderate shrink/swell potential.

MAP UNIT D (Ug 5.29)

Map unit D comprises a heavy clay soil in the major drainage line through the study area. The soil is relatively uniform throughout the unit with the clay becoming lighter and more yellow towards the unit boundaries.

The main soil type consists of organic silt over a grey silty clay that grades into a grey/brown heavy clay at about 20 cm depth.

The heavy clay is highly plastic with high shrink/swell potential. These properties could result in building and road foundation movement unless they are provided for in design.

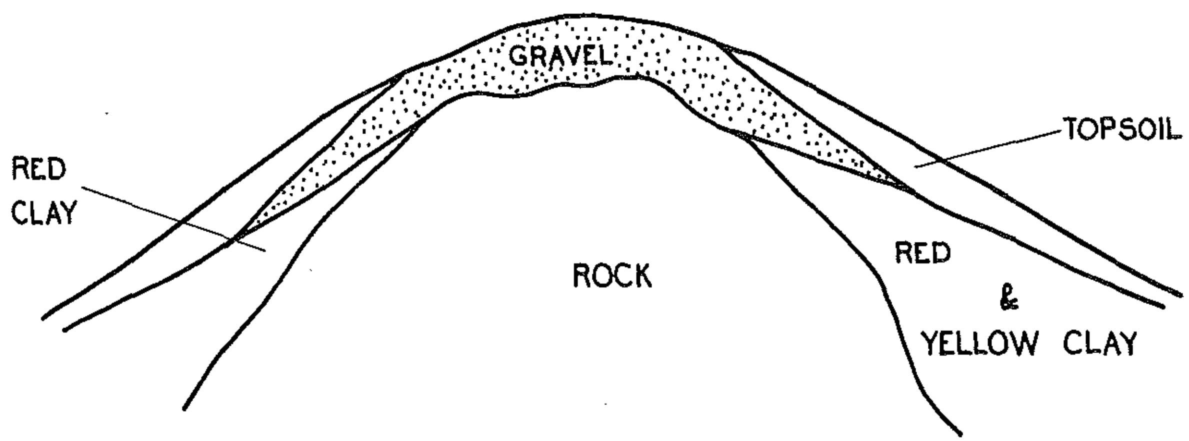
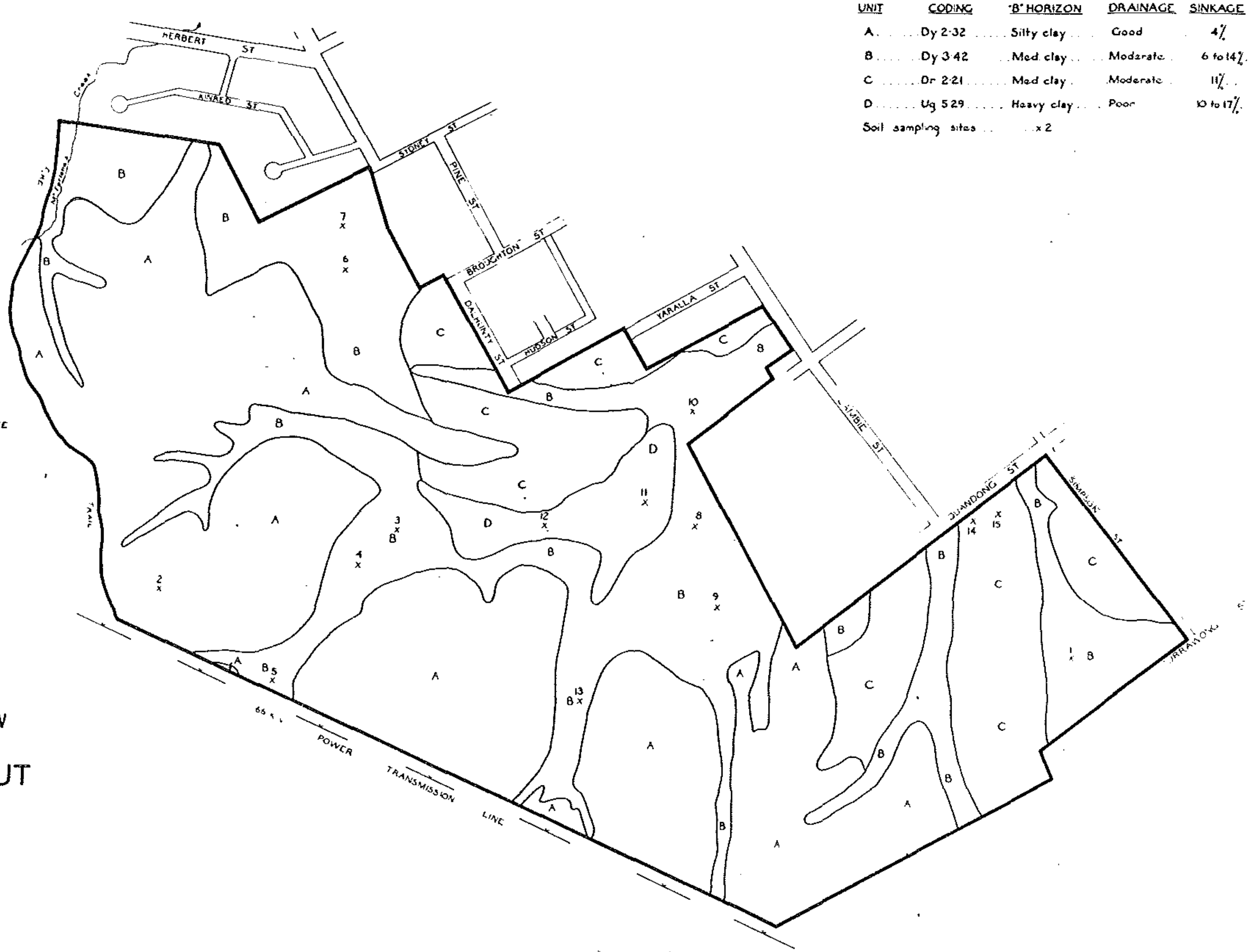


Figure 1: Soil Variation in Map Unit C. - South-West Tumut Study Area

SOILS

MAPPING UNIT	NORTHCOTE CODING	TEXTURE OF 'B' HORIZON	PROFILE DRAINAGE	LINEAR SINKAGE	PLASTICITY INDEX	ERODIBILITY	SPECIAL FEATU[RES]
A	Dy 2·32	Silty clay	Good	4%	6%	High	Shallow
B	Dy 3·42	Med. clay	Moderate	6 to 14%	27%	High	—
C	Dr 2·21	Med. clay	Moderate	11%	19%	Moderate	—
D	Ug 5·29	Heavy clay	Poor	10 to 17%	38%	Moderate	—

Soil sampling sites . . . x 2



Soil Conservation Service of N.S.W

SOUTH-WEST TUMUT

SCALE

Metres 100 50 0 100 200 300 Metres

TABLE 2. SUMMARY OF SOIL PROPERTIES - URBAN CAPABILITY STUDY, SOUTH WEST TUMUT.

MAP UNIT	A	B		C		D	
Northcote Coding	Dy 2.32	Dy 3.42		Dr 2.21		Ug 5.29	
Depth to Bedrock (cm)	0 - 50	>200		0 - >200		>200	
Profile Drainage	Good	Moderate		Moderate		Poor	
Texture of B horizon	silty clay	medium clay		medium clay		heavy clay	
Horizon (No. of samples)	B	A	B	A	B	A	B
Liquid Limit	Moderate	Low	Moderate	Moderate	High	High	High
Plasticity Index	Low	Low	Moderate	Low	Moderate	High	High
U.S.C.S.	ML	ML	ML	CL	MH	MH	MH
Linear Shrinkage	Low	Low	Low	Low	Low	Moderate	Moderate
Dispersal Index	1.4 - 1.9	1.1-2.0	1.9-8.5	1.9	4.0	3.2-4.6	2.9-5.9
Erodibility	High	High	High	Moderate	Moderate	Moderate	Moderate
Suitability for Ponds	Poor	Moderate		Moderate		Good	Good
Topsoil Quality	Poor	Moderate		Good		Moderate	
Ease of Revegetation	Poor	Poor		Moderate		Poor	
Special Features	Shallow Soil	Numerous gravel seams.		Shallow soil near ridge crests.		Heavy clay.	

URBAN CAPABILITY

The urban capability of the land was assessed from a study of the interaction of the physical features of the site. The land has been divided into a number of classes according to its stability and the assessed potential for urban development.

Five major classes of erosion/instability hazard are defined on the urban capability map:

Class A	-	Low
Class B	-	Moderate
Class C	-	High
Class D	-	Very High
Class E	-	Extreme

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

0	-	No major constraint
1	-	Slope
2	-	Drainage/flooding
3	-	Soil characteristic
4	-	Disturbed terrain (quarry)

The use of two numerals indicates that two physical features interact to restrict development.

Subscripts have been used to indicate the nature of the soil limitation attached to sub-class 3.

'e' indicates soil erodibility limitation
'h' indicates soil depth limitation
'v' indicates soil shrink/swell limitation

The physical restrictions (constraints) to development for each sub-class are also itemised in the legend of the Urban Capability Map.

The capability suggested for each sub-class refers to the most intensive urban use which areas in 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 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 refer 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. The development of reserves may require shaping and modification of the ground surface and vegetative improvement, but no building and minimal roadway construction is envisaged.

