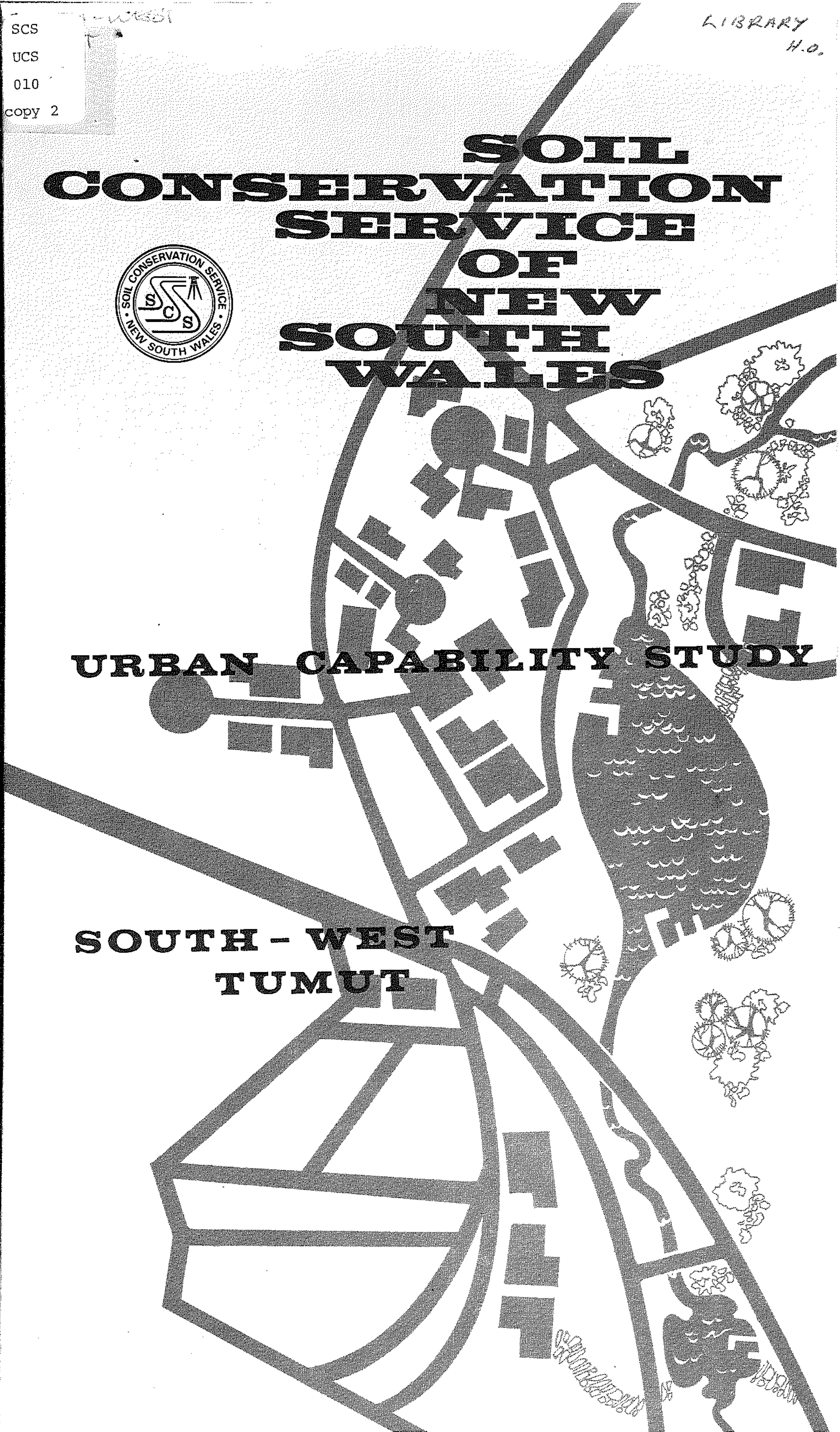
SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

URBAN CAPABILITY STUDY

SOUTH-WEST TUMUT



SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

URBAN CAPABILITY STUDY

TUMUT SHIRE INDUSTRIAL AREA

Prepared for Tumut Shire Council

December, 1981

Report compiled by:

P.J. Barker,
Soil Conservationist.

This report, and the original maps associated with it, have been scanned and stored on the custodian's intranet.
Original maps drafted at 1:2,000 were catalogued SCS 15833/A –Z.
These full size maps have been scanned and named
"UC_Tumut Industrial_theme". S.J. Lucas Dec2014

PREFACE

This report is a guide to development potential in terms of the physical limitations of the study area. It indicates the capability of the physical resources of the study area to sustain various intensities of urban use.

While the maps are intended to assist in subdivision planning, it is important that information is not extracted from them at a scale larger than the scale of the originals.

The maps and the written report are not 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. Rather, they provide a basis onto which other town planning considerations may be imposed to derive a development plan.

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LIST OF TABLES AND MAPS

SUMMARY

The study area comprises approximately 55 hectares of land immediately southeast of Tumut on the Snowy Mountains Highway.

In general, the land falls steeply in a westerly direction from a ridge that forms its eastern boundary. Most sideslopes have gradients ranging from 15 to over 30 percent, while gradients on footslopes range from 5 to 20 percent.

Potential urban land use is assessed in terms of the capability of the land to support various uses without initiating soil erosion.

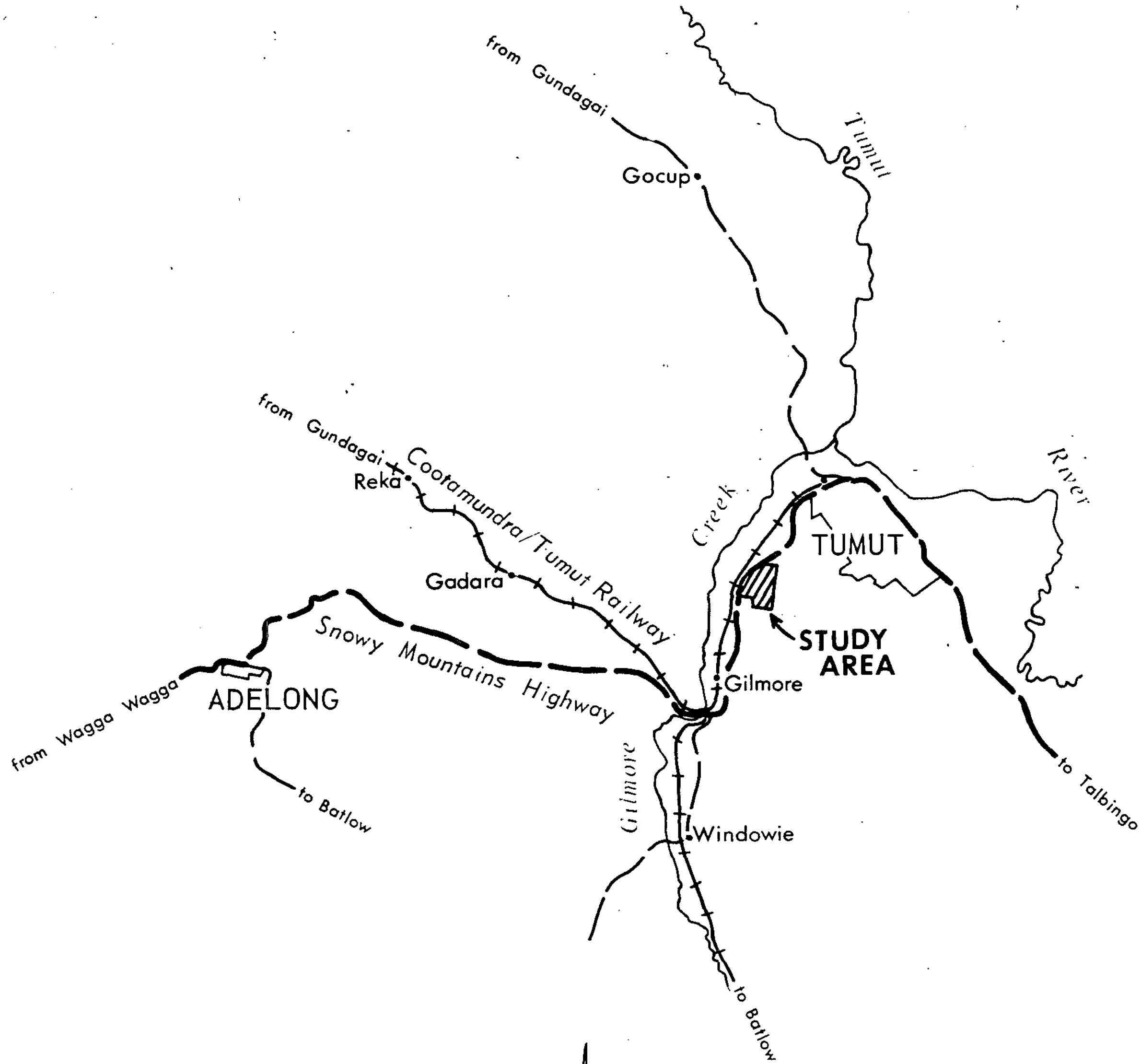
Areas suitable for residential development occur on footslopes and lower gradient sideslopes. Shallow soil depth, topographic location and high soil erodibility are characteristics which variously affect urban development potential on these areas.

