SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

URBAN CAPABILITY STUDY

TOWN OF HOWLONG

THIS REPORT DESCRIBES THE CAPACITY OF THE STUDY AREA TO SUPPORT VARIOUS INTENSITIES OF URBAN USE IN TERMS OF THE INHERENT STABILITY OF THE LAND. IT IS NOT, OF ITSELF, A RECOMMENDATION FOR PARTICULAR FORMS OF DEVELOPMENT ON SPECIFIED AREAS.

THE REPORT TAKES NO ACCOUNT OF OTHER TOWN PLANNING CONSIDERATIONS WHICH MUST INFLUENCE ANY FINAL DECISION. IT PROVIDES A USEFUL BASIS ONTO WHICH THESE MAY BE IMPOSED TO DERIVE A SUITABLE DEVELOPMENT PLAN.

Prepared for the Hume Shire Council

July 1977.

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

Full size original maps have also been scanned and named "UC_Howlong_Hume_theme.pdf"

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SUMMARY

This study includes the existing developed areas of Howlong and adjacent areas likely to be developed for residential purposes in the next twenty years.

Landform is characterised by three distinct river terraces that have developed from the Mürray River.

Soils have been formed from colluvium, alluvium and aeolian parent material. Impeded drainage in natural depressions has influenced their characteristics. The presence in their profiles of clay of high plasticity and volume expansion will impose a constraint urban development.

Urban capability classes have been assessed from an interpretation of landform and soils.

Sub-Class A-0 includes gently sloping land on second and third river terraces. Soils are siliceous sands with good drainage. No major development hazard is associated with this land which will tolerate maximum site development.

Sub-Class A-3 covers relatively level land on the second river terrace. Soils are brown clays of high plasticity and moderate shrink/swell potential. This land is suitable for commercial, industrial, residential or recreational use. However, due to the poor physical attributes of the soils individual site investigations are required for foundation design.

Sub-Class B-1 comprises three small areas with slope gradients ranging from 5% to 10% on sandy and red-brown earth soils. Uncontrolled development may result in soil erosion. They will accept residential subdivision.

Sub-Class C-1 comprises a small area forming the slope between the first and second terrace with slope gradients ranging from 10% to 20%. Soils are red-brown earths. This land is suited for residential development or for passive recreation.

Sub-Class C-1,3 is located on the sideslopes of a drainage depression in the second river terrace. Soils are heavy brown clays. Extensive cut and fill is not recommended. This land is suitable for residential use or for passive recreation.

Sub-Class C-3 occurs on heavy grey clay soils on the second and third river terraces. Slope gradients range from level to 2%. The soil type imposes a major development constraint due to its high volume expansion,

high plasticity index and poor profile drainage. This land is suitable for residential or recreational use. Prior to any development soil tests are required for foundation design. Improvement of surface drainage facilities is also necessary.

Sub-Class D-2,3 includes flood liable land on the lower river terrace that has a very high erosion/instability hazard. Residential or industrial development is not recommended. The most compatible land use is as parkland for passive recreation.

Sub-Class D-2,3,6 comprises the drainage depressions on the second and third river terraces. This land is regularly inundated by local runoff and should be developed as drainage reserves. Building activity is not recommended.

Sub-Class E-1 has an extreme erosion/instability hazard and is confined to the bank of the Murray River on slope gradients in excess of 20%. Severe river bank erosion occurs in places and requires stabilisation to protect adjoining lands. Development is not recommended on this land.

INTRODUCTION

Howlong is located between Albury and Corowa on the Murray River. Over recent years the Hume Shire Council has promoted residential development of the town and the demand for residential land is expected to continue due to its close proximity to the Albury-Wodonga Growth Centre.

Problems have arisen in planning residential developments due to poor drainage, high water tables, erosion of light sandy soils, flooding and river bank erosion of the Murray River.

The Hume Shire Council requested the Soil Conservation Service of N.S.W. to identify the problem areas and physical constraints to urban development, so that unstable lands could be avoided and the requirements necessary to overcome other site difficulties determined. An area of 440 hectares was surveyed.

This Urban Capability Study is based on a survey of the physical features of the site which included soils, landform and drainage pattern.