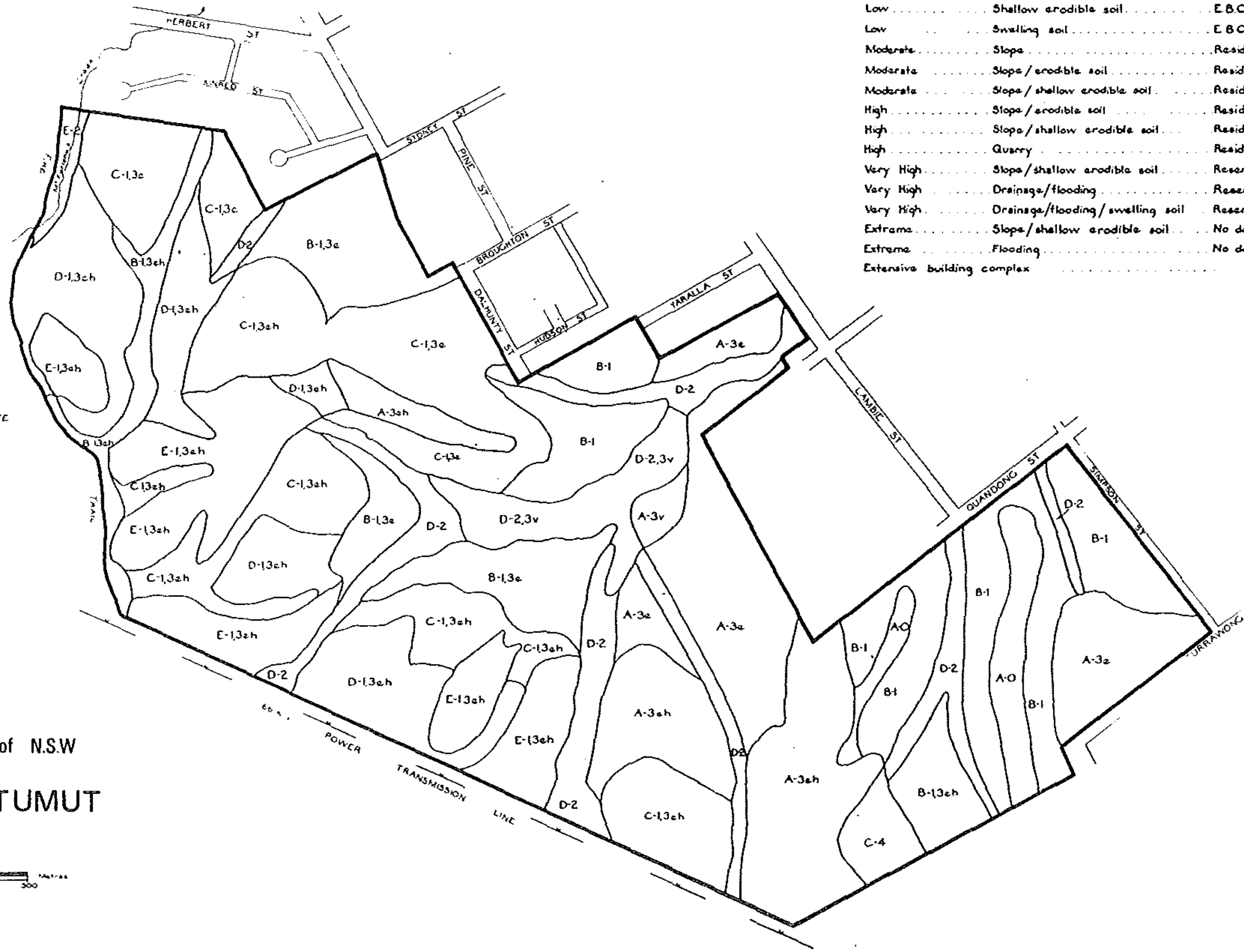
The definition of a site capability for residential development or for extensive building complexes does not exempt developers from normal site analysis procedures in designing and engineering road alignments and buildings. Nor does it imply the capacity of the site to support multistorey units or other major structures. Before structural works of this size are undertaken, a detailed analysis of such engineering characteristics of the soil as bearing capacity and shear strength may be necessary on the specific development site.

In Appendix I guidelines for stabilisation and revegetation techniques are provided. Specific advice relating to these techniques (such aspects as seed and fertilizer mixtures and rates, cultivation and batter slopes) should be sought from the Soil Conservation Office at Gundagai when subdivision work begins.

A detailed description of wide ranging sediment and erosion control, and stormwater management techniques appropriate to developing urban areas is provided in the Soil Conservation Service Urban Erosion and Sediment Control Handbook.

URBAN CAPABILITY

EROSION/ INSTABILITY HAZARD	MAJOR LIMITATIONS	CAPABILITY	CLASS
Low	Nil	*E.B.C.	A-0
Low	Erodible soil	E.B.C.	A-3e
Low	Shallow erodible soil	E.B.C.	A-3eh
Low	Swelling soil	E.B.C.	A-3v
Moderate	Slope	Residential	B-1
Moderate	Slope / erodible soil	Residential	B-1,3e
Moderate	Slope / shallow erodible soil	Residential	B-1,3eh
High	Slope / erodible soil	Residential	C-1,3e
High	Slope / shallow erodible soil	Residential	C-1,3eh
High	Quarry	Residential	C-4
Very High	Slope / shallow erodible soil	Reserve	D-1,3eh
Very High	Drainage/flooding	Reserve	D-2
Very High	Drainage/flooding / swelling soil	Reserve	D-2,3v
Extreme	Slope / shallow erodible soil	No developement	E-1,3eh
Extreme	Flooding	No developement	E-2
Extensive building complex			*E.B.C.



Soil Conservation Service of N.S.W

SOUTH - WEST TUMUT

SCALE

Sub-Class A-0: Low hazard - No major constraint - Suitable for extensive building complexes and active recreation.

Land in this sub-class occurs in narrow strips on low sloping ridge crests in the east. It comprises 2.4 percent of the total area. The soils are the medium texture clays of moderate drainage and moderate erodibility described as soil map unit C. A fine quartz gravel layer occurs in the profile which has been excavated in places. The soil poses no major constraint to urban development if guidelines (a), (c), (d) and (n) in Appendix I are followed.

Sub-class A-0 adjoins sub-class B-1 land and when these lands are developed together the constraints associated with B-1 should be considered for the whole development.

Sub-Class A-3e: Low hazard - Soil erodibility constraint - Suitable for extensive building complexes and active recreation.

This land comprises low gradient foot slopes on part of the perimeter of study area. It comprises 9.8 percent of the total area. The soils of map unit B occur. They are medium textured clays of moderate drainage, and are very erodible. Uncontrolled development could result in deposition of large volumes of silt in drainage lines, stormwater pipes and culverts. Consequently, the erosion hazard will be high during development and particular attention should be paid to items (a), (c), (d), (e) and (n) of the general guidelines in Appendix I.

Sub-Class A-3eh: Low hazard - Shallow erodible soil constraint - Suitable for extensive building complexes and active recreation.

This is gently sloping land on soils of map unit A which are very erodible and shallow (less than 50 cm deep). The land comprises 9.7 percent of the total area.

The shallow soil depth will cause servicing problems due to the proximity of the rock near the surface. Development should be preceeded by detailed site investigations and engineering reports.

During development particular attention should be paid to items (a), (c), (d), (e) and (n) of the general guidelines in Appendix I.

Sub-Class A-3v: Low hazard - Swelling soil constraint - Suitable for active recreation.

This gently sloping land occurs adjacent to the drainage line in the centre of study area. It occupies only 0.5 percent of the area.

Soils of map unit D occur which have a high shrink/swell potential. Consequently, building foundations may be unstable unless specially designed. The heavy clay texture of the soil and its impeded drainage will severely limit the use of on-site septic absorption drains.

During development, particular attention should be paid to items (a), (c), (d), and (n) of the general guidelines in Appendix I.

Sub-Class B-1: Moderate hazard - Slope constraint - Suitable for residential development.

This land occurs in the north east of the area. Gradients range from 5 to 15%. The main soil is of map unit C which is a medium textured clay of moderate drainage and erodibility. This sub-class occupies 11.8 percent of the study area.

Development of commercial, industrial or educational complexes, requiring large scale site levelling is not recommended due to the high risk of erosion and siltation. If, however, such development is undertaken, the erosion hazard can be reduced by adhering closely to items (a), (b), (c), (d), (e), (f), (g), (h), (i), (j), (k), (l) and (n) of the general guidelines in Appendix I.

These lands are suitable for residential development without a severe erosion hazard being generated provided the general guidelines are followed.