It is not recommended that the steeper slopes, which occur over much of the eastern half of the area, be developed due to the severe physical limitations associated with these areas.

Many of the footslopes in the southeastern section of the area are subject to large amounts of run-on water from steeper slopes, while soil erodibility is high. Nevertheless, most of these footslopes are suitable for large building complexes provided adequate recognition is given to their physical limitations. Control of run-on water will be essential to prevent serious erosion occurring during the construction phase of urban development and to ensure long term stability.

Seasonal waterlogging will pose pratical problems for development on some lower footslopes.

If land use within the area is intensified, it will be necessary for most of the natural drainage lines to be upgraded to function as drainage reserves. In addition, the establishment of sediment basins is recommended to control the heavy sediment load anticipated following disturbance of these lands for industrial development.



LOCALITY DIAGRAM

TUMUT SHIRE INDUSTRIAL AREA

URBAN CAPABILITY STUDY

S.C.S. 15833/D

TABLE 1. SUMMARY OF URBAN CAPABILITY CLASSES

TUMUT SHIRE INDUSTRIAL AREA

Class	Limitations	Capability
B-t	Topographic feature	Extensive Building Complexes
B-e	Erodibility	Residential
C-et	Erodibility, topographic feature	Extensive Building Complexes
C-w	Seasonal waterlogging	Extensive Building Complexes
C-st	Slope, topographic feature	Residential
C-ds	Shallow soil, slope	Residential
D-ds	Shallow soil, slope	Reserve
D-f	Flooding	Drainage Reserve
E-s	Slope	Not Recommended for Development
E-f	Flooding	Not Recommended for Development

INTRODUCTION

The area investigated in this study lies immediately southwest of Tumut and is bounded in the northwest by the Snowy Mountains Highway. Total area is approximately 55 hectares.

This study is based on an investigation of the physical features of the site and an interpretation of these features.

Soils of the area have been surveyed and mapped onto a 1:2,000 scale base plan. The characteristics of the soils relating to their erodibility, stability and development limitations have been assessed.

Terrain, slope and drainage pattern have been studied by aerial photograph interpretation in conjunction with detailed field checking. These features are presented on base maps at a scale of 1:2,000.

Interpretation of this physical resource information provided the basis for an urban land capability map. This indicates the potential of the area for various types of urban development with regard to the physical limitations imposed by the terrain, soils and drainage.

While originals of the above maps have been prepared at the scale indicated above, copies presented in this report have been reduced in scale for convenience of presentation. The larger scale originals are available, on request, from the Soil Conservation Service of N.S.W.

The maps should not be enlarged for use at a scale larger than 1:2,000 nor should they be regarded as providing a detailed appraisal of individual development areas within the study area.

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

PART A

INVENTORY OF PHYSICAL FEATURES

Environmental features that influence land stability and the urban capability of the study area include:

1. Climate.
2. Landform (slope, terrain and drainage pattern).
3. Geology and soils.

1. Climate.

The climate of the Tumut area 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 low intensity 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.

2. Landform.

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

The study area falls steeply in a westerly direction from a ridge that forms its eastern boundary. Beneath these sideslopes, with gradients ranging from 15 to over 30 percent, are footslopes with gradients ranging from 5-20 percent.

A second, smaller ridge occurs in the southwestern corner of the area. Here, sideslopes have gradients ranging from 5-20 percent. An incised drainage channel separates this ridge from the balance of the site.

Soil Conservation Service of N.S.W.

URBAN CAPABILITY STUDY

TUMUT SHIRE
INDUSTRIAL AREA

LANDFORM

metres 50 25 0 50 100 150 200 metres

SCALE

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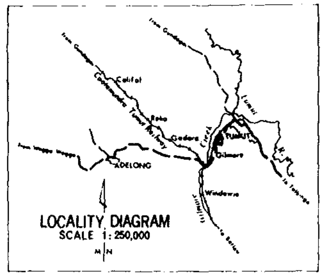

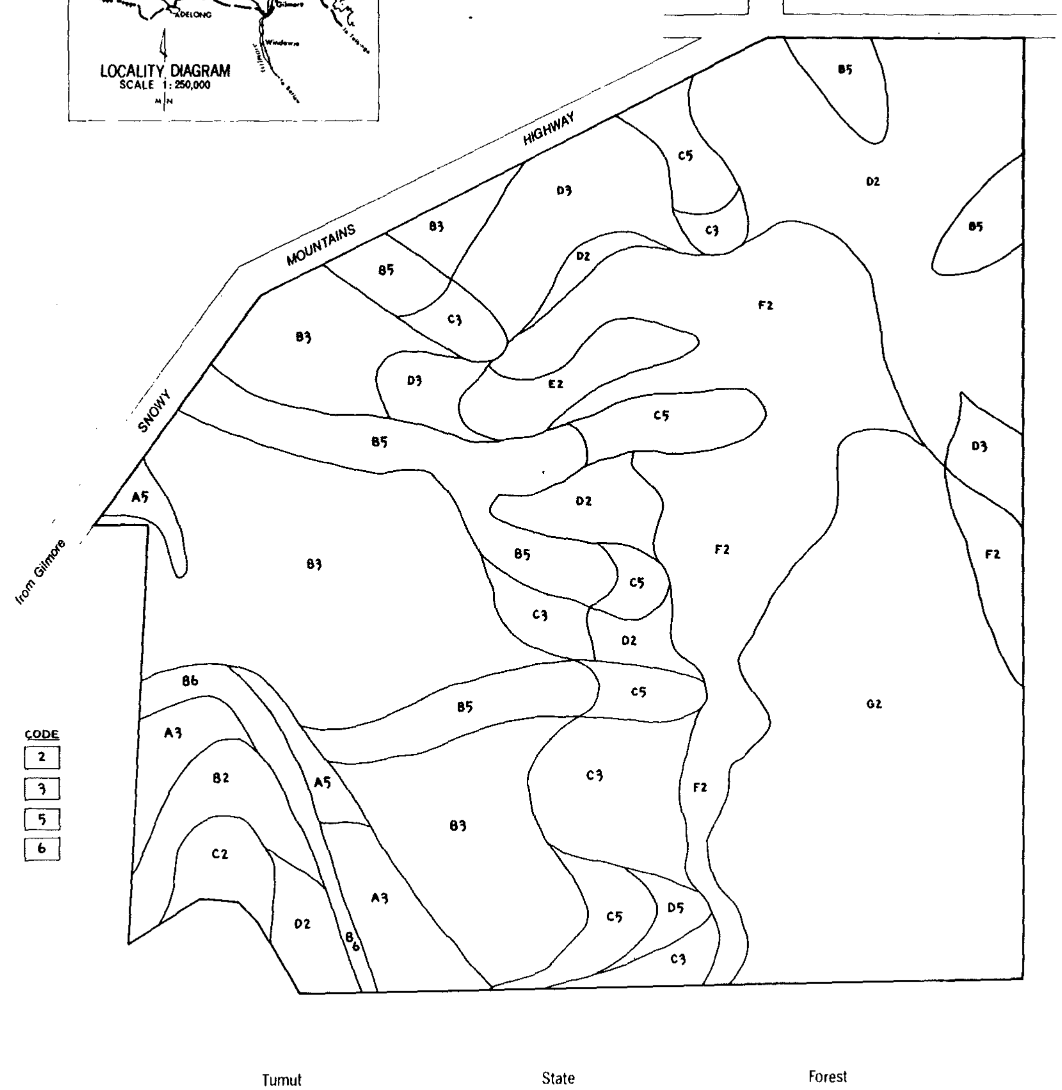

LEGEND

SLOPE

PERCENT	CODE
0 - 5	A
5 - 10	B
10 - 15	C
15 - 20	D
20 - 25	E
25 - 30	F
> 30	G

TERRAIN

UNIT	CODE
Sideslope	2
Footslope	3
Drainage Plain	5
Incised Drainage Channel	6

S.C.S. 15833/A

The following slope and terrain classes are defined on the landform map.

Slope Class	Code
0 - 5%	A
5 -10%	B
10 -15%	C
15 -20%	D
20 -25%	E
25 -30%	F
> 30%	G

Terrain Component	Code
Sideslope	2
Footslope	3
Drainage Plain	5
Incised Drainage Channel	6

3. Geology and Soils.

The geology of the area consists predominantly of Silurian siltstone, which is a fine grained sediment.

On the ridges and steep slopes shallow stony soils occur, with some rock outcrops. On the lower slopes and drainage plains, where colluvial material has accumulated, yellow and mottled yellow duplex soils have formed.

A soil map of the area has been prepared as part of the urban capability investigation. The soil sampling pattern was designed to sample major terrain units previously identified by aerial photograph interpretation and ground observations. Final boundaries for the soil map units were delineated using ground survey information and aerial photograph interpretation.

Soils were classified using the Northcote Factual Key (Northcote, 1979). Laboratory analysis of selected samples included tests for dispersibility, Atterberg limits, grading analysis and linear shrinkage. Results of these tests are presented in Appendix III, while Table 2 summarises the major characteristics of the soil mapping units.

Description of Soil Map Units.

