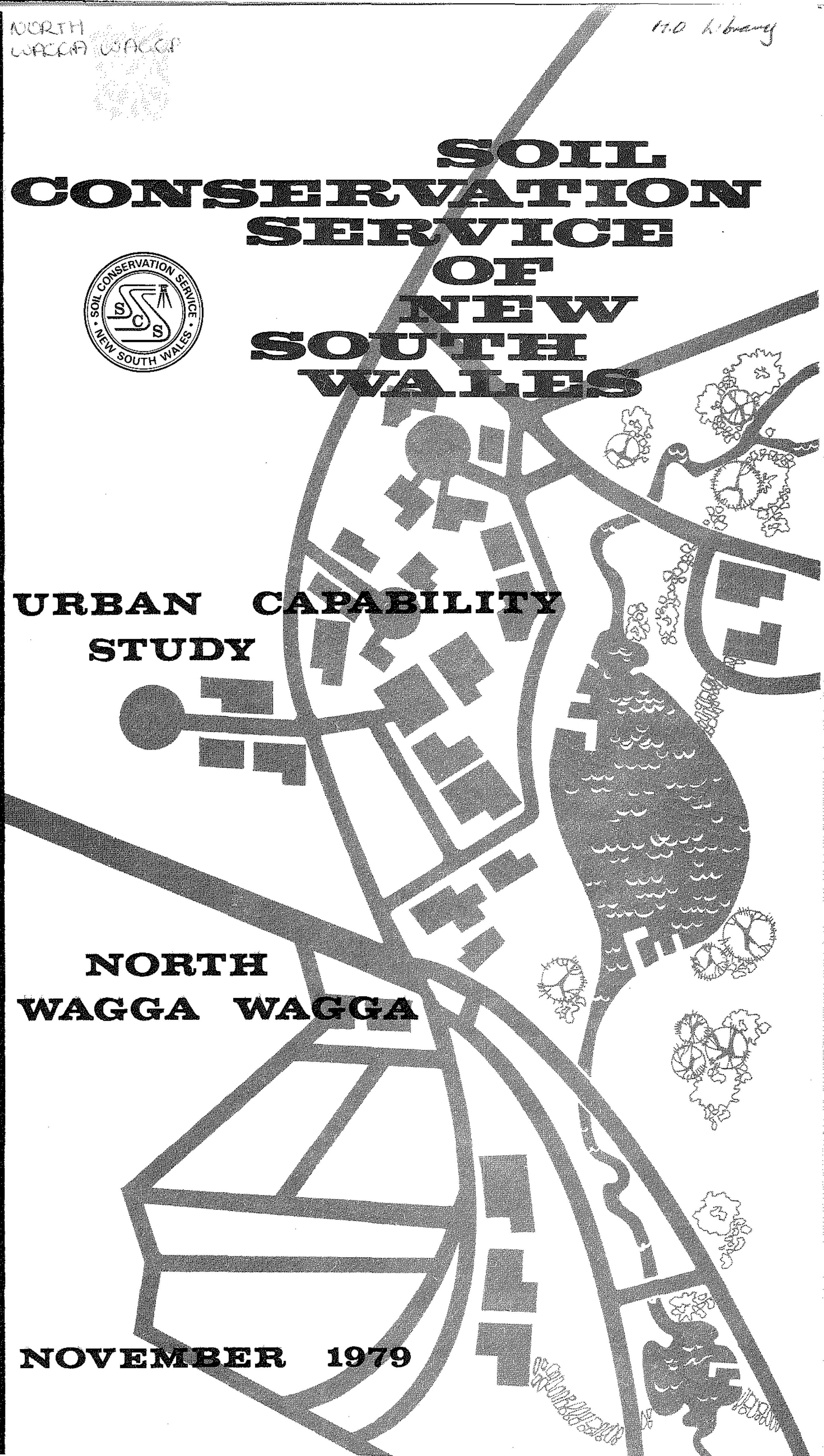
SOIL CONSERVATION SERVICE OF NEW SOUTH WALES



URBAN CAPABILITY STUDY

NORTH WAGGA WAGGA

NOVEMBER 1979

SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

URBAN CAPABILITY STUDY

NORTH WAGGA WAGGA

Report prepared for

Wagga Wagga City Council

COPY 1.

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November, 1979

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 12847/A -Z.
These full size maps have been scanned and named "UC_North Wagga_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 area to sustain various intensities of urban use.

While the maps are intended to assist in subdivision (regional) 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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SUMMARY

The study area occupies 445 hectares of mostly undulating land adjoining the Murrumbidgee River floodplain.

Over most of the site, slope gradients range from 2 to 10 per cent. There are two areas of steeper rocky land with slopes greater than 20 per cent. One of these is in the south of the area, and the other north of Cooramin Street.

Drainage is predominantly in a south to southeasterly direction, with most runoff being directed to the Murrumbidgee River.

Nine soil units have been mapped. Their principal parent material is granite of the Wantabadgery series of the Lower Ordovician Period. Differences in soil morphology are a reflection of the topographic position of the profile.

Soil drainage ranges from good to poor, and soil erodibility ranges from moderate to high. Unit A soils are shallow with a maximum depth of 80 cm and in places considerably less than this. Isolated rock outcrops occur over the site. Planning will need to take this into account wherever excavation is necessary.

The land has been classified into 14 urban capability classes, which are summarised in Table 1. Over 50 per cent of the area is suitable for development with extensive building complexes. Between 5 and 10 per cent is unsuitable for commercial, industrial or residential development, and should be used for drainage or flood reserves.

TABLE 1. Summary of Urban Capability Classes - North Wagga Wagga.

CLASS		LIMITATIONS	CAPABILITY
1.	A-0	Nil	Extensive Building Complexes
2.	A-3d	Erodible soil/ drainage	Extensive Building Complexes
3.	A-5	Rock outcrop	Extensive Building Complexes
4.	B-1	Slope	Residential
5.	B-3	Erodible soil	Residential
6.	B-3d	Erodible soil/ drainage	Residential
7.	B-4	Disturbed terrain	Residential
8.	B-5	Rock outcrop	Residential
9.	C-1,5	Slope/rock outcrop	Low density residential
10.	C-3d	Erodible soil/ drainage	Low density residential
11.	D-1,5	Slope/rock outcrop	Reserve
12.	D-2	Floodplain	Reserve
13.	D-2,3	Flooding/erodible soil	Drainage reserve
14.	D-2,5	Flooding/rock outcrop	Drainage reserve

INTRODUCTION

The North Wagga Wagga Urban Capability Study area, is located north of the Murrumbidgee River, adjacent to the floodplain, and is proposed for urban development by Wagga City Council. Total area is approximately 445 ha.