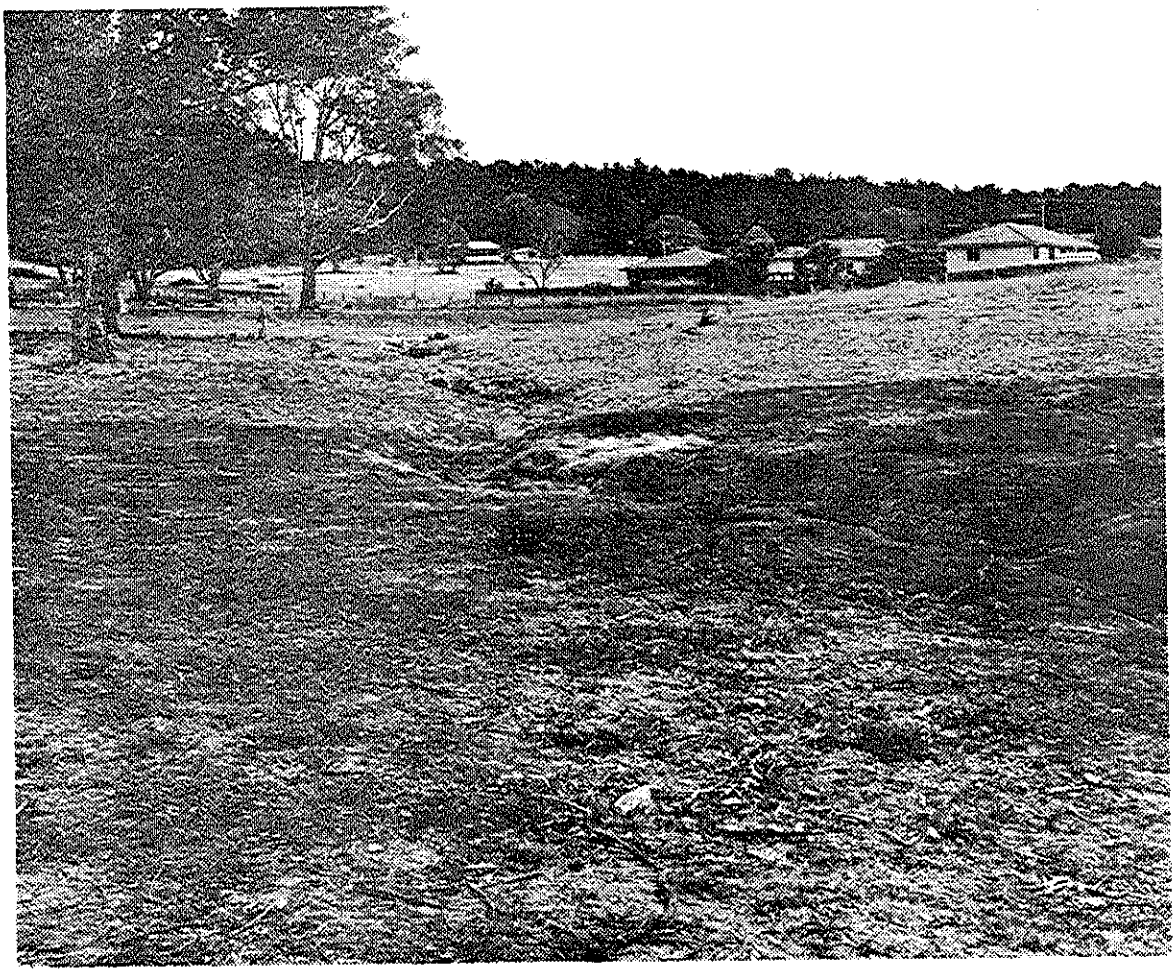


Figure 2. Sub-class B-1 land with a drainage reserve (sub-class D-2) dissecting it.

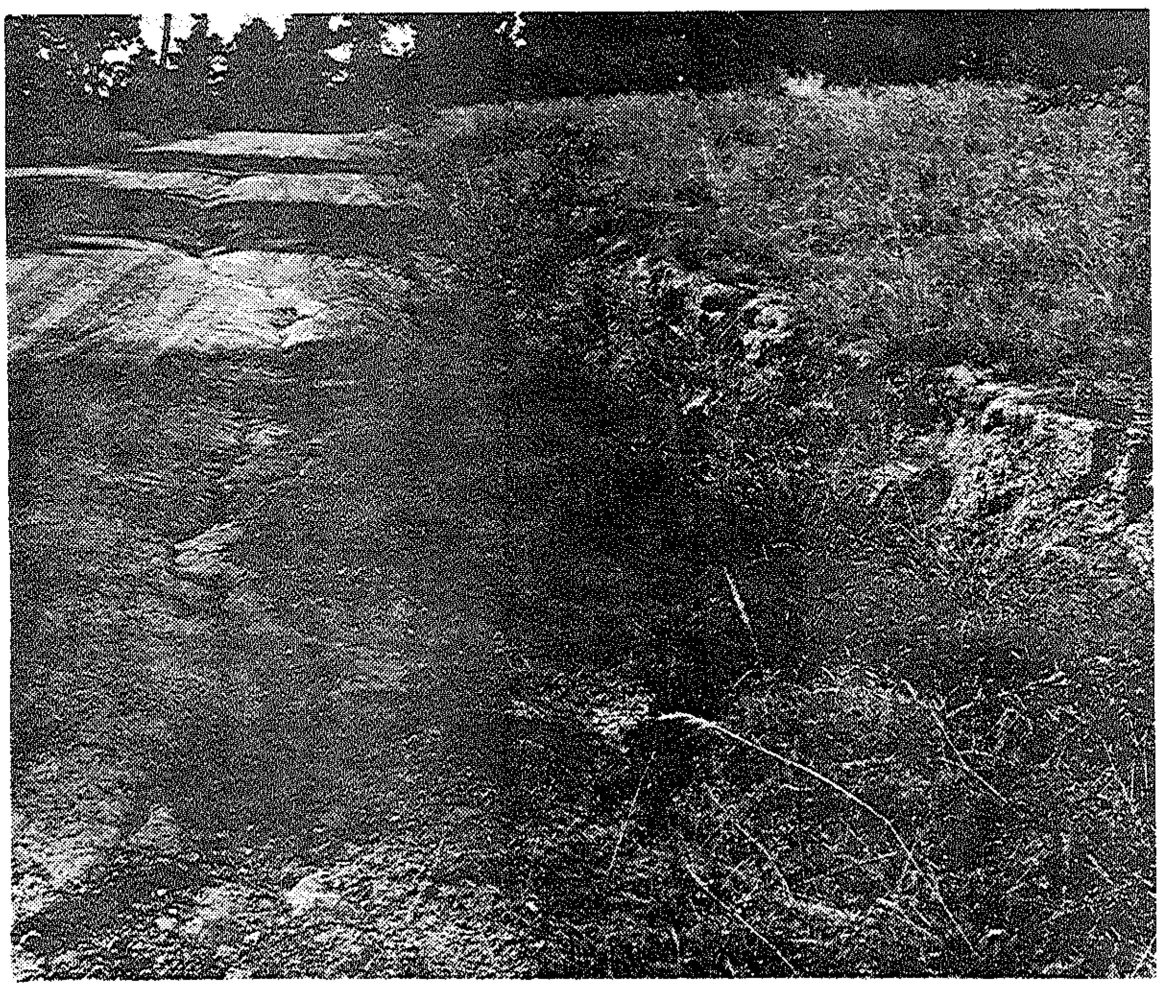


Figure 3. An existing road on sub-class C-1, 3e land. Care must be exercised in developing this land for residential use because of the erosion hazard that will be generated.

Sub-Class B-1, 3e: Moderate hazard - Slope and erodible soil constraints - Suitable for residential development.

This land occurs in three places and occupies 7.6 percent of the study area. It is similar to sub-class B-1 land except that it generally occurs on soils of map unit B, on foot slope gradients of 5 to 10%. These soils are very erodible.

Constraints to development are similar to those described for sub-class B-1, but here, there will be a greater erosion hazard during development because the soils are more erodible. The erosion problem is further accentuated by run-on and subsurface seepage from steep slopes immediately above.

A diversion bank or a roadway built above this land can be designed to collect and direct runoff to a safe outlet which will reduce the erosion hazard on lower land.

Construction of extensive building complexes, requiring large scale levelling is not recommended because of the severe erosion and siltation such disturbance might generate. Should this form of development take place however, the erosion hazard may be minimised by following the guidelines in Appendix I.

The land may be used for residential subdivision or for recreation (which does not require large scale levelling), without creating a serious erosion hazard if attention is paid to the guidelines in Appendix I.

Sub-Class B-1, 3eh: Moderate hazard - Slope and shallow, erodible soil constraint - Suitable for residential development.

This land occurs on the ridge crests in the northwest and comprises 3.9 percent of the total area. This land is similar to sub-class A-3eh, but slope gradients are steeper (up to 10%).

This land is suitable for residential development, and especially for roads. Due to the shallow soil, and presence of rock, development should be preceeded by detailed site investigations and engineering reports.

Sub-Class C-1,3e: High hazard - Slope and erodible soil constraints - Suitable for residential development.

This land mainly occurs on map unit C soils in the north on slope gradients of 10 to 15%. The soils are very erodible. This land occupies 8.6 percent of the total area.

The development potential and constraints of this land are similar to those for B-1,3e land, but the erosion hazard is greater because of the steeper gradients. Uncontrolled development may cause severe sheet, rill and minor gully erosion. Consequently, extensive cut and fill, required for major commercial or industrial centres, is not recommended. The land will accept residential or passive recreational use without severe erosion being generated, provided attention is paid to the guidelines in Appendix I.

Sub-Class C-1,3eh: High hazard - Slope and shallow erodible soil constraints - Suitable for residential development.

This land mainly occurs on map unit A soils which are very erodible and shallow (less than 50cm). The land comprises sideslopes of between 10 and 20% gradient. This sub-class comprises 11 percent of the total area. It is similar to C-1,3e land except for the steeper gradients and shallower soil.

An additional development constraint is its location below much steeper slopes and it is subject to surface runoff from above. Unless this runoff is diverted and controlled it will cause severe sheet and rill erosion during construction. Diversion can be achieved by roads and associated stormwater installations on the upper slopes, and/or diversion banks built to carry water to a safe disposal area.

Careful attention must be paid to the general guidelines in Appendix I.

Sub-Class C-4: High hazard - Disturbed terrain constraint - Suitable for residential development if constraint overcome.

This land comprises a quarry which occupies 1.1 percent of the total area. All topsoil and much of the underlying material has been removed. The area must be shaped or filled and re-topsoiled before development takes place. Servicing will be a problem due to the presence of rock near the surface. Once topsoil has been spread, the general guidelines in Appendix I should be followed to ensure surface stability is established and maintained.