Map Unit A - Shallow Stony Soils.

Shallow stony soils occur on steep slopes in the eastern portion of the area. These soils have formed directly on sedimentary rock.

Shallow sandy loams are common, while yellow and red duplex soils

TABLE 2. SUMMARY OF SOIL CHARACTERISTICS - TUMUT SHIRE INDUSTRIAL AREA

MAP UNIT	DOMINANT SOILS	EROSION HAZARD	MAJOR LIMITATIONS
A	Shallow Stony Soils	High to very high	Shallow soil depth
B	Moderately Shallow Yellow Duplex Soils	Moderate	Topographic location
C	Yellow Duplex Soils	High	High subsoil erodibility Topographic location
D	Deep Mottled Yellow Duplex Soils	Moderate to high	Low subsoil permeability
E	Mottled Yellow Duplex Soils	Moderate to high	Low subsoil permeability Periodic inundation
F	Alluvial Soils	Very high	High soil erodibility Flooding

occur where soil development has been more intense. The duplex soils typically have a hard, sandy loam textured topsoil (A horizon) over a shallow, clay loam textured subsoil (B horizon). A pale coloured layer is often present between the A and B horizons. Bedrock occurs at less than 50 cm depth and some rock outcrops occur.

The erosion hazard of this soil unit is high because of the steep slopes (often in excess of 20 percent gradient), shallow soil depth, dispersible nature of the subsoil and the high stone content.

Map Unit B - Moderately Shallow Yellow Duplex Soils.

These soils occur on midslope positions where some colluvial material has accumulated.

The soil consists of a hard, sandy loam to sandy clay loam textured surface horizon, including an A2 horizon which is up to 25 cm thick. Below this lies a bright brown to yellowish brown sandy clay. Bedrock occurs at between 50 and 100 cm depth.

A moderate erosion hazard exists within this soil unit because of the moderate erodibility of the subsoil and the location of this soil type below steep slopes.

Map Unit C - Yellow Duplex Soils.

These soils have formed on lower slopes where colluvial material has accumulated.

A typical soil consists of a brown to dark brown A1 horizon, 10 cm thick, overlying a bleached A2 horizon which may be up to 60 cm thick. Below this occurs a light to medium clay textured B horizon.

Surface soils are moderately to highly erodible. Laboratory testing indicates that the B horizon is usually dispersible and hence erodibility is high. A high erosion hazard exists because of the erodible nature of the subsoil and location of this soil type in lower positions of the landscape. It is therefore important that erosion and sediment control measures be used during any construction activity.

Although gravelly, these soils will become waterlogged during wet winter months unless adequately compacted and drained.

Most of this unit receives large amounts of run-on water from shallow soils located on steep slopes above. During periods of protracted rainfall this run-on causes areas of seepage to occur on the lower slopes of this soil unit. Provision for disposal of this water must be made when planning urban development.

Soil Conservation Service of N.S.W.

URBAN CAPABILITY STUDY

TUMUT SHIRE INDUSTRIAL AREA

SOILS

metres 50 25 0 50 100 150 200 metres

SCALE

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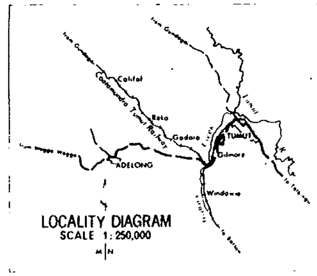
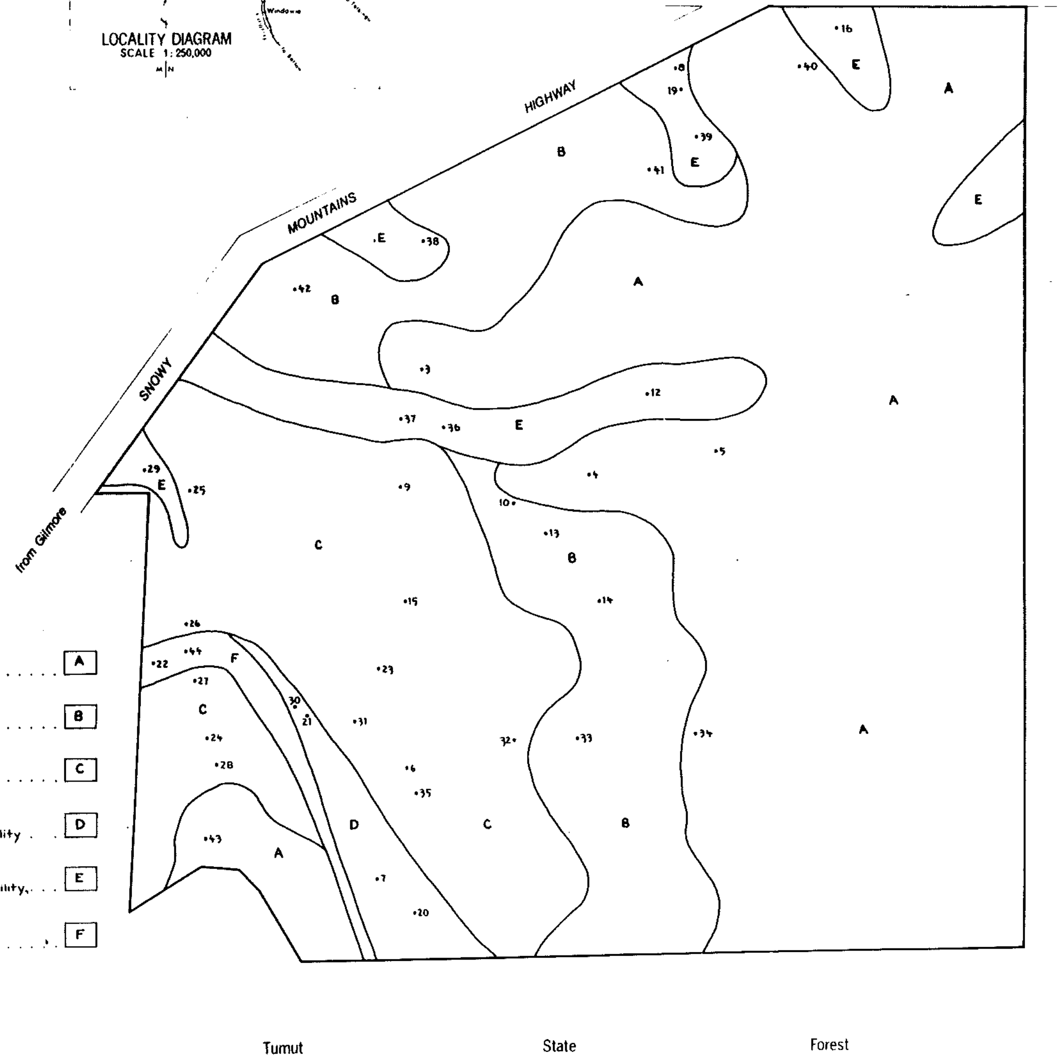


to Tumut



DOMINANT SOILS	RANGE OF NORTHCOTE GROUPINGS	MAJOR LIMITATIONS	
Shallow stony soils	Uc 1.21, Dy 2.22, Dr 2.22, Dy 2.12	Shallow soil depth	A
Moderately shallow yellow duplex soils	Dy 2.21, Dy 2.22	Topographic location	B
Yellow duplex soils	Dy 2.42, Dy 2.22, Dy 2.12, Dy 2.11	High subsoil erodibility, Topographic location	C
Deep mottled yellow duplex soils	Dy 3.42, Dy 2.42	Low subsoil permeability	D
Mottled yellow duplex soils	Dy 3.42, Dy 3.12, Dy 2.42, Dy 3.22, Ug	Low subsoil permeability, Periodic inundation	E
Alluvial soils		High soil erodibility, Flooding	F

• Soil sample site

S.C.S. 15833/B

Map Unit D - Deep Mottled Yellow Duplex Soils.

These soils occur on an area of low-lying footslope and drainage plain terrain adjacent to the incised drainage channel in the south-west of the area.

Surface soils are 20 to 30 cm deep, with silty loam to silty clay loam textured A1 horizons overlying bleached A2 horizons. Subsoils are yellowish brown silty clays to medium clays which are usually mottled grey. Depth to bedrock is greater than 200 cm.

Site drainage will be a problem during periods of protracted rainfall due to the low permeability of the B horizon and the amount of run-on this area receives from footslopes above. Seasonal seepage patches occur within this soil unit.

Linear shrinkage values are low to moderate.

Erodibility of the subsoils is moderate to high. This feature combined with the low topographic position of this soil unit results in moderate to high erosion hazard rating.

Map Unit E - Mottled Yellow Duplex Soils.

These soils have formed on drainage plains from colluvial parent material which has been washed from the adjacent hills.

Topsoils are typically 5 to 70 cm deep with sandy clay loam texture. Bleached A2 horizons, approximately 30 cm thick, are often present. The subsoils are yellowish brown medium to heavy clays which are frequently mottled. Depth to bedrock is usually greater than 200 cm.

Infiltration through the B horizon is generally slow and drainage is mostly poor, so that soils are frequently waterlogged during periods of protracted rainfall.

The erosion hazard is moderate to high because of moderate to high soil erodibility and concentration of waterflow in drainage lines.