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

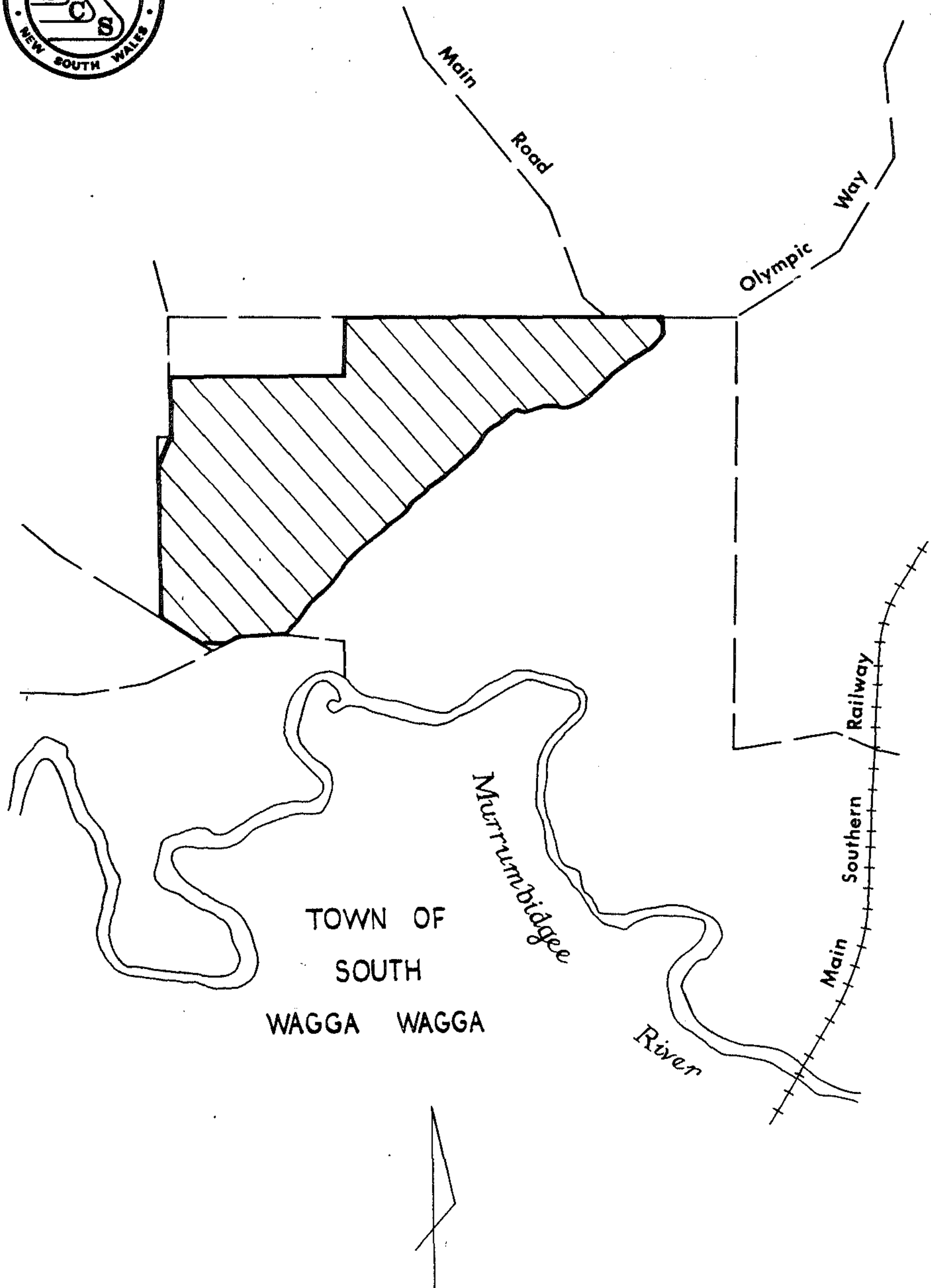
Soils have been surveyed and mapped onto a 1:4000 scale base plan. The characteristics of the soils relating to profile stability and erodibility have been assessed.

Terrain, slope and drainage pattern have been studied by aerial photograph interpretation and detailed field checking. These features are presented on base maps at a scale of 1:4000.

The landform and soils data have been interpreted to produce an urban capability map at the same scale.

While originals of the soils, landform and urban capability maps have been prepared at the scale indicated above, copies presented in this report are reduced in scale for convenience of presentation.

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



LOCALITY DIAGRAM

NORTH WAGGA WAGGA

URBAN CAPABILITY STUDY

INVENTORY OF PHYSICAL FEATURES

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

1. Climate.
2. Landform.
3. Geology and soils.

1. Climate

Mean annual rainfall is 567 mm most of which falls during winter, but, significant rainfall is also received in autumn and spring. Rainfall is most reliable during winter and early spring. Summers are relatively dry and warm to hot, while winters are cool.

Existing vegetation adapted to these conditions is dominated by winter annual grasses and clovers. Couch grass is the main perennial plant.

High intensity rainstorms in summer are a feature of the rainfall pattern (Table 2). These storms may cause severe erosion of the highly erodible soils of the area.

Rainfall intensities shown in Table 2 have been derived using data from Wagga Wagga Soil Conservation Research Centre.

Table 2. Rainfall Intensities (mm/hr) for Various Durations and Return Periods - Wagga Wagga Research Centre.

Duration (Minutes)	Return Period (years)					
	2	5	10	20	50	100
10	80	120	141	168	200	230
15	60	87	104	123	147	170
20	48	72	85	103	122	141

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

Satisfactory plant growth during the summer is less likely than during winter, with December and January being the most unfavourable months. This is due to low soil moisture levels. Although adequate soil moisture is available for plant growth during the winter, growth is usually limited by low temperature, and this is particularly marked from mid-June to late August.

2. Landform

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

Slope (first numeral)

Gradient (per cent)	Code
0 - 2%	1
2 - 5%	2
5 - 10%	3
10 - 15%	4
15 - 20%	5
> 20%	6

Terrain Component (second numeral)

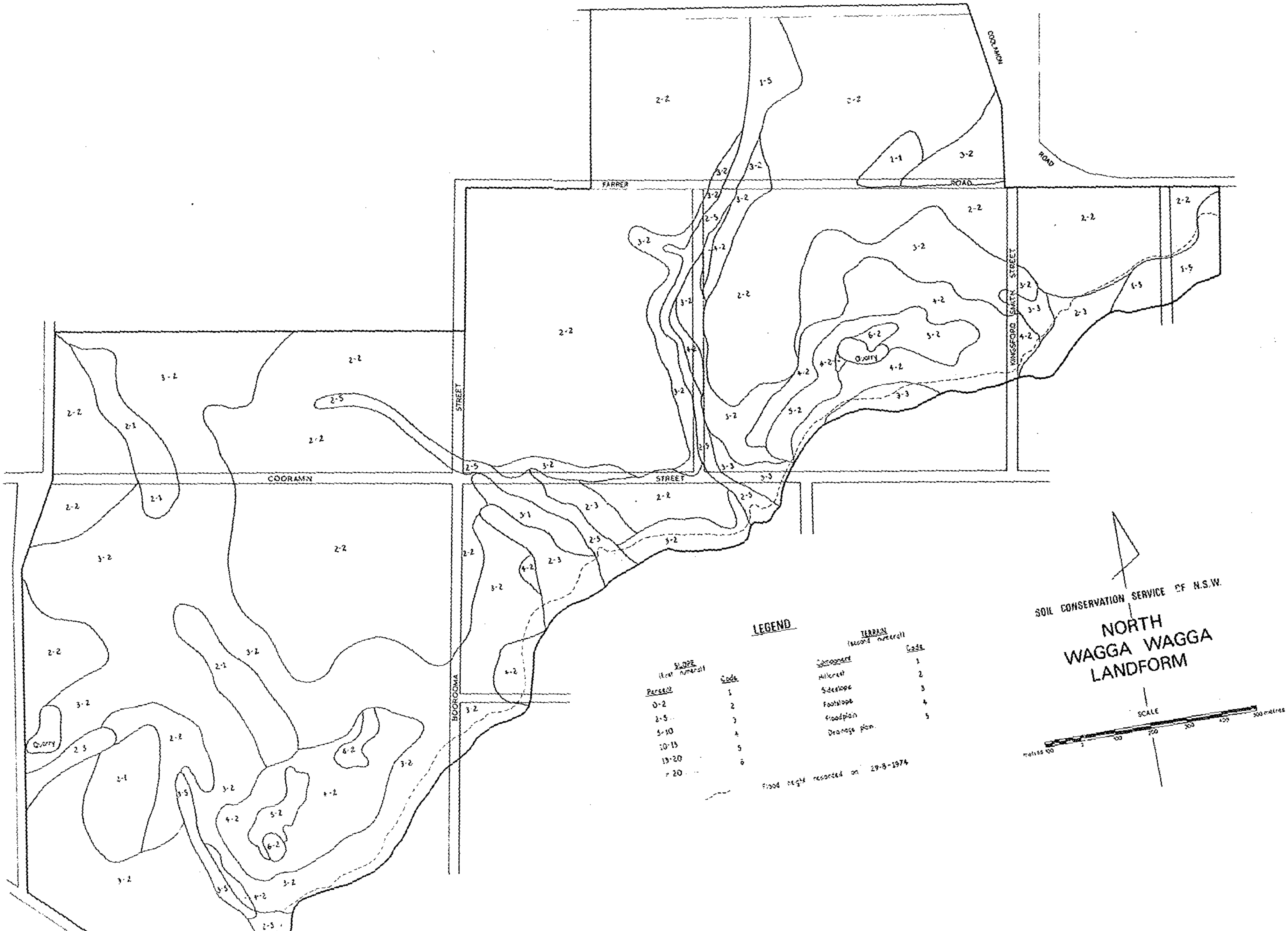
Component	Code
Hillcrest	1
Sideslope	2
Footslope	3
Floodplain	4
Drainage Plain	5

Each unit on the landform map is characterised by two numerals, the first indicating slope and the second, terrain type.

The terrain component classification generalises the dominant terrain types found in the area. The classification is self descriptive and does not require detailed discussion.