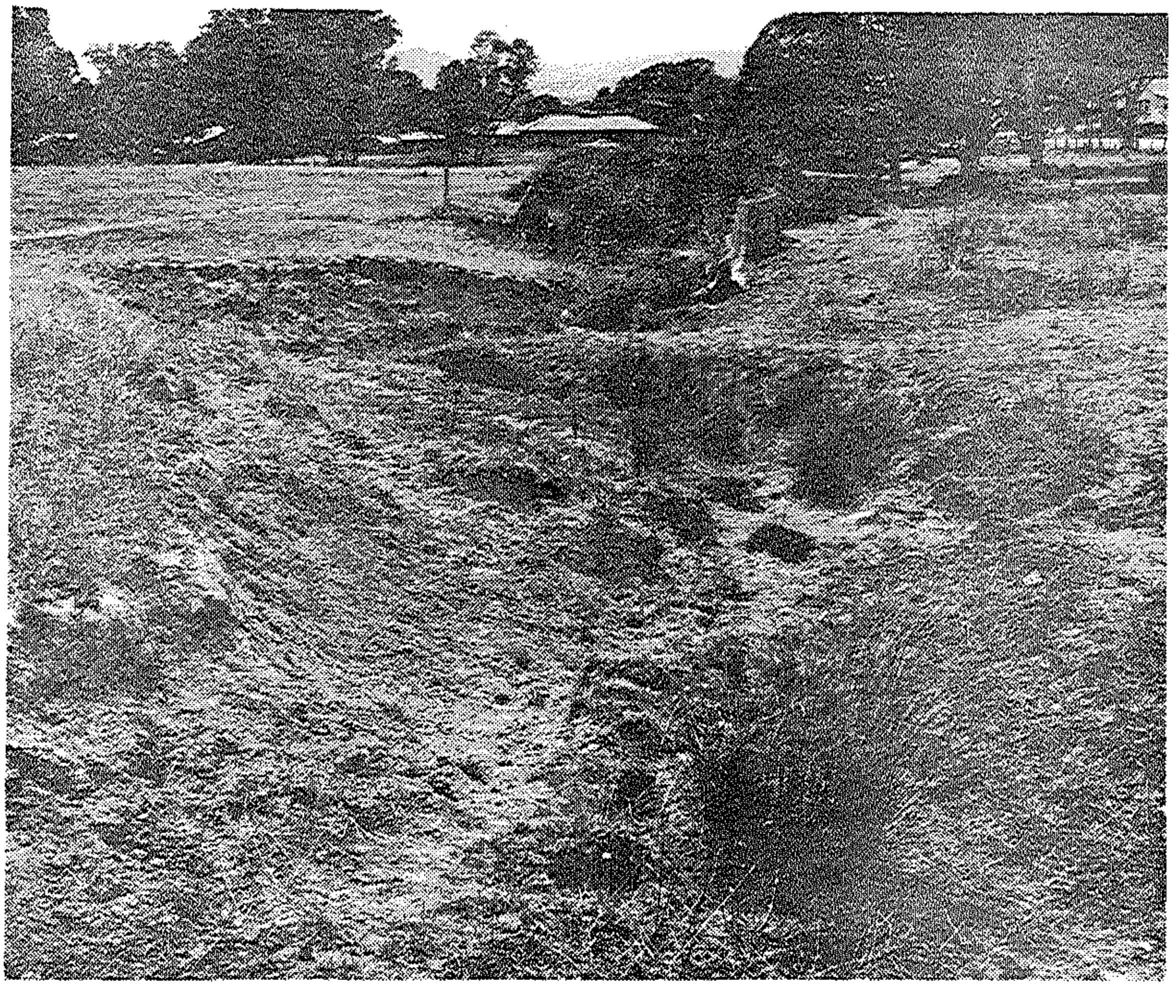


Figure 4. Incised channel of a fourth order stream. This land is sub-class D-2 and will require shaping as a drainage reserve.

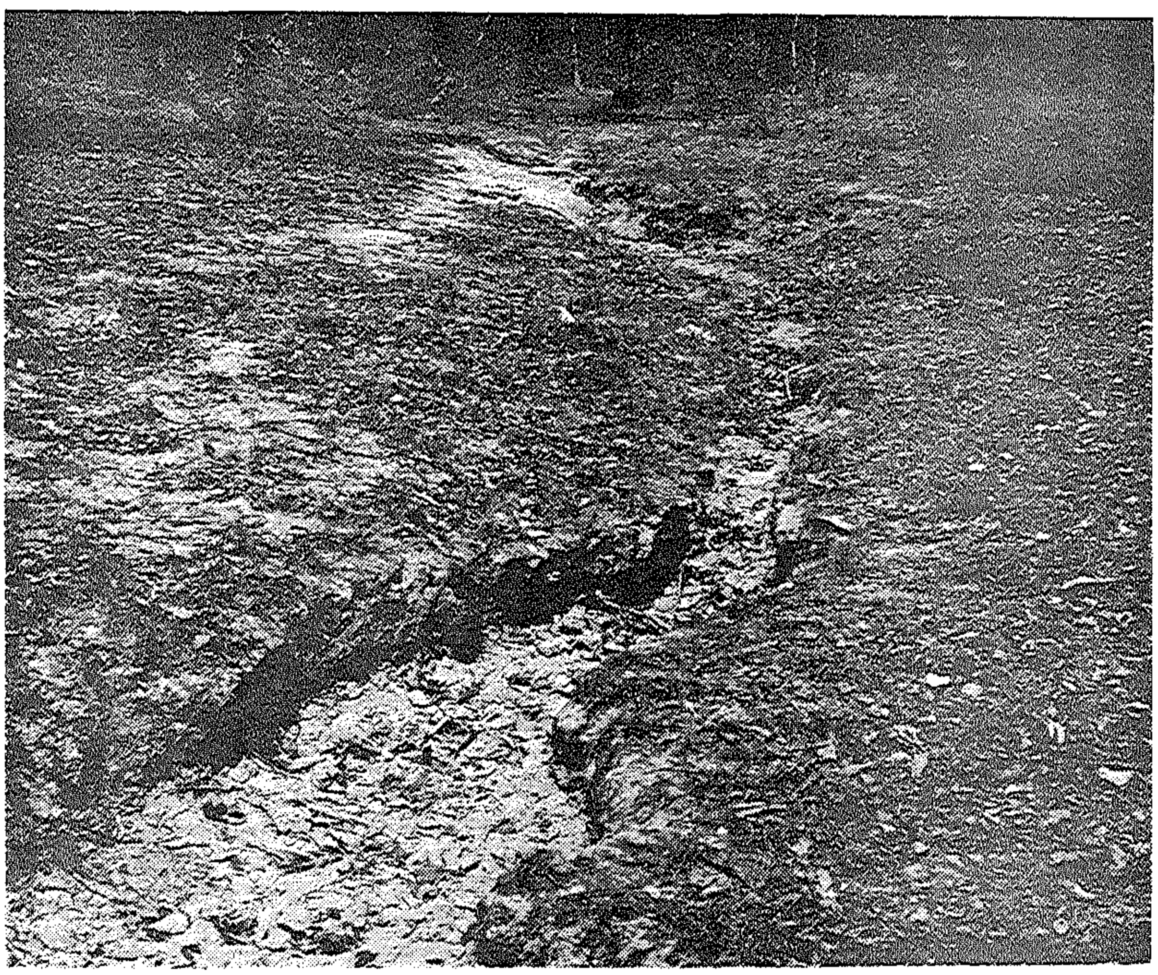


Figure 5. Minor gully erosion on Unit B soils.