Map Unit F - Alluvial Soils.

These soils occur within the incised drainage channel which runs through the southwest corner of the area.

Soils are variable and have a high gravel and stone content.

The erosion hazard is very high because of the erodible nature of the soils and the concentration of waterflow within the drainage channel.

4. Soils and Land Use.

This section describes some of the soil physical limitations to land stability in this area. Factors considered include erosion hazard, profile, drainage, shrink/swell potential, revegetation problems and the use of soil materials for minor earthwork construction.

Erosion Hazard.

The soil erosion hazard assessment takes into account soil erodibility, landform characteristics, the expected incidence of run-on water and potential land use. The rating assesses the hazard following land disturbance associated with urban development.

Soil map unit A has a high erosion hazard rating because of the steep slopes and shallow, erodible soils.

Map unit C has a high erosion hazard rating due to the erodible nature of the soils, particularly the subsoils, and their occurrence in lower portions of the landscape where waterflow is concentrated. High erosion damage and siltation can occur where these soils are exposed.

Soil unit F has a high erosion hazard rating because of the erodible nature of the soil and the concentration of waterflow in the drainage channel.

Soils over the balance of the area are moderately to highly erodible if disturbed and construction activities should include erosion and sediment control measures.

Drainage.

Much of the area surveyed exhibits various degree of drainage problems.

Soils in Map Units D and E are subject to waterlogging during periods of protracted rainfall.

The soils in Unit C are subject to large amounts of run-on water from higher terrain units, and provision for disposal of this water must be made when planning urban development. Unit B soils are also subject to run-on from higher slopes.

Seasonal seepage patches occur on Map Unit C and D soils.

These soil and drainage characteristics will lead to problems in construction, especially traficability of construction vehicles and the laying of foundations and services. A limitation will also be placed on the use of these soils for on-site disposal of sewage effluent.

Shrink/swell Potential.

Although data is variable, soils with a generally moderate shrink/swell potential are found in Map Unit D. This soil property has consequences for the design criteria and installation of foundations for roads, pavements and buildings.

Revegetation.

Subsoils from all soil units have physical limitations to plant growth. Topsoiling of sites prior to revegetation will assist in maintaining an adequate vegetative cover. In critical areas, such as steep batters and vegetated water disposal areas, the respreading of topsoil will be essential for successful revegetation.

Use of Materials for Minor Earthwork Construction.

Minor earthworks include runoff control banks, small water holding dams, sediment basins and minor retarding basins.

Soils in Map Units C, D and E have dispersible subsoils, and adequate compaction during construction will be required to avoid tunnelling failure.

The shallowness of soils in Units A and B, and the high gravel and stone content of soils in Unit F, will present limitations to earthwork construction.

PART B

URBAN CAPABILITY

The Urban Capability map has been developed from an interpretation of the interaction of the physical features of the study area. It has been divided into a number of primary classes according to the physical limitations affecting each class and the assessed potential for urban development. Four primary classes of physical limitation are defined in the Urban Capability map as follows:-

Class B - Areas with minor to moderate physical limitations to urban development. These limitations may influence design and impose certain management requirements on development to ensure a stable land surface is maintained both during and after development.

Class C - Areas with moderate physical limitations to urban development. These limitations can be overcome by careful design and by adoption of site management techniques to ensure the maintenance of a stable land surface.

Class D - Areas with severe limitations to urban development which will be difficult to overcome, requiring detailed site investigation and engineering design.

Class E - Areas where no form of urban development is recommended because of very severe physical limitations to such development that are very difficult to overcome.

Within these primary classes a number of sub-classes are defined relating to the dominant constraint which will restrict development potential. Subscripts and the limitations to which they apply are as follows:-

d - shallow soil
e - soil erodibility
f - flooding
s - slope
t - topographic feature
w - seasonal waterlogging

The combination of two subscripts indicates physical features which interact to affect development.

The capability indicated 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 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 refers to the development of commercial complexes such as offices, shopping centres or industrial estates, which require large scale clearing and levelling for broad areas of floor space and parking bays. Residential development infers a level of construction which provides roads, drainage and services to cater for housing allotments of the order of 600 sq. metres or larger. 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 the construction of extensive building complexes does not exempt developers from normal site analysis procedures in designing building foundations and engineering roadways. Nor does it imply the capacity of the site to support multi-storey units for major structures. Before structural works of such magnitude are undertaken, a detailed analysis of engineering characteristics of the soil, such as bearing capacity and shear strength, may be necessary on the specific development site.

The assessment of capability is objectively based on physical criteria alone. Thus the classification of various areas as capable of accepting certain forms of development is an assessment of the capacity of those areas to sustain the particular level of disturbance entailed. It is not a recommendation that such a form of development be adopted.

Reference is made in the text that follows to various sections of the Soil Conservation Service Urban Erosion and Sediment Control Handbook. The sections referred to provide detailed guidance on relevant sediment and erosion control and stormwater management measures which might be adopted on this area.

Advice on specific aspects of these recommendations - such as seed and fertilizer mixture and rates, cultivation measures, and batter slopes - should be sought from the Gundagai Soil Conservation Service office when subdivision works commence.

Soil Conservation Service of N.S.W.

URBAN CAPABILITY STUDY

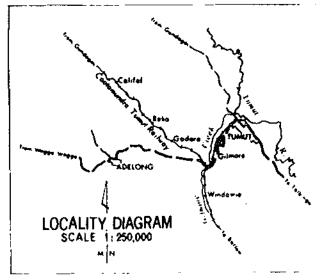
TUMUT SHIRE
INDUSTRIAL AREA

URBAN CAPABILITY

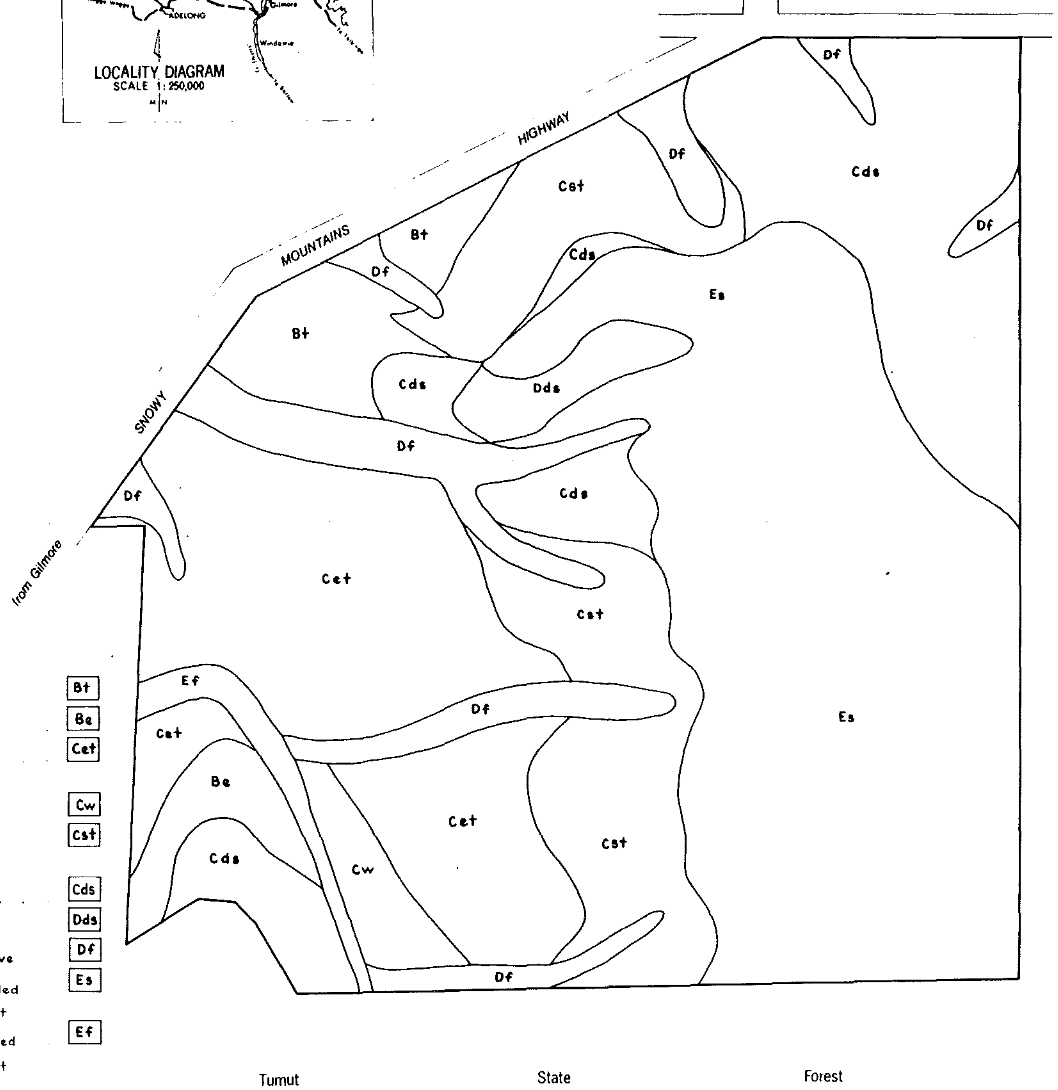
metres 50 25 0 50 100 150 200 metres

SCALE

M.N.