The distinction between floodplain and drainage plain is based on the size of the plain and the magnitude of the stream. The term drainage plain does not always imply an incised drainage channel but indicates areas where overland flow is likely to occur. An incised drainage channel represents the actual flow line of a watercourse.

Approximately 80 per cent of the area consists of undulating slopes with gradients ranging from 2 to 10 per cent. Steeper lands comprise about 15 per cent of the total area, with gradients ranging from 10 to greater than 20 per cent. Rock outcrops exist on these steeper slopes and the soils are shallow.


SOIL CONSERVATION SERVICE OF N.S.W.
NORTH WAGGA WAGGA LANDFORM
SCALE
LEGEND
SLOPE
Percent
0-2
2-5
5-10
10-15
15-20
> 20
Code
1
2
3
4
5
6
TERRAIN
(second numeral)
Component
Hillcrest
Sideslope
Footslope
Floodplain
Drainage plain
Code
1
2
3
4
5
Flood height recorded on 29-8-1974
FARRER
ROAD
COORAMIN
STREET
KINGSFORD SMITH STREET
BOOROOMA
Quarry

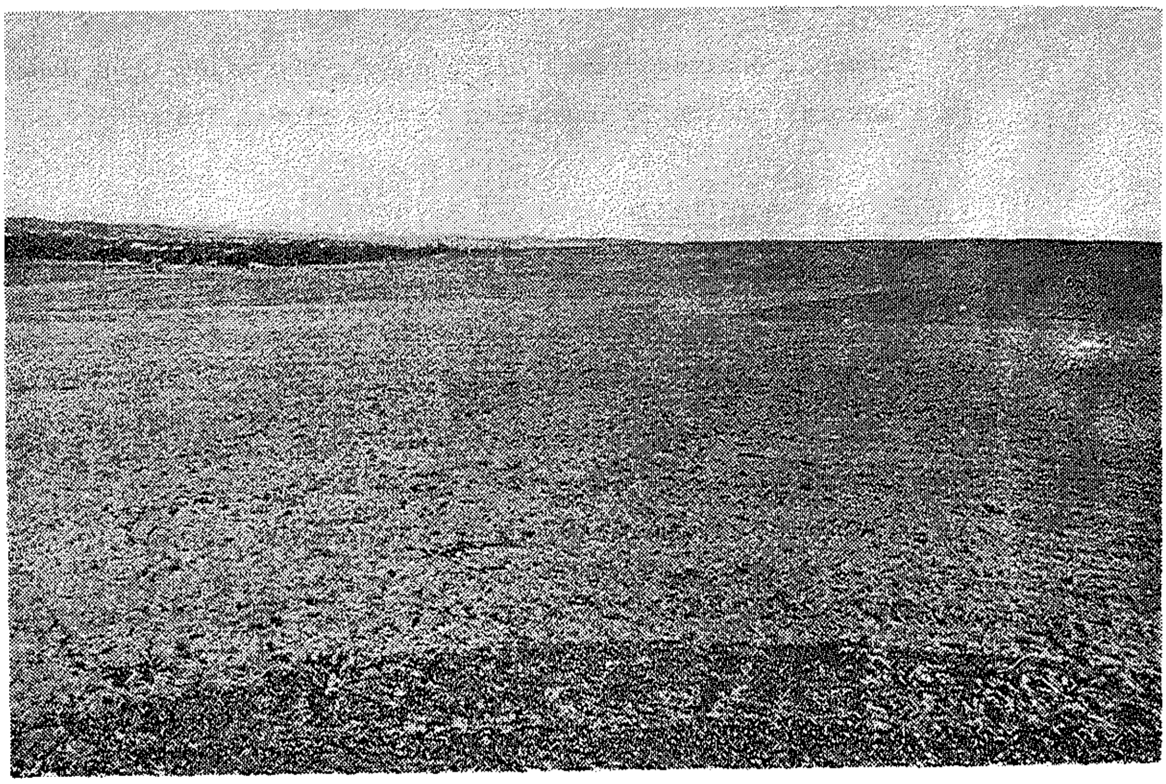


Figure 2. This land is typical of a large proportion of the North Wagga Wagga area, which has a low erosion/ instability hazard, and is suitable for extensive building complexes (E.B.C.).

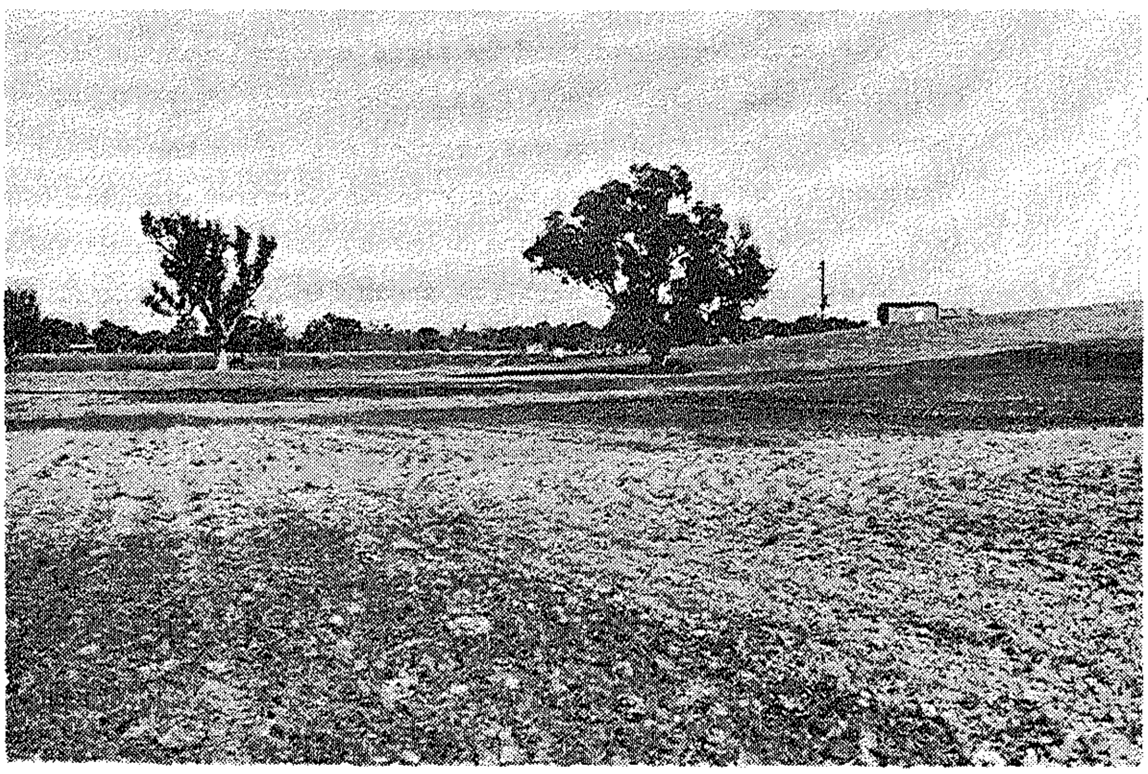


Figure 3. In the foreground is the perimeter of the Murrumbidgee River floodplain which forms the northeast to southwest boundary of the area. To the right is class B-3d, land which is suitable for residential development.

The Murrumbidgee River floodplain forms a diagonal boundary to the area from the northeast to the southwest.

Several drainage lines are present, the major ones descend in a general southerly direction to the floodplain.

3. Geology and Soils.

The study area is situated on granitic ridges, surrounded by colluvium. The area is dissected by various drainage lines containing layered alluvial soils.

The main soil parent material is granite from the Wantabadgery series of the Lower Ordovician Period (N.S.W. Department of Mines, 1966). One area in the study site, contains sand blown from the Murrumbidgee River floodplain during a prior dry period (Beattie, 1972).

Soils are strongly related to parent materials and drainage. Ridges are dominated by shallow skeletal soils which are characterised by a granite tor landscape. These soils merge into well developed red and yellow clay soils on the hillslopes. In the drainage lines and areas of poor internal drainage, a yellow medium clay soil occurs which has a moderately deep A_2 horizon. Boundaries of the soil units are gradual occurring over 25 to 75 metres.

The soils were surveyed by field reconnaissance, using an orthophoto map (scale 1:4000) supplied by the Wagga Wagga City Council. Classification was carried out using the Factual Key (Northcote, 1971) and Soil Conservation Service addendum (Charman, 1978). Soil was sampled from selected sites for later laboratory analysis. Analysis results are presented in Appendix I.