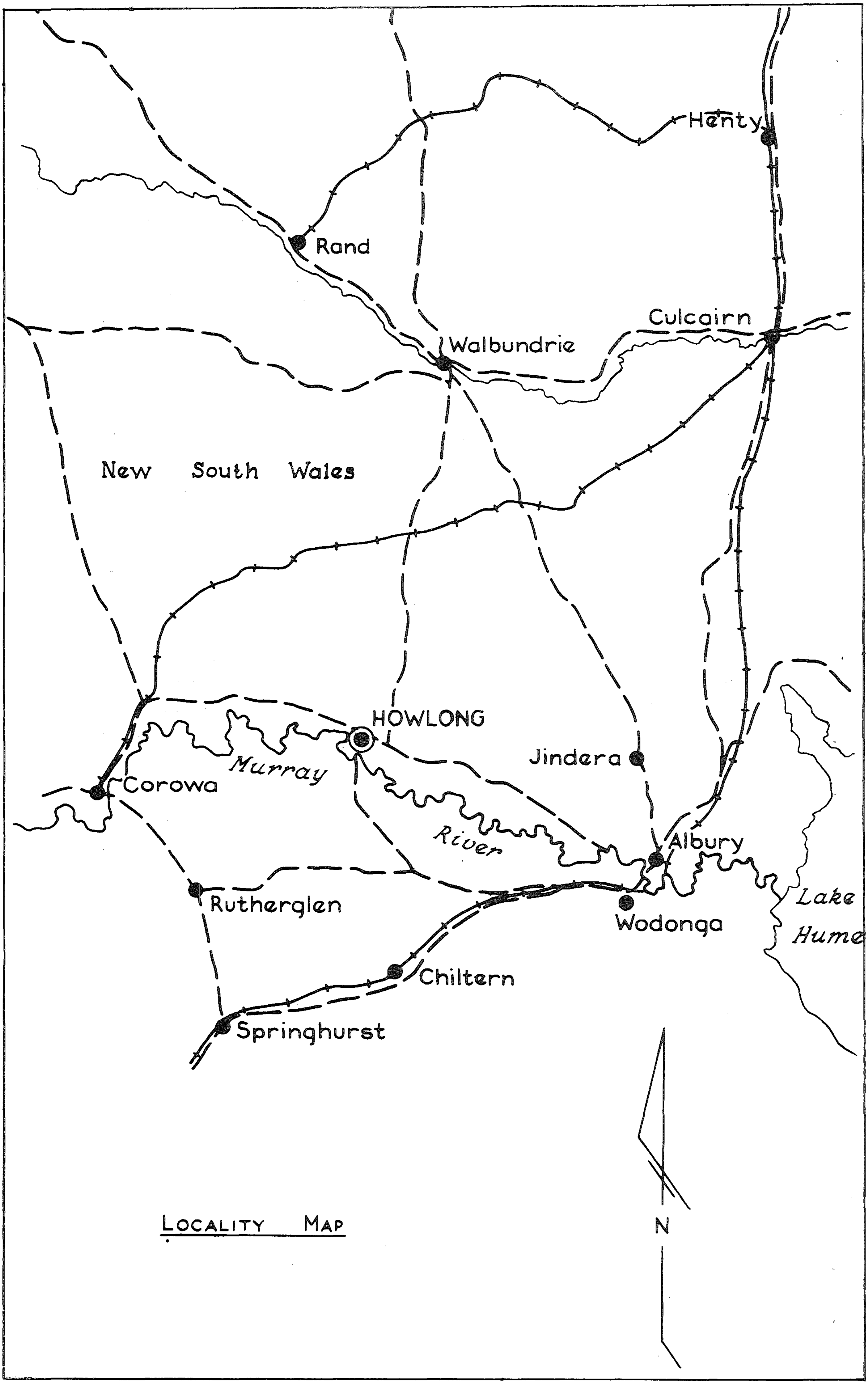
Maps of soils, landform and terrain component have been prepared on 1:5000 scale base plans using aerial photograph interpretation and ground survey. This information has been interpreted to assess the capability of the area for urban development in terms of land stability and erosion hazard.

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

Maps contained in this report have been reduced in size for convenience (placed at the rear). Original 1:5,000 scale maps are part of the SCS cartographic series, and are labelled:

113000/A	Soils
113000/B	Landform
113000/C	Urban Land Capability

These full size maps have been scanned and named "UC_Howlong_Hume_theme".



LOCALITY MAP

Howlong is located on river terraces formed by the Murray River. Three distinct river terraces are present. The lower terrace comprises the floodplain of the present Murray River Systems. This area is liable to frequent flooding and should not be developed for urban purposes. The second and third terraces are not susceptible to flooding from the present hydrological regime of the river. See map at rear, or original map SCS 11300/A.