THE CLASSES AND ASSOCIATED CAPABILITIES DESCRIBED ON THIS MAP ARE A MEASURE OF THE CAPACITY OF LAND WITHIN THE STUDY AREA TO SUPPORT DIFFERENT INTENSITIES OF URBAN USE, BASED ONLY ON THE INHERENT STABILITY OF THAT LAND. THE MAP DOES NOT CONSTITUTE A RECOMMENDATION FOR THE PARTICULAR FORMS OF DEVELOPMENT INDICATED ON THE VARIOUS AREAS



LEGEND

DEGREE OF LIMITATION	MAJOR LIMITATION	CAPABILITY	
Minor to Moderate	Topographic feature	E.B.C. *	Bt
Minor to Moderate	Erodibility	Residential	Be
Moderate	Erodibility/ topographic feature	E.B.C.*	Cet
Moderate	Seasonal waterlogging	E.B.C.*	Cw
Moderate	Slope/ topographic feature	Residential	Cst
Moderate	Shallow soil/ slope	Residential	Cds
Severe	Shallow soil/ slope	Reserve	Dds
Severe	Flooding	Drainage Reserve	Df
Very Severe	Shallow soil/ slope	Not recommended for development	Es
Very Severe	Flooding	Not recommended for development	Ef

* Extensive Building Complexes

S.C.S. 15833/C

Sub-class B-t: Minor to moderate physical limitation - Topographic feature constraint - Suitable for extensive building complexes.

This sub-class comprises footslopes with map unit B soils. Slope gradients are generally around 5 percent, with small pockets of land with gradients between 5 and 10 percent.

A constraint to development of this sub-class land is its location below steep hillslopes, where it is subject to surface run-on. This run-on will cause sheet and rill erosion during the construction phase. Diversion of this run-on may be achieved by strategic location of roads and associated stormwater installations on upper slopes. The maintenance of adjacent drainage reserves (sub-class D-f) will provide a safe disposal area for this water.

Although slope gradients are not severe, extreme care is required during any large scale levelling to prevent serious erosion.

With these provisions, and attention to the guidelines in Sections 2 and 6 of the Urban Erosion and Sediment Control Handbook and in Appendix I, sub-class B-t land may be used for the development of commercial or industrial complexes or for residential development without serious erosion occurring.

Sub-class B-e: Minor to moderate physical limitation - Erodible soil constraint - Suitable for residential development.

This sub-class comprises sideslopes in the southwestern corner of the site with soils of map unit C. Slope gradients range from 5 to 10 percent.

The erosion hazard associated with this land is high. Careful management of the soil during construction will be required to prevent erosion.

Uncontrolled development of B-e land will lead to sheet and rill erosion, minor gully erosion, erosion of cut and fill batters, and siltation of local drainage lines.

The development of extensive building complexes, requiring large scale cut and fill for levelling, is therefore not recommended as this would generate an unacceptable level of erosion and siltation. Land in this sub-class may be used, however, for residential subdivision.

The control of erosion and siltation will be essential during construction, and guidelines in Appendix I, and in Sections 2 and 6 of the Urban Erosion and Sediment Control Handbook should be followed.

Sub-class C-et: Moderate physical limitations - Erodible soil and topographic feature constraints - Suitable for extensive building complexes.

This sub-class comprises footslopes in the southwest of the area. Soils occurring on this land are the yellow duplex soils of map unit C. The majority of this sub-class has slope gradients of approximately 5 percent, however the upper slopes have gradients of up to 10 percent.

Soil erodibility is high and the erosion hazard is further accentuated by run-on and areas of seepage from higher slopes. Control of this run-on will be essential to prevent serious erosion occurring during the construction phase of urban development and to ensure long term stability. The use of on-site effluent disposal methods will further aggravate site drainage problems, and should be investigated further.

Diversion of run-on may be achieved by strategic location of roads and associated stormwater installations on higher slopes. The drainage reserve (sub-class D-f) shown within this land must be retained to provide a safe disposal area for runoff water.

This sub-class land may be suitable for extensive building complexes, requiring large scale cut and fill for levelling, provided adequate recognition is given to the severe erosion and siltation hazard such disturbance might generate. On slopes approaching 10 percent gradient it should be recognized that large scale cut and fill for levelling will create massive soil disturbance.

Residential development would be a much more acceptable land use on the steeper slopes within this sub-class, reducing the hazard of surface instability.

During development the guidelines in Appendix I and in Sections 2, 4.5 and 6 of the Urban Erosion and Sediment Control Handbook should be followed.

Sub-class C-w: Moderate physical limitation - Seasonal waterlogging constraint - Suitable for extensive building complexes.

This sub-class land consists of a low-lying footslope and drainage plain terrain on soil of map unit D, with gradients ranging up to 5 percent.

These soils have low permeability and are subject to poor surface drainage, so that seasonal waterlogging can be expected. These low-lying areas also receive run-on from the slopes above which compounds the problem. Control of surface runoff can be achieved by strategically locating roads and associated stormwater installations on higher slopes.

If on-site effluent disposal systems are used, areas in this sub-class are liable to suffer wetness and pollution from local absorption fields. The adjacent drainage line may also be polluted by effluent seeping from this land.

In addition to poor site drainage, soils in this sub-class have moderate to high erodibility.

With provision for appropriate surface and sub-surface drainage, and appropriate erosion and sediment control measures, this land may be suitable for extensive building complexes.

To allow for development of some sites imported fill material may be required. Fill material should be clean and coarse and topsoil should be stripped and stockpiled prior to placement of the fill. Areas of fill not to be built upon immediately should be re-surfaced with topsoil prior to establishing vegetation.

Attention should be paid during development to guidelines in Appendix I and to Sections 2, 4.5 and 6 of the Urban Erosion and Sediment Control Handbook.

Sub-class C-st: Moderate physical limitations - Slope and topographic feature constraints - Suitable for residential development.

This sub-class consists mainly of upper footslopes on soils of map unit B with gradients ranging from 10 to 20 percent. Some areas of drainage plain terrain also occur in this sub-class.

Sub-class C-st has similar limitations to sub-class B-t but, because of the steeper slope gradients, the erosion hazard associated with development is increased.

Uncontrolled development of this sub-class may lead to severe sheet and rill erosion, minor gully erosion and erosion of cut and fill batters.

This land is suitable for residential development provided attention is paid to the slope limitation and run-on characteristics. On slope gradients approaching 20 percent, however, it should be recognised that cut and fill earthworks will be extensive. The potential for surface instability would be reduced if the steeper slopes were allocated as yard space for house sites located on lower grades.

Attention should be paid during development to guidelines in Appendix I and to Sections 2, 4.5 and 6 of the Urban Erosion and Sediment Control Handbook.

Sub-class C-ds: Moderate physical limitations - Shallow soil and slope constraints - Suitable for residential development.

This sub-class occurs on sideslopes and footslopes with gradients of 10 to 20 percent. Soils are the shallow stony soils of map unit A.

The erosion hazard associated with soils in this sub-class is high. In some areas the erosion hazard is further accentuated by runoff emanating from steeper slopes immediately above.

Uncontrolled development of C-ds land will lead to sheet and rill erosion, minor gully erosion, erosion of cut and fill batters and siltation of local drainage lines.

The shallow soil depth places a limitation on effective absorption of septic effluent and may also restrict trenching activities for services.

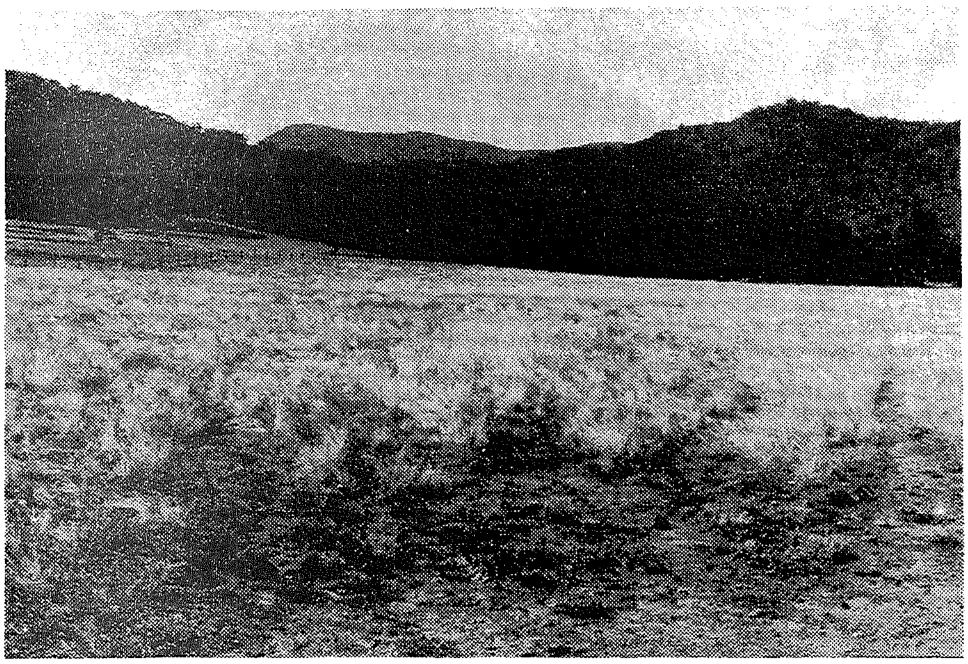
This sub-class land is suited to residential development. On the slopes approaching 20 percent gradient, however, it should be recognised that cut and fill earthworks will be fairly extensive, and excavation difficult and expensive due to the shallowness of the soil. Potential for surface instability would be reduced if the steeper slopes were allocated as yard space for house sites located on lower grades.