Description of Soil Map Units.

Nine map units have been defined and their characteristics are summarised in Table 3.

Map Unit A: (Dr 2.22 - 2/2/20) - Site 12.

Map Unit A soils mainly occur on the ridges. They range from very shallow, sandy red podzolic soils lying directly on granitic rock to more clayey soils with granite at about 80cm depth.

The landscape is featured by granite tors, while some areas of deep sand occur.

A typical profile consists of a sandy loam A horizon overlying a red, sandy clay B horizon with moderate shrink/swell potential. Soil erodibility is moderate.

The soil pH is neutral to slightly acid throughout the profile.

A major constraint to development is the presence of rock close to the surface. This causes seasonal seepage areas to develop throughout this soil unit. It will also create difficulties with the installation of services and foundations in urban development.

Map Unit B: (Db 3.23 - 3/1/50) - Site 6.

Soils in this unit occupy mid-slopes in the centre of the study area. They are similar to soils in map unit A but depth to bedrock is usually greater than 180 cm, although some shallower soils may occur.

A typical profile consists of a light fine sandy loam A horizon overlying a sandy clay loam B horizon. The soil is slightly acid throughout the profile. Soil erodibility is moderate although the erodibility of the A_2 horizon is moderate to high.

Major constraints to development are the occurrence of seasonal seepage areas, a moderate soil erodibility and a moderately expansive clay in the B horizon.

Map Unit C: (Gn 1.13 - 2/0/15) - Sites 7 and 10 .

The soils in this unit occur mainly on gradients of 2 to 5 per cent. They are moderately plastic red earths with a variable depth A horizon overlying a red earth B_1 horizon which in turn overlies a yellow clay B_2 horizon. Soil in the B_2 horizon is moderately dispersible at some sites.

This soil is similar to, but deeper than the soils of map unit A. Granite outcrops do not occur in this unit. It shows no evidence of impeded drainage.

The very sandy A horizon is highly erodible. Minor rill erosion has occurred on these soils when cultivated for crop production.

As surface soils in unit C have a high erodibility, erosion and sediment control measures must be used in conjunction with urban development.

Map Unit D: (Gn 2.13 - 4/1/20) - Sites 4, 5 and 8.

This unit occurs mainly in the central survey area.

The soils consist of a loam A horizon which grades into a plastic, red, earthy clay at about 30 cm. At 60 cm this soil merges with a well structured yellow medium clay with moderate shrink/swell potential. The gradual transition between horizons and the earthy B_1 horizon produces a well drained profile.

Erodibility of these soils is low and no serious erosion problems are expected.

Map Unit E: (Dy 4.23 - 2/1/40) - Site 3.

Map unit E occurs mainly in the western section of the area.

A typical soil profile consists of a sandy loam A_1 horizon, a dispersible bleached A_2 horizon and a yellow sandy clay B horizon. The B horizon is moderately plastic and has moderate shrink/swell potential.

Internal drainage is poor.

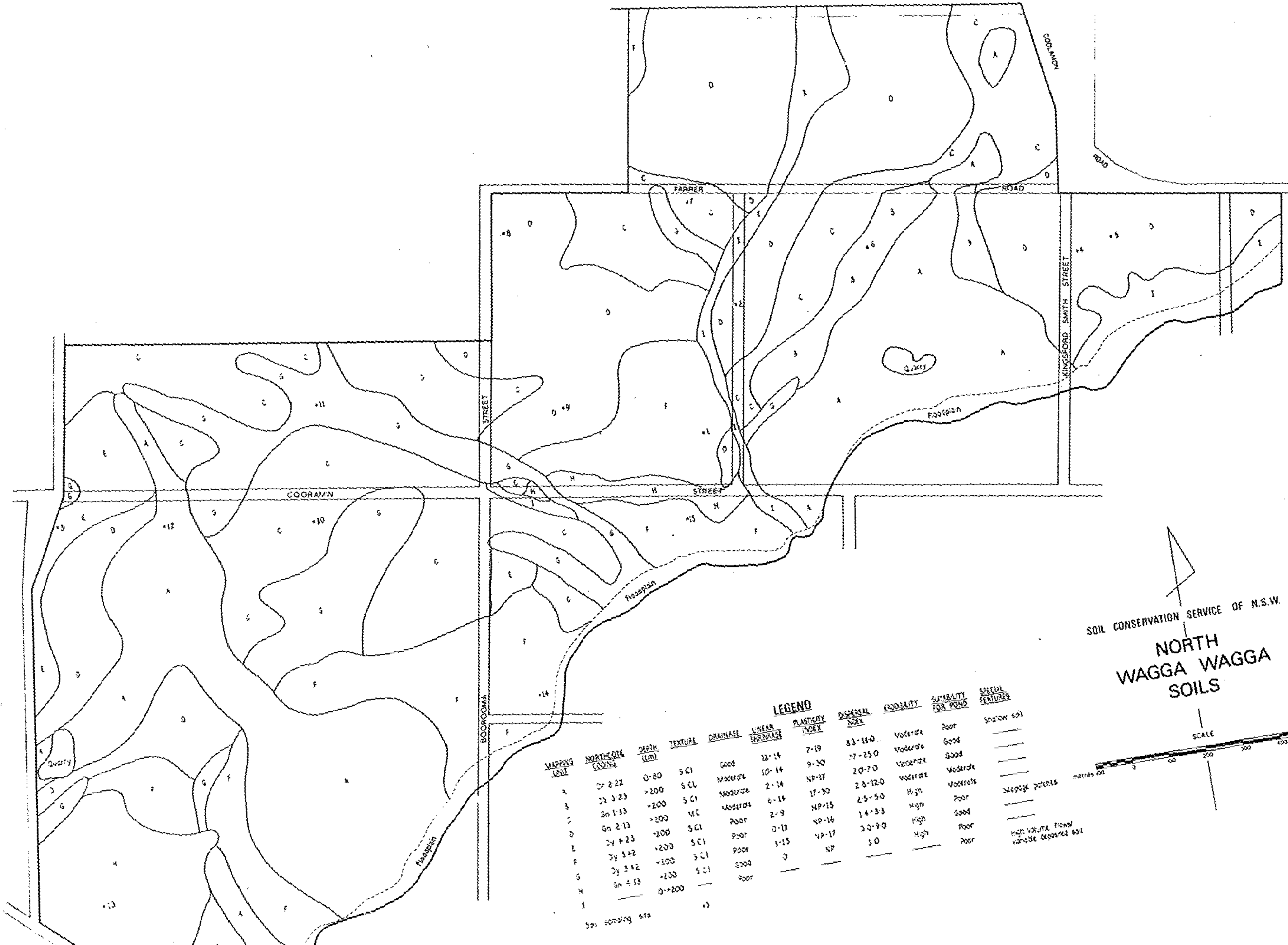
Soil erodibility is high and vegetative cover is required to prevent erosion.

Map Unit F: (Dy 5.42 - 1/0/60) Sites 1, 14 and 15.

This map unit occurs mainly on the lower slopes of the area.

The soils are deep, grading from a sandy loam A horizon to a sandy clay B horizon. The soil is dispersible throughout and has a low shrink/swell potential (linear shrinkage 10 to 11 per cent). In some places the A horizon is typically deeper and the soil texture more sandy.

Soils in the unit are dispersible and soil erodibility is high. Profile drainage is poor, and seasonal seepage areas occur during and following periods of protracted rainfall.



SOIL CONSERVATION SERVICE OF N.S.W.

NORTH WAGGA WAGGA SOILS

LEGEND

MAPPING UNIT	NORTHCOTE CODING	DEPTH (cm)	TEXTURE	DRAINAGE	LINEAR SHRINKAGE	PLASTICITY INDEX	DISPERSAL INDEX	ERODIBILITY	SUITABILITY FOR PONDS	SPECIAL FEATURES
A	Dr 2.22	0-80	S Cl	Good	12-14	7-19	8.3-15.0	Moderate	Poor	Shallow soil
B	Dy 3.23	>200	S CL	Moderate	10-14	9-30	3.7-25.0	Moderate	Good	—
C	Gn 1.33	>200	S Cl	Moderate	2-14	NP-37	2.0-7.0	Moderate	Good	—
D	Gn 2.13	>200	MC	Moderate	6-14	17-30	2.8-12.0	Moderate	Moderate	—
E	Dy 4.23	>200	S Cl	Poor	2-9	NP-15	2.5-5.0	High	Moderate	—
F	Dy 3.42	>200	S Cl	Poor	0-11	NP-16	1.4-3.3	High	Poor	Seepage patches
G	Dy 3.42	>200	S Cl	Poor	1-15	NP-17	3.0-9.0	High	Good	—
H	Gn 4.33	>200	S Cl	Good	0	NP	1.0	High	Poor	—
I	—	0->200	—	Poor	—	—	—	—	Poor	High volume, flood variable deposited soil

•3 Soil sampling site

Map Unit G: (Dy 3.42 - 2/2/40) - Site 11.