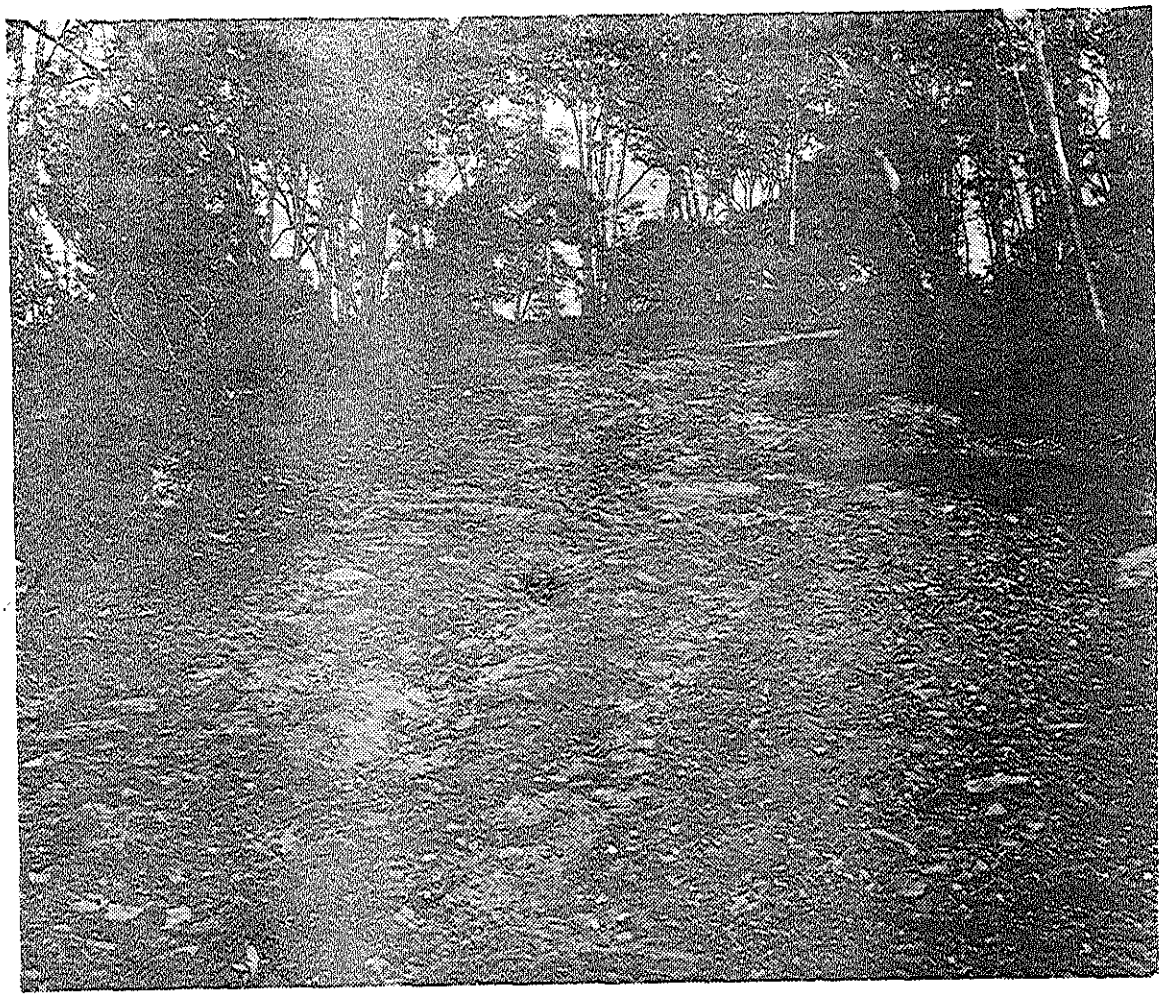


Figure 6. Fire trail on Unit A soils on a slope with gradient of 15 to 20%. Note the shallow depth of soil. This land is sub-class C-1,3eh.

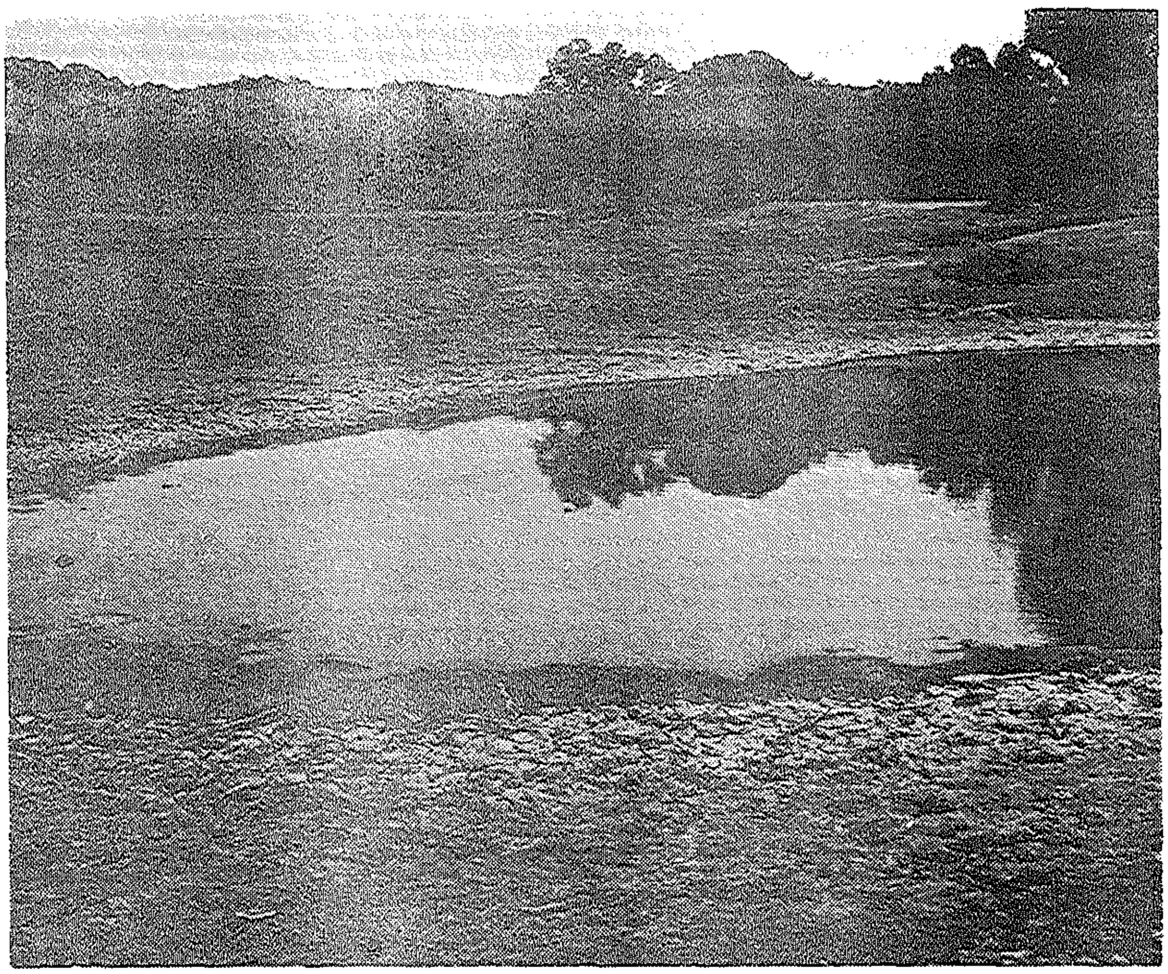


Figure 7. A broad drainage line above an existing dam in the town common. This is an area proposed for construction of retarding basins. The area immediately above the dam contains Unit D soils which have a high shrink/swell potential and fall in sub-class D-2,3v.

Sub-Class D-1,3eh: Very high hazard - Slope and shallow erodible soil constraints -
Suitable for reserves and passive recreation.

This is steep land adjoining sub-class E-1,3eh in the southwest. It occupies 10.9 percent of the total area. Map unit A soils occur on 20 to 25% gradients.

Residential development should be avoided due to the very high erosion risk and difficulty of servicing because of the proximity of rock to the surface. The most intensive use suggested is for reserves, passive recreation areas or as yard space for houses constructed on adjoining sub-class B-1,3eh land. Good vegetative cover should be retained.

If more intensive development is proposed, appropriate engineering and vegetative measures must be adopted to mitigate erosion, drainage and instability problems.

Sub-Class D-2: Very high hazard - Drainage constraint -
Suitable for reserves.

This land comprises the majority of the drainage lines and occupies 8.7 percent of the total area. Slopes range from 1 to 5% gradient. The drainage lines are mostly well defined, with the exception of a second order stream in the south.

The soils are mainly the highly erodible colluvial soils of map unit B. The land is subject to periodic flows which will cause serious erosion if the land surface is left unprotected. Building development is not recommended due to the flooding risk.

Urban development will increase the amount and frequency of flows in the drainage lines. To reduce the impact of this on flooding and creek bank erosion downstream, it is recommended the drainage lines be developed as grassed waterway reserves.

Vegetated channels - by comparison with concrete channels - carry runoff at a lower velocity. Retention of meander in channels, where practical, also delays the concentration of flow. These two features, provide simple runoff detention and reduce discharge peaks.

Grassed waterway reserves are cheaper to construct and provide green belts which are an attractive break in the continuity of roads and buildings. They may also be used as alignments for bikeways and footpaths.

To convert existing natural channels to drainage reserves which will efficiently dispose of urban stormwater, a certain amount of land shaping may be necessary, followed by the establishment of stablilizing vegetation. This is discussed further in Appendix II.

To further reduce the influence of urbanisation on stormwater discharges and possibly maintain post-urban flows at pre-urban levels, a system of retarding basins is recommended and are discussed in Appendix II.

Sub-Class D-2,3v: Very high hazard - Drainage and swelling soil constraints -
Suitable for reserves.

This land is similar to sub-class D-2 land, but with the added constraints of soil with shrink/swell potential and poor drainage. This land occupies 2.9 percent of the total area. It occurs on soils of map unit D on 1 to 5% gradients.

The soil is not suitable for roads or buildings without special foundation designs. Development is further constrained by the risk of flooding and consequently this land should be used according to the criteria for sub-class D-2 land.

Sub-Class E-1,3eh: Extreme hazard - Slope and shallow erodible soil constraints -
Not recommended for development.

This land occurs on map unit A soils on gradients steeper than 25% and occupies 10.4 percent of total area. The steep gradients and high soil erodibility produce an extreme erosion hazard.

Urban development and associated land disturbance would cause severe soil erosion, as well as the possibility of local slope failure. Lower land would be affected by erosion debris washing downslope.

Development of E-1,3eh land is therefore not recommended. It is suggested it be preserved in its natural state, retaining a good vegetative cover to stabilise it against erosion.