Attention should be paid during development to guidelines in Appendix I and to Sections 2, 4.5 and 6 of the Urban Erosion and Sediment Control Handbook.

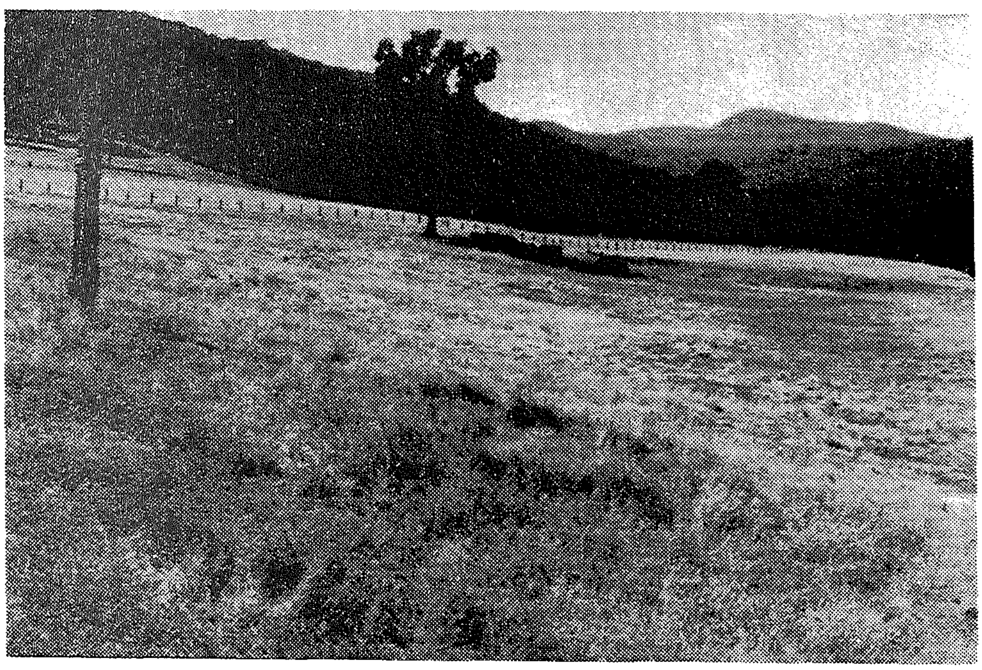
Sub-class D-ds: Severe physical limitations - Shallow soil and slope constraints - Suitable for reserve.

This sub-class land comprises an area of steep sideslopes in the northwest of the site with slope gradients between 20 and 25 percent. Shallow soils of map unit A occur within this sub-class.

Sub-class D-ds land has similar limitations to sub-class C-ds land but, because of the steeper gradients, the erosion hazard



Sub-class C-et land in the foreground is subject to run-on water from higher slopes. The drainage plain (Sub-class D-f land) running across the photograph, just above centre, should be maintained to provide a safe disposal area for this water.



The low lying land to the right of this photograph comprises Sub-class C-w land, while the adjacent footslopes fall into Sub-class C-et and Sub-class C-st. The steep timbered slopes in the background comprise Sub-class E-s land.

associated with development is increased.

Residential development is not suited to this area due to the very high erosion hazard associated with any site disturbance, and the constraints on servicing and septic effluent disposal systems imposed by the shallow soils. The most intensive use recommended for this land is passive recreation or yard space for houses built on more gentle slopes adjacent. Good vegetative cover should be retained at all times.

If more intensive development is proposed, detailed site investigations must be carried out.

Guidelines contained in Sections 2, 4.1 and 6 of the Urban Erosion and Sediment Control Handbook will assist in development of this land class.

Sub-class D-f: Severe physical limitation - Flooding constraint - Suitable for drainage reserve.

This sub-class comprises most of the drainage lines on the site. Soils of map unit E are the most common, but some areas of map units B, C and D soils also occur.

This land is subject to periodic runoff flows which will cause serious erosion if the land surface is left unprotected. Building development is not recommended due to the risk of flooding and undermining of development works.

Urban development will increase the volume and frequency of flows within the drainage lines. To reduce the impact of this on flooding and creek bank erosion downstream, it is recommended that the drainage lines be developed as grassed drainage reserves. Recommendations for the establishment of drainage reserves are given in Appendix II.

The establishment of sediment basins is recommended to control the heavy sediment load anticipated following large scale disturbance of these lands for industrial or residential development. This measure will ensure that sediment does not leave the site and cause siltation and drainage problems on adjoining lands.

Stormwater management is discussed in detail in Section 3 of the Urban Erosion and Sediment Control Handbook, while Section 6, which covers revegetation principles and techniques, is also relevant to the establishment of drainage reserves.

The dam in the foreground is located in a drainage reserve (Sub-class D-f land) in the central portion of the study area. Above the dam the drainage reserve branches to the left and right. The steep slopes in the background comprise Sub-class E-s land, while the lower slopes are classified as Sub-class C-ds and Sub-class C-st land.

Shallow depth of soil is a characteristic feature of the soils in map unit A.

Sub-class E-s: Very severe physical limitation - Slope constraint - Not recommended for development.

This sub-class land comprises a large portion of steep sideslopes in the eastern section of the area, where slope gradients exceed 25 percent. Soils are the shallow soils of map unit A.

The erosion hazard of soils in this sub-class is very high.

Any increase in loading by building construction, or in slope angle by cut operations, will lead to soil instability problems and the possibility of local slope failure. Disturbance of these shallow soils will affect lower land by erosion debris washing downslope.

Removal of trees and shrubs, even without any further surface disturbance, would itself increase the hazard of erosion.

It is therefore recommended that this land remain undisturbed. Maintenance of a good vegetative cover will protect it against serious erosion.

Sub-class E-f: Very severe physical limitation - Flooding constraint - Not recommended for development.

This sub-class comprises the bed and bank of the incised drainage channel in the southwest section of the area. Soils are the alluvial soils of map unit F.

The erosion hazard within this sub-class is very high due to the combination of flood risk and high soil erodibility.

Apart from occasional clearing to remove obstructions to flows, or the installation of sediment control measures, this channel should be left in its natural state.

A high degree of bank erosion is a potential hazard associated with clearing or other unnecessary disturbance, particularly if high flows occur while the channel environs are disturbed. Such enterprises should therefore be carefully controlled, to minimise the area disturbed along the banks at any one time, and to re-establish grass cover on disturbed areas.

Where the adjacent D-f drainage reserves flow into this sub-class, grade control structures and energy dissipators will be required to reduce the hazard of gully head erosion.

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PART C

APPENDICES

APPENDIX I

PRINCIPLES AND GUIDELINES FOR SEDIMENT AND EROSION CONTROL

PRINCIPLES AND GUIDELINES FOR SEDIMENT AND EROSION CONTROL.

Proper planning in urban development will maintain the quality of the environment and reduce the severity of soil erosion and sedimentation problems. To deal with these problems, it is recommended that erosion and sediment control principles be included in any development plan. These principles should provide for the use of vegetative and structural measures to provide surface protection to exposed soils.

The technical principles of erosion and sediment control involve:

(i) Reducing the area and the duration of exposure of soils.

(ii) Covering exposed soil with mulch and/or with vegetation.

(iii) Delaying runoff using structural or vegetative measures.

(iv) Trapping sediment in runoff.

Points (iii) and (iv) and discussed in Appendix II, while points (i) and (ii) are broadly covered in the following guidelines.

These guidelines are aimed at the control of erosion and siltation during development of the site. They should be applied once a development form has been selected that is compatible with the physical conditions of the site. Specific advice on the implementation of these can be provided from the Gundagai office of the Soil Conservation Service, while greater detail on these and other measures for erosion control and stormwater management on developing areas is provided in the Urban Erosion and Sediment Control Handbook.

(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 re-spreading. 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. This can be provided by a cover crop such as Japanese millet sown in spring/summer or Wimmera ryegrass and ryecorn sown in autumn/winter, or by treatment with a surface mulch of straw or a chemical stabilizer.

(e) Where appropriate, exposed areas such as construction sites may 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. Cut and fill and general grading operations should be restricted to the minimum essential for development.

(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) When excavations are made for conduits, topsoil and subsoil should be stockpiled separately. Subsoil should be replaced in the trench first with 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 trench lines to prevent erosion, particularly on long, steep slopes.

(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 areas or on highly erodible soils. Topsoil from these areas should be stockpiled, and erosion control earthworks may be constructed to protect them from upslope runoff.

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

(m) Cut and fill batters should be formed to a safe slope. Where vegetative - rather than structural - stabilization is proposed, early revegetation of exposed batters is essential.