This unit occurs mainly in drainage lines and in lower mid-slope positions.

Soils consist of a sandy loam A_1 horizon, a bleached fine sandy loam A_2, and a mottled yellow/grey sandy clay B horizon. The A_2 horizon contains ironstone nodules which indicate severe seasonal water logging.

Soil erodibility is high with active erosion present in parts of the drainage lines. Drainage lines experience trickle flows during winter.

Profile drainage is poor in these soils.

Map Unit H: (Gn 4.13 - 5/2/55) - Site 13.

This map unit consists of sand overlying a reddish brown clay. Depth of sand is variable, often extending to 200 cm.

The sandy textured surface soil has a much lower mica content, and is more evenly graded than other soils in the area. Development of the soil profile is minimal but some darkening of the top 50 cm has occurred due to accumulated organic matter.

Soil erodibility is high, and prevention of massive sand movement during development will be necessary. Application of revegetation techniques and suitably engineered runoff retention works should be used on these soils during and following any disturbance phase.

Map Unit I: (Variable deposited alluvium).

This map unit occupies two major drainage lines in the area. The soils are highly variable with no representative soil profile exhibited.

Soil development is variable and in places it is overlain by up to 100 cm of recently deposited alluvial material.

TABLE 3.

SUMMARY OF SOIL PROPERTIES - NORTH WAGGA WAGGA

MAP UNIT	A		B		C		D		E	
Northcote Coding	Dr 2.22 - 2/2/20		Db 3.23 - 3/1/50		Gn 1.13 - 2/0/15		Gn 2.13 - 4/1/20		Dy 4.23 - 2/1/40	
Underlying Material	-		-		-		-		-	
Depth to Bedrock	80 cm		-		-		-		-	
Profile Drainage	Good		Moderate		Moderate		Moderate		Poor	
Texture B Horizon	Sandy clay		Sandy clay loam		Sandy clay		Sandy clay - medium clay		Sandy clay	
Horizon	B1	B2	B1	B2	B1	B2	B1	B2	A2	B1
Liquid Limit	49-52	47-52	40	57	NL-43	34-42	24-36	39-48	NL	30
Linear Shrinkage	12-14	13-14	10	14	2-10	7-14	6-12	12-14	2	9
Plasticity Index	7-11	11-19	9	30	NP-12	13-17	9-12	17-30	NP	15
U.S.C. Code	ML	CL	ML	CH	CL	CL	CL	CL	ML	CL
Dispersal Index	8.3	11.0	25	7.7	3.0-5.0	2.0-7.0	2.8-7.5	6.5-12.0	2.5	5.0
Emerson Class	1	2	1	1	2	1	2	1	2	1
Erodibility	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	High
Suitability for Ponds	Poor	Poor	Good	Good	Good		Moderate	Moderate	Moderate	Moderate
Topsoil Quality	Good	Good	Good	Good	Moderate		Moderate	Moderate	Moderate	Moderate
Ease of Revegetation	Moderate	Moderate	Moderate	Moderate	Moderate		Moderate	Moderate	Moderate	Moderate
Special Features	Shallow Soil		-		-		-		-	

TABLE 3.(Continued) SUMMARY OF SOIL PROPERTIES - NORTH WAGGA WAGGA.

MAP UNIT	F		G		H		I
Northcote Coding	Dy 5.42 - 1/0/60		Dy 3.42 - 2/2/40		Gn 4.13 - 5/2/55		Variable Deposited Alluvium
Underlying Material	-		-		-		Variable
Depth to Bedrock	-		-		-		-
Profile Drainage	Poor		Poor		Good		Poor
Texture B Horizon	Sandy clay		Sandy clay		Sandy clay		-
Horizon	A2	B1	A2	B1	A	B	
Liquid Limit	30	NL-48	NL	24-45	NL		
Linear Shrinkage	Sh-8	10-11	1	6-15	0		
Plasticity Index	NP-10	NP-16	NP	7-17	NP		
U.S.C. Code	ML	ML	ML	ML	ML		
Dispersal Index	1.7-3.0	1.4-3.3	3.0	3.4-9.0	1.0		
Emerson Class	1	1	3	2	1		
Erodibility	High		High		High		
Suitability for Ponds	Poor		Good		Poor		Poor-Moderate
Topsoil Quality	Low		Low		Moderate		Moderate
Ease of Revegetation	Moderate		Moderate		Moderate		Moderate
Special Features	Deep A2	Seepage patches	-		Variable depth A horizon		High seepage flows

Figure 4. A rocky drainage depression in sub-class D-2,5 land. It should be retained as a drainage reserve.

Figure 5. Evidence of dispersible soil in the table drain of a road in the study area. This illustrates the need for careful development incorporating soil conservation techniques.

URBAN CAPABILITY.

The urban capability of the land was assessed from a study of the interaction of the physical features of the site.

The area has been divided into a number of land classes according to landscape 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

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

0	-	No major constraint
1	-	slope
2	-	flooding
3	-	soil type
4	-	disturbed terrain
5	-	rock outcrop

The letter 'd' attached to subscript '3' indicates impeded profile drainage as a specific soil constraint.

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

The physical constraints to development for each sub-class are also itemised in the legend of the urban capability map.

The capability recommended for each sub-class refers to the most intensive urban use which areas within that sub-class will tolerate without the occurrence of serious erosion and siltation in the short term, and possible instability and drainage problems in the long term. In assessing this capability no account is taken of development costs, social implications, aesthetics, or other factors relating to ecology and the environment. Development which is planned to minimise the 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 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 housing blocks of the order of 600 square metres or larger. Low density residential refers to blocks of 0.5 hectare and upwards. The development of reserves, on the other hand, may require shaping and modification of the ground surface and vegetative improvements, 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 multi-storey units or other major structures. Before structural work of this magnitude is 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.

A detailed description of wide ranging sediment and erosion control, and, stormwater management techniques in urban areas is provided in the Soil Conservation Service Urban Erosion and Sediment Control Handbook. Specific advice relating to these techniques may be obtained from the Wagga Wagga office of the Soil Conservation Service.

Sub-Class A-O: Low Hazard - No major constraints
Suitable for Extensive Building Complexes.

This is the largest sub-class in the study area. It comprises sideslopes with gradients ranging from 2 to 5 per cent. Soils consist of the duplex type of map unit B and the gradational type of map units C and D. These soils are moderately erodible.

There is little instability hazard associated with development of this land, and it is suitable for shopping areas, educational complexes, residential subdivision, or sporting facilities.

Where development does occur, attention should be paid to recommendations outlined in the Soil Conservation Service Urban Erosion and Sediment Control Handbook, with particular reference to section 6, dealing with revegetation techniques.

Sub-Class A-3d: Low Hazard - Erodible Soil/Drainage constraints Suitable for Extensive Building Complexes.

This sub-class occurs on hillcrests and sideslopes that have gradients ranging from 2 to 5 per cent.

Both surface and subsoil horizons of the soils in this unit are highly erodible. This will present an erosion problem if they are exposed for an extended period. It is important that vegetative cover be re-established as soon as possible after earthworks, associated with urban development, are completed.

This sub-class may be used for extensive building complexes such as shopping centres, schools, or home units, which require considerable ground disturbance. Serious erosion will not be generated provided measures outlined in the Service's Urban Erosion and Sediment Control Handbook are adhered to. Particular attention should be paid to sections 5.3 and 6 which describe techniques to overcome instability caused by the high erodibility and poor profile drainage characteristics of the soils.

Sub-Class A-5: Low Hazard - Rock Outcrop constraint Suitable for Extensive Building Complexes.

This land occurs on hillcrest and sideslopes with gradients between 2 and 5 per cent.

The soils are shallow, generally less than 80 cm deep, with granite occurring close to, or, at the surface as floaters, rather than solid reefs.