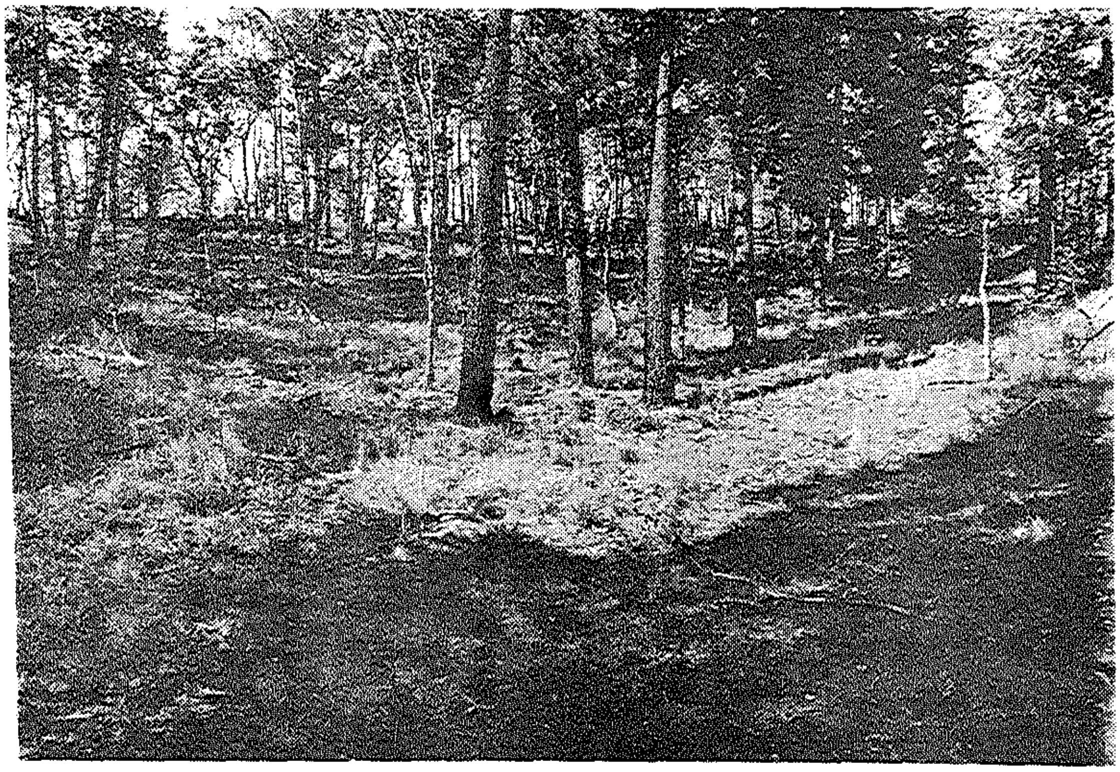


Figure 8. An area of sub-class D-1, 3eh land on Unit A soils on a 20 to 25% gradient.

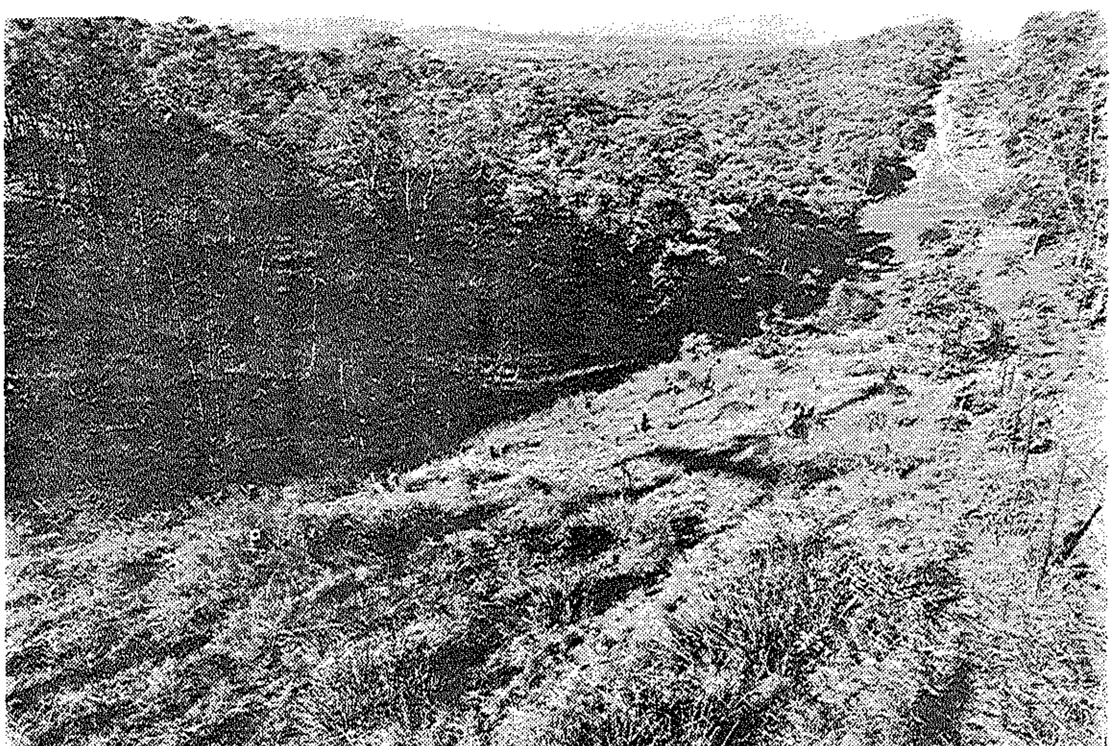


Figure 9. An area of E and D class land with gradients greater than 30% and 20% respectively on Unit A soils. Development of this area is not recommended.

Should other considerations compel development, prior site investigation is essential to design the conservation and/or engineering measures that will be required to maintain land stability.

Sub-Class E-2: Extreme hazard - Flooding and erodible soil constraint - Not recommended for development.

This land only occupies 0.6 percent of the total area. It occurs along McFarlane's Creek on soils of map unit B. Slope gradients of the creek banks are between 20 and 25%. The land is subject to periodic flooding. The combination of flood risk, steep banks and high soil erodibility will generate an extreme erosion risk if urban development occurs immediately adjacent to the creek.

Surface soil erosion, siltation, bank failure and increased flood risk are all possible. Development is therefore not recommended.

It is suggested that this land be preserved in its natural state, retaining a good vegetative cover along the creek banks to stabilise them against erosion.

REFERENCES

ADAMSON, C.M. (1975) A Simple Method for Determining Rainfall Intensities for the Riverina and Southern Soil Conservation Districts. Wagga Wagga Research Centre Technical Bulletin No. 5.

ADAMSON, C.M. (1975) A Manual of Soil Conservation Design for the Riverina and Southern Soil Conservation Districts - Part 1 - Estimation of Runoff. Wagga Wagga Research Centre Technical Bulletin No. 11 (reprinted July 1976).

AUSTRALIAN STANDARD A89 (1966) Testing Soils for Engineering Purposes. Standards Ass. of Aust. North Sydney.

BLACK, C.D. (ed) (1965) Methods of Soil Analysis Part I. Madison, Wisconsin; American Society of Agronomy.

BUREAU OF METEOROLOGY (1975) Climatic Averages N.S.W. Aust. Govt. Printing Service.

CHARMAN, P.E.V. (ed) (1975) Soils of New South Wales. Their Characterisation, Classification and Conservation. Soil Cons. N.S.W. Handbook.

CASAGRANDE, A. (1948) Classification and Identification of Soils. Trans. A.S.C.E. 113: (901).

EMERSON, W.W. (1967) A Classification of Soil Aggregates based on their Coherence in Water. Aust. Journal of Soil Research 5 (47).

LAMBE, T.W. AND WHITMAN, R.V. (1969) Soil Mechanics. Massachusetts Institute of Technology. Wiley & Sons, Inc. Sydney.

NAGEL, R.R. (1975) Storm Water Management - Pond Design Manual. Maryland Association of Soil Conservation Districts.

NORTHCOTE, K.H. (1971) A Factual Key for the Recognition of Australian Soils. Rellim Technical Publications, South Australia.

QUILTY, J.A.; HUNT, J.S.; AND HICKS, R.W. (ed) (1978) Urban Erosion and Sediment Control. Soil Conservation Service Handbook (in press).

STACE, H.C.T. et al (1968) A Handbook of Australian Soils. Rellim Technical Publications, S.A.

WICKHAM, H.G. AND TREGENZA, G.A. (1973) Modified Computation Procedure Keen - Raczowski Volume Expansion Test. J. Soil Cons. N.S.W. 29 (3) 170:177.

APPENDIX I

Guidelines for Sediment and Erosion Control

A range of general recommendations aimed at the control of erosion and siltation during development applies to the total site. Guidance in their implementation should be sought from the Gundagai Office of the Soil Conservation Service as planning and construction proceed.

(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 fast growing species such as millet in spring-summer, and cereal rye, oats or barley in autumn-winter, or by treatment with a surface mulch of straw or a chemical stabiliser.

(e) Where appropriate, exposed areas such as construction sites may be protected by locating temporary banks and/or 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 alteration of the natural landscape. In this context cut and fill and general grading operations should be limited to the minimum necessary for development.

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

(h) The location of temporary silt filters around stormwater inlets and the channelling of runoff through sediment basins below construction zones will assist the control of soil movement during construction, while the ground surface is bare.

(i) When excavations are made for conduits, topsoil and subsoil should be stockpiled separately. Subsoil should be replaced in the trench first, and topsoil spread later.

Subsoil used to backfill trenches should be thoroughly compacted. If the soil is either very wet or very dry, adequate compaction is difficult and the risk of subsequent erosion along the trench line is increased.

Backfilling to a level above the adjacent ground surface will allow for subsequent settlement.

Check banks may be required along filled trench lines to prevent erosion, particularly on long, steep slopes.

(j) 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.

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

(l) 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 may be constructed to protect them from upslope runoff.

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

(n) Cut and fill batters should be formed to a stable slope. Where vegetative - rather than structural - stabilisation of batters is proposed, early revegetation of the exposed face is essential:

(i) Possible plant species for use in this area include kikuyu, paspalum, carpet and couch grasses for spring-summer establishment, and couch or perennial rye for autumn-winter establishment. These should be sown at a heavy rate with a liberal dressing of fertilizer. Specific advice on suitable mixtures can be obtained from the Gundagai Office of the Soil Conservation Service.

(ii) Establishment of vegetation on batters is greatly 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 batter stabilisation technique. A mixture of seed, fertilizer, wood or paper pulp and water is sprayed onto the batter through a specially designed applicator. This is a simple and effective technique for vegetating batters.