(i) Plant species which might be considered for seed mixtures 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 recommendation on mixtures and application rates will be provided, on request, from the Gundagai Soil Conservation Service office.

(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 stabilization technique. A mixture of seed, fertilizer, wood or paper mulch and water is sprayed onto the batter through a specifically designed applicator. This is a simple and effective technique for vegetating batters.

(v) Establishment of vegetation is most assured of success if seed is sown in autumn or spring. However, if seed is sown in spring, provision for watering may be required during summer.

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

(vii) Batters may 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 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 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. The range of species which may be considered for general revegetation work includes kikuyu, paspalum, carpet and couch grasses for spring/summer establishment, and couch or perennial rye for autumn/winter establishment.

(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, from the Gundagai Soil Conservation Service 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 fertilizer is necessary in the early years of establishment, while mowing will control weeds and promote a vigorous turf.

APPENDIX II

ESTABLISHMENT OF DRAINAGE RESERVES AND SEDIMENT BASINS

ESTABLISHMENT OF DRAINAGE RESERVES AND SEDIMENT BASINS.

In the event of a more intense form of land use occurring at a site, a number of significant hydrological changes will occur. Unless these changes are effectively controlled they may cause local flooding, channel erosion and sedimentation. These may in turn cause erosion damage to existing or future development works in the vicinity of drainage channels.

The principles of stormwater management are outlined in Section 1 of the Soil Conservation Service Urban Erosion and Sediment Control Handbook, while detailed discussions on the implementation of such techniques is given in Section 3. The following discussion outlines specific recommendations for stormwater management within this area.

The suggested approach to the control of erosion, sedimentation and stormwater runoff involves formation of grassed drainage reserves and the installation of sediment retarding basins on them.

Development of Drainage Reserves

The benefits of grassed reserves include:

(i) lower velocities of flow and increased channel storage, which result in a longer time of concentration and lower flood peaks downstream;

(ii) green belts can be developed along the reserves, providing an attractive break in subdivision. These may be used for recreation and incorporate cycle or pedestrian paths;

(iii) grassed reserves encourage filtration and/or settlement of pollutants such as silt and oil, washed from urban areas. By comparison, these would flow freely through stormwater pipes or lined channels.

Urban development should not encroach onto the drainage reserves so that they can provide for unimpeded flood flows.

To develop the reserves, existing flowlines should be shaped into broad, shallow, parabolic waterways. These should be of sufficient width to carry flows at a velocity not exceeding two metres per second. Flows of greater velocity scour vegetated channels, and structural lining is then required. Specific engineering design to cater for expected flows is required prior to construction.

Trickle flows may be catered for by providing an underground pipe with sufficient capacity to handle minor flows or by locating a half pipe or a lined invert along the centre of the channel. Without this provision, continuous trickle flows will erode the channel floor, while rushes, sedge and other water-loving plants will proliferate along the trickle path.

After formation, the reserves should be stabilized with vegetation. A heavy dressing of fertilizer should be applied at sowing, and follow-up applications of fertilizer will be necessary. Stabilization 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.

Installation of Sediment Retarding Basins.

These are small temporary storages located on flow lines. Their primary function is to hold runoff temporarily and trap the sediment it is carrying. A potential secondary function is to provide flood storage. They are designed to drain completely and to retain their effectiveness, sediment should be regularly removed. Good access is required to facilitate sediment removal from the basin floor.

Development of sediment basins would be most advantageous prior to the construction of drainage reserves.

The desirability of locating sediment basins on drainage reserves within this proposed industrial site must be highlighted.

APPENDIX III

SOIL DESCRIPTIONS AND LABORATORY ANALYSES OF SOILS

TABLE 3. DESCRIPTION OF SOIL UNITS - TUMUT SHIRE INDUSTRIAL AREA

MAP UNIT	NAME	NORTHCOTE CODE AND VARIANTS	DESCRIPTION
A	Shallow Stony Soils	Uc 1.21, Dy 2.22 Variants Dr 2.22 Dy 2.12	These shallow stony soils occur as steep slopes in the east of the area. Shallow sandy loams (Uc 1.21) are common while yellow and red duplex soils (Dy 2.22 and Dr 2.22) occur where the soil profile is more developed. The duplex soils have a hard-setting, dark brown, sandy loam A horizon 5-10 cm deep. A2 horizons are frequently present. There is a clear colour and texture boundary to the B horizon. The B horizon is a bright brown to yellowish brown clay loam. Bedrock occurs at less than 50 cm depth and some rock outcrops occur.
B	Moderately Shallow Yellow Duplex Soils	Dy 2.21, Dy 2.22	Hard, dark brown, sandy loam A1 horizon to 5 cm deep. The A2 horizon has sandy loam to sandy clay loam texture, massive structure and is up to 25 cm thick. There is a clear colour and texture boundary to the B horizon. The B horizon is a bright brown to yellowish brown sandy clay. Soil reaction trends are acid to neutral. Bedrock occurs at between 50 and 100 cm depth.

TABLE 3. (CONTINUED)

MAP UNIT	NAME	NORTHCOTE CODE AND VARIANTS	DESCRIPTION
C	Yellow Duplex Soils	Dy 2.42 Variants Dy 2.22 Dy 2.12, Dr 2.11	A1 horizons are typically 10-20 cm deep, brown to dark brown in colour and with light sandy clay loam to sandy clay loam texture. Structure is apedal to weak. A2 horizons are frequently present. These are usually bleached, with sandy clay loam texture and may be up to 60 cm thick. There is a clear colour and texture boundary to the B horizon. The B horizon is a bright reddish brown to bright yellowish brown, light to medium clay. Soil reaction trends are neutral. Other soil types present include red duplex soils with reddish brown B horizons (Dr 2.11). Depth to bedrock is greater than 100 cm.
D	Deep Mottled - Yellow Duplex Soils	Dy 3.42 Variant Dy 2.42	A horizons are 20-30 cm deep and have silty loam to silty clay loam texture. A1 horizons are typically 5-15 cm deep and greyish brown in colour. Below these occur bleached A2 horizons 10-15 cm thick. Some nodules occur in the A2 and upper B horizons. There is a clear colour and texture boundary to the B horizon. The B horizon is a yellowish brown silty clay to medium clay which is usually mottled grey. Soil reaction trends are neutral. Depth to bedrock is greater than 200 cm.

TABLE 3. (CONTINUED)

MAP UNIT	NAME	NORTHCOTE CODE AND VARIANTS	DESCRIPTION
E	Mottled - Yellow Duplex Soils	Dy 3.42, Dy 3.12 Variants Dy 2.42 Dy 3.22, Ug	A1 horizons are typically 5-40 cm deep, dark brown in colour and with sandy clay loam texture. Bleached A2 horizons are often present and are approximately 30 cm thick. There is a clear colour and texutre boundary to the B horizon. The B horizon is a yellowish brown medium to heavy clay which is frequently mottled. Soil reaction trends are neutral. Small areas of uniform heavy clay soils (Ug) also occur. Depth to bedrock is usually greater than 200 cm.
F	Alluvial Soils		Soils are variable. Includes loamy soils with up to 80% gravel and stones in the bed of the creek, and, some exposed rock.

TABLE 4. FIELD DESCRIPTIONS OF SOIL PROFILES - TUMUT SHIRE INDUSTRIAL AREA

MAP UNIT	PROFILE NO.	NORTHCOTE CODE	TEXTURE A HORIZON	DEPTH A HORIZON cm	DEPTH TO BEDROCK cm
A	3	Uc 1.21	Sandy loam	10	10
Shallow	4	Dy 2.22	Sandy loam	10	30
stony soils	5	Uc 1.21	Sandy loam	10	10
Uc 1.21	34	Dy 2.12	Sandy loam	10	15
+ shallow B's	40	Dy 2.22	Sandy loam	20	50
	43	Dy 2.12	Sandy loam	10	30
B	10	Dy 2.22	Sandy loam	30	60
Mod shall	13	Dy 2.22	Sandy loam	30	70
Yellow Duplex	14	Dy 2.22	Sandy loam	20	50
	33	Dy 2.21	Sandy loam	20	80
Dy 2.21, 22	41	Dy 2.21	Light sandy clay loam	25	80
	42	Dy 2.21	Light sandy clay loam	25	80
C	6	Dy 2.12	Silt loam	10	
	9	Dy 2.42	Sandy clay loam	70	>100
Yellow	15	Dy 2.42	Light sandy clay loam	60	>100
Duplex	26	Dr 2.11	Light sandy clay loam	30	>200
	28	Dy 2.42	Light sandy clay loam	35	>100
	32	Dy 2.22	Sandy clay loam	30	150
	35	Dr 2.11	Light sandy clay loam	10	>100
	31	Dy 2.12	Silty clay loam	10	>100
D	7	Dy 3.42	Silt loam	25	300
Mottled	20	Dy 3.42	Silt loam	25	> 200
Yellow Duplex	30	Dy 2.42	Silty clay loam	30	> 200
E	8	Dy 3.32	Silt loam	15	>100
	12	Dy 3.12	Sandy clay loam	6	>200
	19	Dy 3.12	Sandy clay loam	5	>100
	29	Dy 3.12	Sandy clay loam	20	> 200
	36	Dy 3.21	Fine sandy clay loam	30	> 200
F	37	Dy 3.42	Sandy clay loam	35	> 200
Ml.	38	Dy 2.42	Sandy clay	50	> 200
	39	Dy 3.42	Sandy clay loam	70	>100