This land is suitable for extensive building complexes, although excavation will be difficult due to the proximity of rock to the surface. However, the depth of soil does vary and specific site investigation will be necessary, prior to development, to determine if the rock will interfere with foundations, or trenching for the installation of services.

The same problems would exist, although to a lesser extent, because of reduced cut and fill, if the area was developed for residential purposes.

Recommendations in the Service's Urban Erosion and Sediment Control Handbook, should be adhered to if the area is developed.

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

The areas identified in this sub-class are sideslopes with gradients ranging from 5 to 15 per cent.

The moderate hazard associated with development of this land is due largely to the slope. Longer batters are necessary in levelling operations, run-on and runoff water are problems needing diversion works, and silt transport following any erosion will be more extensive. To minimise these effects, recommendations on stormwater management in section 3 and revegetation techniques in section 6 of the Urban Erosion and Sediment Control Handbook, need to be followed.

The soils are classified as units B, C, and D.

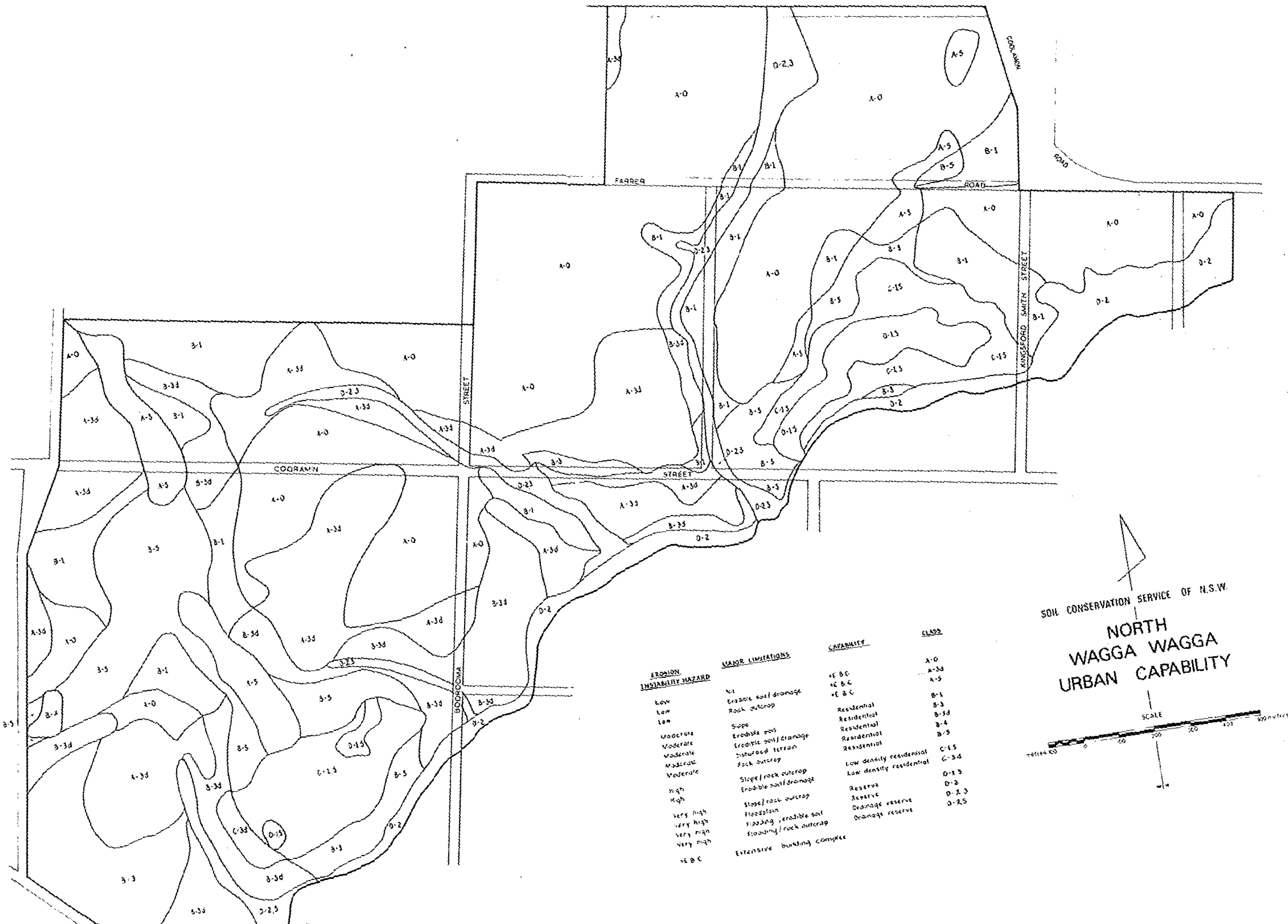
The B horizons are moderately erodible but this factor is not considered a constraint for this sub-class. However, the A horizon of the gradational soils of unit C, have a sandy texture, and are highly erodible. If this soil is left in a bare unvegetated state, erosion and siltation will occur, particularly on the steeper slopes.

The soils have a moderate shrink/swell potential, and this should be taken into account in foundation design.

Development of extensive building complexes requiring large scale surface disturbance and levelling is not recommended for this land, because of the erosion hazard associated with the steeper slopes. It will support residential development without serious erosion occurring, providing the recommendations outlined in the Urban Erosion and Sediment Control Handbook are followed.

Sub-Class B-3: Moderate Hazard - Erodible Soil constraint Suitable for Residential Development.

Sub-class B-3 is found on the sandy soil of map unit H, on sideslopes with 5 to 10 per cent gradient.


SOIL CONSERVATION SERVICE OF N.S.W.
NORTH
WAGGA WAGGA
URBAN CAPABILITY
SCALE
EROSION INSTABILITY HAZARD
MAJOR LIMITATIONS
CAPABILITY
CLASS
Low
Low
Low
Moderate
Moderate
Moderate
Moderate
Moderate
High
High
Very high
Very high
Very high
Very high
Nil
Erodible soil/drainage
Rock outcrop
Slope
Erodible soil
Erodible soil/drainage
Disturbed terrain
Rock outcrop
Slope/rock outcrop
Erodible soil/drainage
Slope/rock outcrop
Floodplain
Flooding/erodible soil
Flooding/rock outcrop
Extensive building complex
Residential
Residential
Residential
Residential
Residential
Low density residential
Low density residential
Reserve
Reserve
Drainage reserve
Drainage reserve
A-0
A-3d
A-5
B-1
B-3
B-3d
B-4
B-5
C-1.5
C-3d
D-1.3
D-2
D-2,3
D-2,5
FARRER
ROAD
COOLAMON
ROAD
COORAMIN
STREET
STREET
KINGSFORD SMITH STREET
BOOROOMA
STREET

The soil features a very low clay content, sandy texture, poor profile development, and there is a very high hazard associated with its disturbance. Stormwater control and revegetation measures will need to be implemented during and following a disturbance phase to prevent massive sand movement.

Development of extensive building complexes, requiring large scale surface disturbance and levelling, is not recommended.

Residential development and passive recreation should not cause serious erosion problems provided the measures mentioned above are adopted. These measures are outlined in the Service's Urban Erosion and Sediment Control Handbook.

Active recreation facilities, such as ovals requiring large scale cut and fill are not recommended.

Sub-Class B-3d: Moderate Hazard - Erodible Soil/Drainage constraints Suitable for Residential Development.

In this sub-class are sideslopes and some hillcrests, with gradients ranging from 5 to 10 per cent. The soils are those of map units F and G, which are highly erodible and poorly drained.

Much of this sub-class is situated on the lower hillslopes, adjacent to drainage lines. Diversionary works will be necessary during development to prevent run-on from the slopes above flowing through the site and causing severe erosion and siltation.

Seasonal seepage patches will develop in these soils and, in those areas where surface drainage is not adequate, waterlogging does occur. The attention of developers should be drawn to this, as effective surface and subsurface drainage will be a necessary component of development.

Sections 2.3, 5.3 and 6 of the Urban Erosion and Sediment Control Handbook, should be consulted.

Sub-Class B-4: Moderate Hazard - Disturbed Terrain constraint Suitable for Residential Development.

This land comprises a gravel quarry on the western boundary of the area. Gravel has been extracted to a depth of about 2 metres.

Shaping and filling of the area will be necessary before development takes place. Following these earthworks, topsoiling and seeding must be carried out . Topsoil may need to be imported to the site. Particular attention should be paid to section 4.3 of the Urban Erosion and Sediment Control Handbook.