(v) Once vegetation is established on batters, regular topdressing with fertilizer encourages the persistence of a vigorous sward.

(vi) Batters may be protected from upslope runoff by locating catch drains immediately above them. On high batters, berm drains located at intervals down the batter face will prevent the accumulation of erosive concentrations of local runoff.

(o) 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 topsoil return.

(ii) Topsoil structure will be damaged if it is very wet or very dry when respread.

(iii) Grasses should be sown into a prepared seed bed. Species suggested for batter stabilisation are also suitable for inclusion in any general revegetation mixture.

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

Specific recommendations on seed and fertilizer mixtures and application rates will be provided, on request, by the Gundagai Soil Conservation Office.

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

A more detailed description of sediment and erosion control and stormwater management techniques appropriate to urban areas is provided in the Soil Conservation Service Urban Erosion and Sediment Control Handbook.

APPENDIX II

Development of Grassed Drainage Reserves and Retarding Basins.

The upgrading of existing natural channels to drainage reserves will involve some land shaping followed by the establishment of stabilising vegetation (Appendix I).

Areas suitable for development as grassed drainage reserves have been classified as sub-class D-2 and D-2,3v.

To assist the design of the reserves, discharges have been calculated for the three main drainage channels shown on the Drainage Pattern map the catchments of which are designated A, B, and C. The discharges were calculated using the Rational Method formula, using local data for rainfall intensity and runoff coefficients (Adamson 1975, 1976). Details are given in Table 3.

The discharge frequencies were selected as the basis for planning a drainage system. The system consists of a small diameter underground pipe and a shaped channel (Figure 10).

Proposed Drainage System.

1. Pipe System.

It is recommended an underground pipe system be designed to carry the expected 1 - year peak discharge.

The pipe will also dispose of trickle flows during winter. If allowed to flow over the grassed channel, these flows would impair the growth of vegetation and increase the risk of channel erosion.

2. Overland Channel System.

The capacity of the overland channels should be based on the 20 - year frequency discharge. They should be constructed with a parabolic cross-section, with batter gradients no steeper than 1:5. They must be vegetated, and a flow velocity of 2.0 m/sec should not be exceeded for the lowest retardance condition expected. If high vegetal retardance conditions are experienced (e.g. in unmown channels) extra capacity will be required.

The overland channel system is designed to handle flows in excess

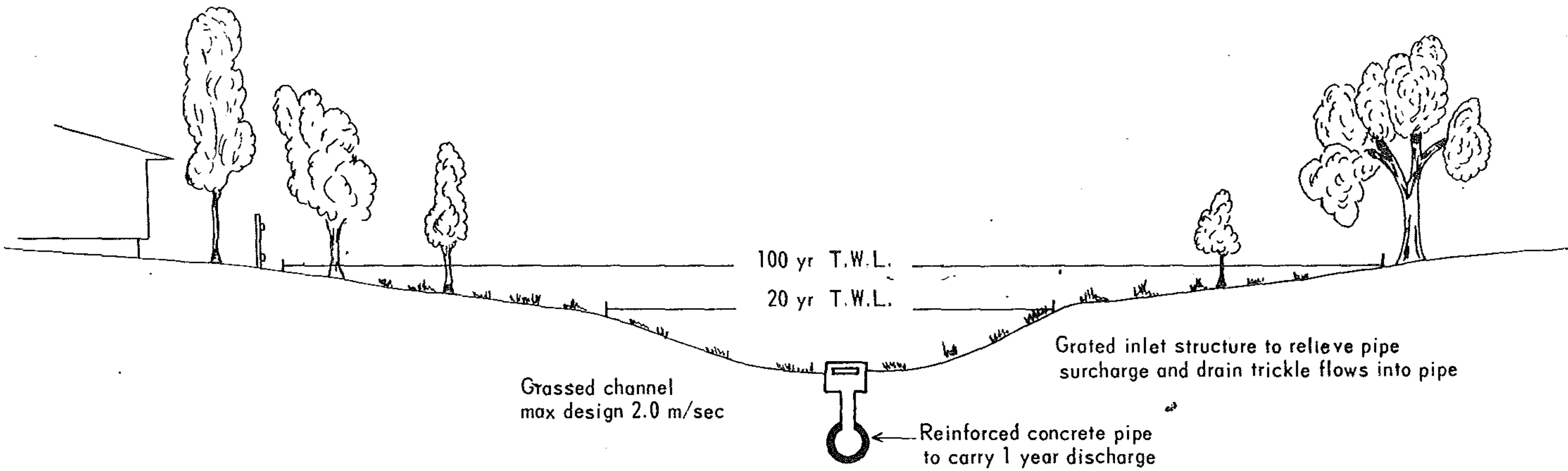


Fig 10 DIAGRAM SHOWING THE PIPE AND OVERLAND CHANNEL DRAINAGE SYSTEM – GRASSED DRAINAGE RESERVES

S.C.S 12069

TABLE 3. EXPECTED CATCHMENT DISCHARGES FOR SELECTED CATCHMENTS - EXISTING LAND USE CONDITIONS - SOUTH WEST TUMUT.

				1 YEAR			20 YEAR			100 YEAR		
CATCHMENT	AREA ha.	LAND USE	TIME OF CONCEN-TRATION mins.	RAINFALL INTENSITY mm/hr.	RUNOFF COEFF-ICIENT C.	PEAK DISCHARGE $m^3/s.$	RAINFALL INTENSITY mm/hr.	RUNOFF COEFF-ICIENT C.	PEAK DISCHARGE $m^3/s.$	RAINFALL INTENSITY mm/hr.	RUNOFF COEFF-ICIENT C.	PEAK DISCHARGE $m^3/s.$
A	201.8	95% Forest 5% Rural	150	5.8	0.10	0.33	25.3	0.20	2.84	34.5	0.40	7.74
B	23.4	60% Rural 40% Forest	54	9.4	0.15	0.09	57.5	0.32	1.20	78.2	0.53	2.70
C	16.6	90% Rural 10% Forest	34	16.1	0.15	0.11	80.5	0.33	1.22	115.0	0.54	2.86

of the capacity of the pipe system. The two systems are therefore interconnected by a series of combined inlet - outlet structures spaced where required. Thus, when discharge exceeds the pipe system's capacity, the surcharge can outlet into the overland channel. When pipe surcharge decreases, reverse flow from the channel back into the pipe will occur.

The overland channels should be mown to maintain a good stand of vegetation.

- Flood area.

For extreme flood events, the 100 - year discharge should be used to determine the flood width. Building should not be allowed in these areas and the channel should not be restricted by filling. They are best suited to passive recreation or for use as reserves.

Advantages of the proposed system.

1. The pipe and channel system is considerably cheaper than a conventional trunk drainage system where major flows are piped underground.

2. The overland channels and floodplain will provide an aesthetically pleasing environment in the urban area. The vegetated channels provide additional flow retardance, and their cross-sections are safer for children should they be caught in the channel during a storm.

3. Maintenance costs of undeveloped channels downstream will be reduced due to better control over discharge from the system.

4. Increased channel losses of runoff in the system will reduce runoff volume and provide additional groundwater recharge.

The total effect will be to provide a storm drainage system that is stable and environmentally acceptable while still retaining hydraulic effectiveness.

Storm Water Management.

The hydrology of the study area is affected by external catchments. Runoff from these forested catchments is minimal and little deterioration of natural channels has occurred. If the hydrology of these catchments is upset by a change in land use (e.g. from rural to urban or clearing or burning of the forest), serious downstream flooding and channel deterioration will occur.

To avoid this, a stormwater management system is proposed that will allow flows to be regulated and maintained at, or near, pre-development levels.

The concept of stormwater management has been developed in the U.S.A. in the State of Maryland (Nagel, 1975). This requires that development does not increase the 2 - and 10 - year flood discharges over the pre-urban level.

The 2 - year flood discharge is recognised as the landscaping discharge for most natural channels. That is, streams will adjust their natural channels to accommodate this discharge. Thus in Maryland, if the 2 year discharge is maintained after development, channel stability will be maintained.

The 10 - year flood discharge is the normal design frequency for minor storm drainage systems in Maryland. To minimise flooding of downstream occupiers resulting from upstream development, the 10 - year discharge is also controlled.

Control of storm runoff at pre-development levels is achieved by retarding basins. These provide temporary flood storage and have a controlled piped outlet. An emergency spillway is also required.

During the urban construction phase the basin can also serve as a sediment trap. This will preserve channel capacity and reduce channel maintenance costs.

This concept is complementary to the proposed grassed drainage reserve system and ideally should be incorporated in it.

Retarding Basin Location.

Comparison of the Drainage Pattern and Urban Capability maps shows that a diversion of water into catchment A has been proposed.

The Drainage Pattern map shows a second order stream flowing into the area presently being developed by the N.S.W. Housing Commission. It is proposed this drainage line be diverted, as indicated by the line of sub-class D-2 land joining sub-class D-2,3v land.

This diversion is proposed to divert any increase in surface runoff away from the Housing Commission area. It is understood that present drainage in this area would not handle the increased flow which will result from upstream development.

It is recommended that four sites be studied for construction of retarding basins. These are indicated on the Drainage Pattern map as sites 1, 2, 3 and 4.

Site 1.

This is located on a soil with significant shrink/swell potential. It is recommended this site be developed as a sport and recreation area that would also serve as a shallow retarding basin. This would require the area to be levelled and a low earth embankment placed around its perimeter. The embankment would pond water to a shallow depth and release it through a restricted pipe outlet.

Site 2.

This is located at the head of the diversion to catchment A.