TABLE 5. PROPERTIES OF MAJOR SOILS - TUMUT SHIRE INDUSTRIAL AREA

MAP UNIT	A	B		C	
Northcote Code	Dy 2.22	Dy 2.21		Dy 2.42	
Depth to bedrock	Less than 50 cm	50-100 cm		Greater than 100 cm	
Profile drainage	Good	Good		Moderate	
Sample depth (cm)	10-30	5-20	25-50	10-60	60-100
USCS code	SC	SM, SC	SC, CL	ML, SM	CL, ML, SM
Liquid limit %	40	29 (28-30)	36 (28-43)	29 (28-30)	40 (35-45)
Plasticity Index	10	7 (4-10)	15 (9-20)	5	12
Linear shrinkage %	5	3 (2- 3)	5 (3- 7)	4 (3- 4)	5 (4 - 8)
Dispersal Index	2.4	3.5 (3- 4)	4.4 (4.3-4.5)	2.1 (2.2-2.0)	2.8 (2.7-3.0)
Erodibility	High	Moderate		High	
Suitability for ponds	Poor	Poor		Moderate	
Topsoil quality	Poor	Moderate		Moderate	
Ease of revegetation	Poor	Poor		Poor	

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TABLE 5. (CONTINUED)

MAP UNIT	D		E	
Northcote Code	Dy 3.42		Dy 3.42	
Depth to bedrock	Greater than 200 cm		Greater than 200 cm	
Profile drainage	Poor		Poor	
Sample depth (cm)	15-30	50-100	20-50	40-100
USCS code	ML, CL	MH, CL	CL	CL, CH
Liquid limit %	40 (38-42)	47 (43-51)	35 (27-45)	52 (47-57)
Plasticity Index	15 (11-18)	21 (16-26)	14 (6-22)	26 (21-34)
Linear shrinkage %	5	9 (6-12)	4 (3-6)	8 (6-10)
Dispersal Index	4.8 (2.7-6.8)	2.9 (2.3-3.5)	3.0 (2.9 - 3.4)	3.9 (2.5-5.8)
Erodibility	Moderate to high		Moderate to high	
Suitability for ponds	Good		Good	
Topsoil quality	Good		Moderate	
Ease of revegetation	Moderate		Poor to Moderate	

TABLE 5. (CONTINUED)

MAP UNIT	F
Northcote Code	
Depth to bedrock	
Profile drainage	
Sample depth (cm)	
USCS code	
Liquid limit %	
Plasticity Index	
Linear shrinkage %	
Dispersal Index	
Erodibility	High
Suitability for ponds	Poor
Topsoil quality	Poor
Ease of revegetation	Poor

TABLE 6. LABORATORY ANALYSES FOR INDIVIDUAL SOIL PROFILES - TUMUT SHIRE INDUSTRIAL AREA

MAP UNIT	Site No.	Depth (cm)	Clay %	Silt %	Fine Sand %	Coarse Sand %	Gravel %	Stones %	L.L.* %	P.I.*	USCS	D.I.*	L.S.* %	E.A.T.*
A	4	10- 30	15	15	8	20	17	25	40	10	SC	2.4	5	3
B	33	5- 20	11	11	15	25	17	21	28	4	SM	4.0	2	3
		20- 40	39	13	14	16	9	9	43	20	CL	4.5	7	5
	41	0- 2	15	16	17	43	4	4				19.0	5	**
		2- 25	21	16	23	37	2	1	30	10	SC	3.0	3	5
		25- 60	20	14	12	44	6	4	28	9	SC	4.3	3	5
C	9	10- 70	20	20	23	20	11	7	30	5	ML	2.2	4	2
		70- 80	33	25	12	13	10	8	45	12	ML	3.0	8	2
		80-100	22	14	11	25	17	11	39	12	SM-SC	2.8	4	2
	15	10- 60	9	12	11	26	19	24	28	5	SM-SC	2.0	3	2
		60- 80	26	16	16	23	8	11	35	12	CL	2.7	4	2
	32	0- 10	16	20	49	14	1	1	36	10	CL	4.5	2	7
		10- 30	14	11	33	11	7	24	25	7	SC	4.0	2	3
		40- 70	19	12	18	19	18	12	31	14	SC	3.6	4	2
		70-100	37	15	18	11	7	11	49	25	CL	3.4	8	2
	35	10- 30	27	16	16	20	13	8	31	13	CL	4.7	5	5
		30- 50	26	11	13	31	12	7	34	14	SC	5.2	5	5
	31	0- 10	26	30	34	10	0	0	37	12	ML	4.0	4	7
		50- 70	42	15	15	12	6	10	52	27	CH	4.4	6	5

* L.L. - Liquid Limit

* P.I. - Plasticity Index

*E.A.T. - Emerson Aggregate Test

* D.I. - Dispersal Index

* L.S. - Linear Shrinkage

** - Insufficient sample

TABLE 6. (CONTINUED)

MAP UNIT	Site No.	Depth (cm)	Clay %	Silt %	Fine Sand %	Coarse Sand %	Gravel %	Stones %	L.L.* %	P.I.*	USCS	D.I.*	L.S.* %	E.A.T.*
D	20	5- 20	26	44	20	10	0.	0	38	11	ML	6.8	5	2
		25- 50	52	32	15	1	0	0	51	16	MH	3.5	12	2
	30	0- 15	32	38	22	8	0	0	53	23	MH	4.3	6	5
		15- 30	37	29	13	18	2	1	42	18	CL	2.7	5	5
		85-100	48	20	14	18	0	0	43	26	CL	2.3	6	2
E	19	10- 30	31	26	22	8	10	3	37	10	ML	2.3	7	2
	29	0- 10	20	38	38	4	0	0	51	12	MH	8.0	4	8
		20- 45	52	22	14	12	0	0	54	29	CH	2.8	7	3
		30- 50	44	30	20	6	0	0	42	22	CL	3.1	4	5
		70-100	41	18	18	5	6	12	57	34	CH	3.7	8	5
	36	5- 30	22	22	47	9	0	0	27	6	CL-ML	7.0	3	5
		30- 60	54	13	21	6	2	4	54	31	CH	7.6	10	2
	37	5- 35	21	25	31	12	7	4	27	6	CL-ML	2.9	3	3
		35- 50	46	23	21	6	2	1	50	24	CL-CH	5.8	8	5
		80-100	32	24	19	10	8	7	47	21	CL	3.0	6	5
	38	0- 20	24	34	35	7	0	0	45	12	ML	4.8	5	7
		20- 50	50	30	13	7	0	0	45	22	CL	3.4	6	5
		50- 90	65	23	9	1	1	1	56	24	MH	4.3	10	5
		90-130	60	26	14	0	0	0	50	28	CL-CH	2.5	7	2
	39	2- 40	27	20	13	38	1	1	41	17	CL	4.0	4	3
		40- 70	32	20	11	36	1	0	33	13	CL	2.6	4	2

APPENDIX IV

GLOSSARY OF TERMS

GLOSSARY OF TERMS

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. (See Lambe and Whitman, 1969, p. 33).

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.) (1978).

Emerson Aggregate Test (E.A.T.)

The Emerson Aggregate Test 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 to 6 generally represent aggregates from the soils which are highly, moderately, slightly and non-dispersible respectively.

Soil Erodibility and Erosion Hazard

The erodibility of soil material is an inherent property of that material. It is directly related to those basic properties which make the material susceptible to detachment by erosive forces and which prevent the soil absorbing rain, thus causing runoff. The erosion hazard of a given soil in the field is also controlled by soil profile and landform characteristics, run-on and land use. The qualitative categories for soil erosion hazard adopted by the Soil Conservation Service of New South Wales are low, moderate, high, very high and extreme.

Linear Shrinkage

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 1289, Testing Soils for Engineering Purposes (1977).

Shrink/swell potential is related to linear shrinkage values as follows:

		%
Low	Non-critical	0 - 12
Moderate	Marginal	12 - 17
High	Critical	17 - 21
Very High	Very critical	$>$ 21

Northcote Code

The Northcote Code represents the characterization 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 code 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). The properties are defined in Northcote (1974).

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).

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.

A full description of the system is given by Casagrande (1948) or Lambe and Whitman (1969).

Descriptions used in Tables 6 and 7 are:

CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.

CH Inorganic clays of high plasticity, fat clays.

MH Inorganic silts, micaceous or diatomaceous fine, sandy or silty soils, plastic silts.

ML Inorganic silts and very fine sands, rock flour, silty or clayer fine sands with slight plasticity.

SC Clayey sands, poorly graded sand-clay mixtures.

Soil Permeability

Permeability is a property of the soil which governs the rate at which water moves through it. It influences soil drainage.

Soil Drainage

Soil drainage provides an indication of the period for which a profile may be wet during the year. A soil which is very poorly drained may be near saturation for most of the year, while one with very good drainage will be saturated only during or immediately after heavy rainfall.

Topography or Terrain

This refers to the position of a site in the landscape. The various classes of terrain affect run-on amount and drainage conditions.

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