This land is suitable for residential development and passive recreation without serious instability problems, provided the above precautions are taken.

Sub-Class B-5: Moderate Hazard - Rock Outcrop constraint
Suitable for Residential Development.

Sub-class B-5 occurs on sideslopes of 5 to 10 per cent gradient, with the shallow soils of map unit A. These soils are generally less than 80 cm deep, and sporadic rock outcrops occur.

This land is suitable for residential purposes. However, specific site investigations should be made prior to development, to determine the depth to rock. This will be necessary to ascertain its effects on excavations , foundations and service trenching.

The Service's Urban Erosion and Sediment Control Handbook, should be consulted, and its recommendations implemented to minimise erosion and siltation during the construction phase.

Sub-Class C-1,5: High Hazard - Slope and Rock Outcrop constraints
Suitable for Low Density Residential Development.

This land occurs on steep hillslopes in the study area. Gradients range from 10 to 15 per cent and the soils are those of map unit A. Surface rock is sporadically present, and the shallow depth of soil,(generally less than 80 cm), will affect excavation and construction of foundations and service trenches.

There is a high erosion hazard associated with development of this sub-class. This is due principally to the steep slopes, but also to the added disturbance necessary with excavation amongst the rock.

Potential erosion and instability problems include serious rill and gully erosion of exposed batters. Particular care should be taken in controlling surface flow to prevent high runoff rates and silt deposition affecting lower land. Installation of drainage works, early in the construction phase, will assist in this respect.

Low density residential development is the recommended capability of this land, i.e. minimum block size 0.5 hectare. Excavation and building could be located on the areas of lower slope and deeper soil. Special attention should be paid to sections 2 and 4.2 in the Urban Erosion and Sediment Control Handbook.

The land is suitable for passive recreation purposes, but good vegetative cover must be maintained on these slopes, to ensure stability.

Sub-Class C-3d: High Hazard - Erodible Soil/Drainage constraints Suitable for Low Density Residential Development.

This sub-class is relatively small and occurs on a lower sideslope below sub-class C-1, 5 land with gradients of 10 to 15 per cent.

The soil, classified as map unit F, is highly erodible and poorly drained. These factors, combined with the steep slope, give a high erosion hazard associated with disturbance of the topsoil.

The land is best suited to low density residential development, i.e. minimum block size 0.5 hectare, with excavation and buildings preferably placed on the areas of lower slope.

Special attention should be paid to sections 2.3, 5.3 and 6 of the Urban Erosion and Sediment Control Handbook.

Sub-Class D-1, 5: Very High Hazard - Slope/Rock Outcrop constraints Suitable for Reserves.

This land is located on the soils of map unit A with gradients ranging from 15 to above 20 per cent. Rock outcrops occur at the surface, and the soil is very shallow.

The combination of steep slope and rock outcrop, make use of this land for structural development unwise.

Potential erosion problems during and following development include serious rill and gully erosion and high siltation. The rock presents problems for foundations and servicing of buildings.

This land is best suited to passive recreation uses, or as yard space for houses built on adjacent sub-class C-1, 5, B-5 or C-3 land.

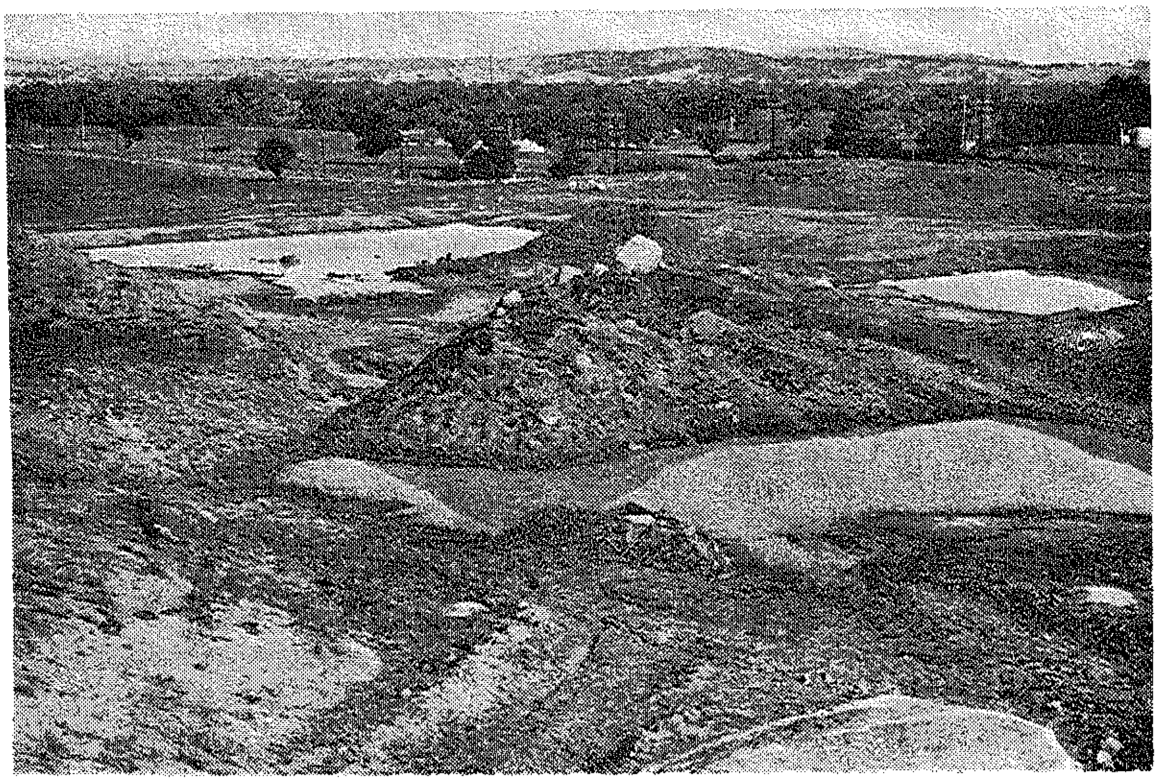


Figure 6. Disturbed terrain at a gravel quarry on the western boundary of the area. Classified as B-4, it can be reclaimed for residential development.

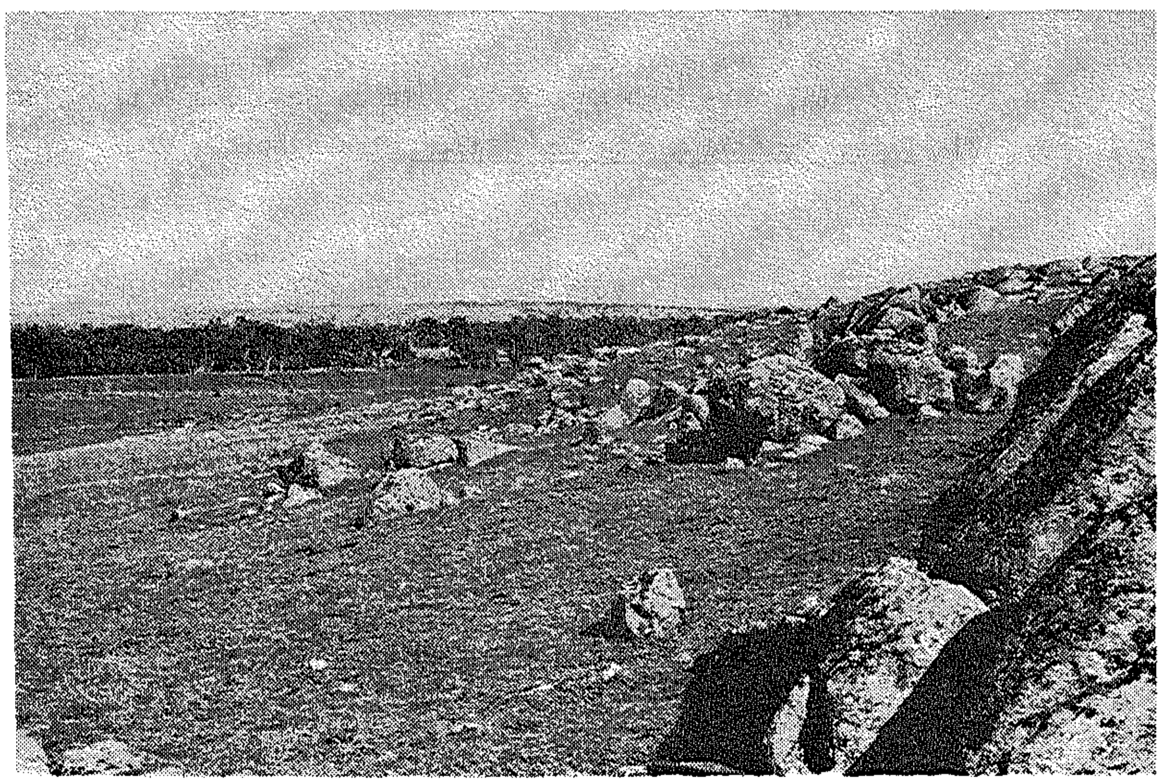


Figure 7. The presence of rock outcrops and the steep slope give this sub-class C-1, 5 land a high erosion/ instability hazard rating. Careful, well planned development will be necessary if this land is to be used for residential purposes.