The pipe outlet should be restricted to control flows to a level compatible with the capacity of existing drains through the Housing Commission area. Flows in excess of these would be diverted into catchment A.

Site 3.

This is located at the confluence of two catchments and should be a conventional retarding basin.

Site 4.

It is understood that Council is considering building a car park for a large shopping complex at this site. This would increase runoff from the area. Runoff control could be achieved by either temporarily storing water to a depth no greater than 100 mm over the entire car park or in a separate retarding basin downstream.

The Soil Conservation Service can assist Council with further investigation of the concept of stormwater management in the study area.

APPENDIX III - LABORATORY ANALYSES OF SOILS - URBAN CAPABILITY STUDY - SOUTH WEST TUMUT

Sampling Site	Sample		Particle Size Analysis										
	No.	Depth cm	Clay %	Silt %	Fine Sand %	Coarse Sand %	Gravel %	Stones %	LL %	PI %	USCS	DI	L/S
A	1	0-30	10	33	32	25	0	0	21	2	ML	1.2	1
	2	30-55	37	7	25	15	13	0	47	15	ML	4.5	10
	3	55-85	45	11	28	12	4	0	43	11	ML	8.5	12
	4	85-120	46	14	29	4	2	1	57	31	MH	1.6	16
B	5	10-40	10	9	8	9	17	46	28	6	CL-ML	1.4	3
C	6	20-	14	9	17	18	23	16	35	9	ML	2.2	4
D	7	30-	5	9	28	17	13	27	14	2	ML	1.1	1
E	8	20-100	28	24	20	9	11	6	38	12	ML	2.0	7
	9	100-120	26	21	20	21	8	3	27	7	CL	1.9	6
F	10	30-50	9	9	11	9	41	18	18	3	CL	1.5	4
	11	60-100	34	12	15	6	17	12	36	11	ML	2.4	8
G	12	20-40	17	18	28	14	17	4	19	3	CL	1.9	4
	13	40-100	37	15	21	5	18	2	37	9	ML	3.0	9
H	14	15-50	30	9	14	3	29	16	55	27	MH	4.6	14
	15	50-70	50	20	26	3	0	1	49	18	ML	5.9	10
	16	70-100	39	27	28	1	2	2	40	16	CL	4.7	10
	17	100-120	39	28	30	2	0	1	35	16	CL	3.7	9
I	18	40-45	24	17	15	13	24	7	28	9	CL	3.5	6
	19	45-70	20	16	18	12	21	12	25	7	CL-ML	3.7	5
	20	70-100	17	19	18	16	18	12	29	9	CL	2.1	4

APPENDIX III - LABORATORY ANALYSES OF SOILS - URBAN CAPABILITY STUDY - SOUTH WEST TUMUT (Continued)

Sampling Site	Sample		Particle Size Analysis										
	No.	Depth cm	Clay %	Silt %	Fine Sand %	Coarse Sand %	Gravel %	Stones %	LL %	PI %	USCS	DI	L/S
J	21	20-40	49	20	22	2	6	1	57	25	MH	7.1	14
	22	50-70	46	19	19	4	10	3	51	20	MH	7.2	8
	23	20-80	30	12	11	2	33	12	52	24	MH	1.7	14
	24	80-120	47	23	23	1	5	1	48	22	ML	1.8	14
L	25	20-50	40	16	20	1	22	2	70	33	MH	3.2	16
	26	50-120	56	18	16	1	4	2	71	38	MH	2.9	17
M	27	30+	41	20	26	10	3	1	38	13	ML	2.8	9
N	28	20+	1	1	3	1	8	86	26	5	CL-ML	1.9	4
O	28A	0-20	25	17	21	18	15	3	27	10	CL	1.9	6
	29	20-70	46	16	12	4	21	0	52	19	MH	4.0	11

APPENDIX IV Descriptions, Typical Soil Profiles - Urban Capability Study - South West Tumut.

MAP UNIT A

Site B (Dy 2.32)

Depth (cm)

0-10	Dark brown (10YR 3/4) sandy loam, hard, about 30% gravel 1 to 2cm diameter. pH6, clear to:-
10-40	Yellowish brown (10YR 6/6) silty clay, 50% gravel increasing with depth until the soil is present only in fracture planes between the rocks. pH6.

MAP UNIT B

Site A (Dy 3.42)

Depth (cm)

0-10	Dark brown (10YR 3/3) loam, hard setting surface apedal. pH5, sharp to:-
10-30	Dull yellow-orange (10YR 6/4 moist) light yellow-orange (7.5YR 8/3 dry) apedal. pH5, sharp to:-
30-85	Yellowish brown (10YR 5/8) with some orange and some grey mottles, medium clay, very fine crumb structure set in coarse blocks. pH6, gradual to:-
85-120	Yellowish brown (10YR 5/8), 20% grey mottles, heavy clay, coarse blocky. pH6.

MAP UNIT C

Site O (Dr 2.21)

Depth (cm)

0-15	Dark brown (7.5YR 3/4) sandy loam, crumb structure, some quartz gravel to 1.5cm diameter. pH 6.5, clear to:-
15-30	Brown (7.5YR 4/3) clay loam, 50% or more quartz gravel, very hard, structureless, clear to:-
30-120	Reddish brown (2.5YR 4/8) medium clay, medium angular blocky, plastic. pH6.

MAP UNIT D

Site L (Ug 5.29)

Depth (cm)

0-10	Black (2.5Y 2/1) organic silt, very spongy. pH5 clear to:-
10-20	Greyish yellow brown (10YR 5/2) silty clay, hard, fine crumb. pH5.
20-120	Dull greyish yellow (2.5Y 4/2) heavy clay, coarse blocky, plastic. pH6.

APPENDIX V

GLOSSARY OF TERMS

Active Recreation

Active recreation refers to ovals, camp sites and other activities requiring extensive clearing or levelling for facilities.

Atterberg Limits

The Atterberg Limits are based on the concept that a fine-grained soil can exist in any of three states depending on its water content. Thus, on the addition of water, a soil may proceed from the solid state through to the plastic and finally liquid states. The water contents at the boundaries between adjacent states are termed the plastic limit and the liquid limit.

Plastic Limit (P.L.)

The plastic limit of a soil is the moisture content at which the soil passes from the solid to the plastic state. A description of the plastic limit test is given in Black (ed.), (1965).

Liquid Limit (L.L.)

The liquid limit is the moisture content at which the soil passes from the plastic to the liquid state. A full description of the liquid limit test is given in Black (ed.), (1965).

Plasticity Index (P.I.)

The plasticity index of a soil is the difference between the plastic and the liquid limits. Toughness and dry strength are proportional to the plasticity index. (See Black (ed.), (1965)).

Dispersal Index (D.I.)

The Dispersal Index of a soil is the ratio between the total amount of very fine particles of approximately clay size, determined by chemical and mechanical dispersion, and the amount of very fine particles obtained by mechanical dispersion only. Highly dispersible soils have low dispersal indices because their very fine particles are already in a dispersed state, and the ratio approaches one. Slightly dispersible soils have high dispersal indices.

The test has been shown to reflect field behaviour of soils in that dispersible soils are often highly erodible and subject to tunnelling, both in situ and when used in earthworks.

A full description of the Dispersal Index test and the background to it is given in Charman (ed.), (1975).

Emerson Aggregate Test

The Emerson Aggregate Test (E.A.T.) classifies soil aggregates according to their coherence in water. The interaction of clay size particles in soil aggregates with water may largely determine the structural stability of a soil.

The Emerson classes 1, 2, 3 and 4 - 6 generally represent aggregates from soils which are highly, moderately, slightly and non-dispersible respectively.

A full description of the test is given by Emerson (1967).

Erosion Hazard

The erosion hazard is a qualitative assessment of the potential for erosion to occur, with consideration given to the whole soil unit, its erodibility and topographic situation. The erosion hazard of an area is also related to the proposed use of the land.

Linear Shrinkage (L.S.)

The linear shrinkage is the decrease in one dimension of a soil sample when oven dried (at 105°C for 24 hours) from the moisture content at the liquid limit, expressed as a percentage of the original dimension.

The linear shrinkage test is fully described in the Australian Standard A89-1966.

Northcote Grouping

The Northcote Grouping represents the characterisation of a soil profile according to a system for the recognition of soils in the field described by Northcote (1974).

The Soil Conservation Service of New South Wales addendum to this grouping comprises three additional digits representing the surface texture, surface soil structure and depth of the A horizon in centimetres, respectively, of the soil profile described. Texture classes range from 1 to 6 (sand to heavy clay). Structure classes range from 0 to 3 (structureless to strongly developed structure). These properties are defined in the above reference.

Particle Size Analysis

Particle size analysis is the laboratory procedure for the determination of particle size distribution in a soil sample. The hydrometer method used for this report is given by Day in Black (ed), (1965). International standards have been used to differentiate the various fractions.

Passive Recreation

Passive recreation refers to walking tracks, parkland and drainage reserves, where minor shaping, clearing and possible revegetation may be desirable to provide for a particular use, but no extensive development is permitted.

Unified Soil Classification System (USCS)

The USCS is a classification system which has been correlated with certain engineering properties of soils such as optimum moisture content, permeability, compressibility and shear strength.

- 'ML' refers to inorganic silts and very fine sand, and silty or clayey fine sands of low plasticity.
- 'MH' refers to inorganic silts, fine sandy or silty soils, and plastic silts.
- 'CL' refers to inorganic clays of low to medium plasticity gravelly clays, sandy clays and lean clays.
- 'CH' refers to inorganic clays of high plasticity, and expanding clays.

A full description of the system is given by Casagrande or Lambe and Whitman (1969).