Use of the land in this way should present no erosion problems, although a good vegetative cover should be maintained.

Sub-Class D-2: Very High Hazard - Flooding constraint
Suitable for Reserve.

Land in sub-class D-2 includes the floodplain of the Murrumbidgee River. It is a narrow strip extending diagonally from the north to the south of the study area.

It is recommended that building be prohibited on this land. It may be suitable for yard space of houses situated on adjacent land.

The floodplain should be preserved to afford flood protection to adjacent urban areas. Sports ovals, intensive outdoor recreational areas and landscaped parks can be located on this land.

In developing this land, particular attention should be paid to section 5.1 of the Urban Erosion and Sediment Control Handbook.

Sub-Class D-2, 3: Very High Hazard - Flooding and Erodible
Soil constraints
Suitable for Drainage Reserves.

This land consists of the major drainage lines which flow through the area. Gradients range from 2 to 5 per cent. Soils are highly erodible and poorly drained yellow duplex soils and the variable soils of map unit I, which consist of deposited material from the catchment above.

Structural development of these drainage lines may lead to serious gully erosion in the short term, and, flooding, waterlogging and undermining of structures in the long term.

It is recommended that these areas be developed as drainage reserves. They may also incorporate pedestrian corridors or playgrounds/adventure grounds for children. Where necessary they should be shaped to allow regular mowing, which will help the maintenance of a good vegetative cover.

There will be a very high erosion hazard associated with any earthworks, in this sub-class, due to periodic flooding. In the event of runoff, any disturbed area would scour and the silt would be carried downstream.

Special attention should be paid to section 3 of the Urban Erosion and Sediment Control Handbook.

Sub-Class D-2, 5: Very High Hazard - Flooding/Rock Outcrop constraints
Suitable for Drainage Reserve.

This land has a similar capability to that of sub-class D-2, 3.

Land shaping and maintenance may be more difficult due to the proximity of rock near the surface. Recreational pursuits are limited by the steeper gradients and occurrence of rock.

Development as a drainage reserve is recommended, and section 3 of the Urban Erosion and Sediment Control Handbook, should be consulted.

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LABORATORY ANALYSES OF SOIL - NORTH WAGGA WAGGA

Site	Depth (cm)	Clay (%)	Silt (%)	Fine Sand (%)	Coarse Sand (%)	Gravel (%)	Stones (%)	LL (%)	PI (%)	USCS	D	E.C.T.	LS
1	20-60	6	8	35	49	1	2	NP	NP		1.7	2	0
	60-80	32	9	24	30	3	1	30	10		3.2	1	8
	80-100	34	4	25	33	3	1	28	10		4.8	1	9
	100-115	35	4	23	33	3	3	35	14		3.3	1	11
	120-140	32	6	24	35	1	2	33	14		2.3	1	9
2	10-20	12	31	19	37	0	0	NP	NP		2.0	2	3
	20-40	44	4	27	22	1	2	33	8		8.0	1	10
	40-60	47	6	26	18	3	1	43	14		5.2	1	11
	95-105	50	12	22	15	2	0	48	18		5.6	2	12
3	20-40	12	9	33	35	12	0	NL	NP	ML	1.4	2	2
	60-80	29	10	26	34	1	0	30	15	CL	5.0	1	9
	100-120	25	8	26	22	18	0	36	36	CL	3.2	1	10
4	20-40	34	5	23	24	14	0	40	21	CL	2.5	1	10
	50-70	41	12	27	20	0	0	47	30	CL	7.0	1	13
5	30-60	28	15	30	22	5	0	33	12	CL	7.5	1	8
	70-100	40	8	23	14	14	0	48	24	CL	12.0	2	12
6	15-50	18	11	32	30	8	0	27	10	CL	5.0	1	3
	70-100	41	11	24	15	7	2	57	30	CH	7.7	1	14
7	25-40	45	7	30	10	8	0	29	12	CL	25.0	2	10
	70-100	40	7	35	11	7	0	42	17	CL	2.0	1	14
	100-120	37	7	32	14	7	4	42	16	CL	2.4	1	14
8	20-50	29	13	36	19	2	0	NL	NP	ML	4.3	1	3
	90-110	47	8	28	17	0	0	38	19	CL	8.3	1	13
9	30-55	32	11	33	16	8	0	36	12	CL	3.0	1	12
	60-80	43	9	27	10	12	0	47	25	CL	6.5	2	14

IS - Insufficient Sample

Site	Depth (cm)	Clay (%)	Silt (%)	Fine Sand (%)	Coarse Sand (%)	Gravel (%)	Stones (%)	LL (%)	PI (%)	USCS	D	E.C.T.	LS
10	15-40	15	10	41	33	2	0	NL	NP	ML	3.0	2	2
	40-60	25	8	29	22	15	0	33	10	CL	5.3	1	9
	65-80	39	3	24	20	12	2	34	13	CL	7.7	2	7
	95-115	43	6	27	19	5	0	44	19	CL	5.8	2	11
11	20-40	23	19	32	23	3	1	IS	IS		3.0	3	IS
	40-60	31	15	36	16	2	0	24	7	CL	3.6	2	6
	90-110	46	9	24	12	10	0	45	17	ML	9.0	1	15
12	0-20	10	13	40	35	2	0	NL	NP	ML	2.3	3	1
	60-70	59	7	11	16	6	0	52	11	MH	11.0	2	14
	70-80	44	11	16	23	7	0	47	19	CL	8.3	2	13
13	20-55	2	8	42	51	0	1	NL	NP	ML	1.0	3	0
	55-60	35	6	22	32	5	0	IS	IS		3.2	2	8
	60-80	35	6	31	28	0	0	NL	NP	ML	1.8	2	4
14	15-30	8	10	41	42	0	0	NL	NP	ML	3.0	2	< 1
	40-60	40	6	30	22	2	0	36	9	ML	4.2	2	10
	80-110	24	4	29	36	7	0	NL	NP	ML	1.6	2	6
15	15-40	4	8	37	51	0	0	NL	NP	ML	3.0	2	0
	40-75	35	5	27	22	10	0	34	13	CL	1.4	2	11
	85-100	55	2	25	20	0	0	48	16	ML	1.8	2	13

IS - Insufficient Sample

APPENDIX II

DEFINITION OF TERMS

Atterberg Limits

The Atterberg Limits are based on the concept that fine-grained soil can exist in any of three states depending on its water content. This, 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).

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 Crumb Test

The Emerson Crumb Test (E.C.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, Testing Soils for Engineering Purposes, (1966).

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

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

Northcote Coding

The Northcote Coding represents the characterisation of a soil profile according to a system for the recognition of soils in the field described by Northcote (1971).

The Soil Conservation Service of New South Wales addendum to this coding comprises three additional digits representing the surface texture, surface soil structure and depth of 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 1 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).

Soil Erodibility

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 erodibility of a given soil in the field is also controlled by soil profile characteristics.

The qualitative categories for soil erodibility adopted by the Soil Conservation Service of New South Wales are low, moderate, high, very high and extreme.

Underlying Material

Underlying material refers to the weathered bedrock or other soil material such as alluvium.

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.

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

'GC' - Clayey gravels, poorly graded gravel-sand-clay mixtures.

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

'ML' - inorganic silts and very fine sands, rock flour; silty or clayey fine sands with slight plasticity.

'SC' - Clayey sands, poorly graded sand-clay mixtures.

'SM' - silty sands, poorly graded sand-silt mixtures.

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

Profile Drainage

Profile drainage indicates of how readily water drains vertically down through the soil profile. It indicates the period for which a soil may be wet. The scale is; poor - near saturation for long periods of the year, to good - only saturated during or immediately after heavy rainfall.

D. West, Government Printer, New South Wales