Sideslopes occur between the river terraces. Slope gradients greater than 20% are not recommended for urban development as they are potentially unstable, particularly those between the lower and second terrace.

Drainage depressions located on the second and third terrace are a constraint to urban development. A seasonal high water table, poor drainage, and soils of high plasticity and volume expansion are associated with this terrain component.

Water bodies are located on the lower terrace and comprise lagoons, channels and the Murray River. They have a recreational and wildlife value. Recreational facilities should be designed to withstand flooding with negligible damage and yet not divert, retard or impound flood waters.

3. Soils

Howlong is located at the eastern extremity of the Riverine Plain of the Murray River. The soils have been formed from colluvium, alluvium or aeolian deposition. No rock outcrops occur in the immediate vicinity of the town.

A sheet of sand, possibly aeolian in origin, is situated on the western side of the study area. Other soils appear to have formed on alluvial material. Natural drainage of the second and third terraces has caused waterlogging on the inland edge of both terraces. This has resulted in more rapid weathering and the formation of heavy clay soils.

Soil map units were selected using soil features related to soil stability as defined in "A Factual Key for the Recognition of Australian Soils" (Northcote 1971).

Soil boundaries were mapped using ground survey information and aerial photograph interpretation.

Representative sites in each soil unit were classified and sampled for laboratory analyses. These results are presented in Appendix A.

Table I summarises the salient characteristics of the six map units defined on the soils map. See map at rear, or original map SCS 11300/B.

PHYSICAL FEATURES

Environmental features that influence site stability and the urban capability of this land include:

1. Climate
2. Landform (terrain, slope and drainage)
3. Soils

1. Climate

The median annual rainfall at Howlong is 550 mm. Rainfall is generally highest during winter and spring and lowest during summer. Summers are relatively dry and warm to hot, while winters are cool. The average frost free period is 233 days.

High intensity storms during summer may cause severe erosion damage to excavations and drainage works in the sandy soils of the area. Protracted rainfall during winter may cause high water tables and localised areas may be inundated for long periods.

2. Landform

Landform features have been mapped as two individual elements, a slope component and a terrain component. These features together with data about soil type enable an assessment of the behaviour and stability of the site under different intensities of land use.

The following slope gradient classes are defined on the landform map:

Slope Class	
1.	0-2%
2.	2-5%
3.	5-10%
4.	10-20%
5.	20-50%
6.	above 50%

The terrain component describes the physical appearance of the slopes. Those identified are:

Terrain Component	
(1)	Lower river terrace
(2)	Second terrace
(3)	Third terrace
(4)	Sideslope
(5)	Drainage depression
(6)	Water body

Description of Soil Map Units

Map Unit A - Siliceous Sand

Siliceous sand occurs as a sheet over the western half of the area on the third river terrace. It has been deposited over a yellow clay and varies in depth from 30 cm to greater than 3 metres.

The soil is a uniform coarse sand, stained red and cemented by iron oxide below 50 cm. It is highly permeable and only moderately erodible. However, concentrations of runoff from paved areas, roads or drainage facilities may cause severe erosion especially of bare soil.

Low cohesion of the sand particles will cause soil slumping during excavation and erosion of bare soil surfaces by high intensity rain.

Map Unit B - Brown Clay Soil

The brown clay soil occupies a substantial part of the second terrace between the light red brown earth and the grey clay soil units.

It consists of a silty, slightly acid A_1 horizon overlying a silty clay unbleached A_2 horizon. This grades into a brown heavy clay B horizon that is alkaline at depth. Surface recognition of this unit is assisted by slight gilgai development and a vegetation change that reflects periodic waterlogging.

Urban development may be restricted by medium to high soil plasticity and a medium shrink/swell potential. The heavy clay soil has a poor profile drainage and individual site investigations will be required to determine their suitability for absorption of septic effluent.

Map Unit C - Grey Clay Soil

The grey clay soil unit occurs at the inland edge of both the second and third terraces. The boundary is well defined in terms of vegetation differences, extensive soil cracking on drying, prolonged waterlogging and the texture of the surface soil.

The soil consists of a silty surface horizon overlying a heavy grey clay containing some orange mottles. This is underlain by an alkaline brown clay. All horizons have a high to very high shrink/swell potential. Gilgais over the area indicate a high degree of soil movement that will continue after levelling and construction. This movement will be most severe in the northern area.

The main constraint to development is the high shrink/swell potential of the soil,its very high plasticity and poor drainage.

The high shrink/swell potential is an inherent soil property which cannot be greatly modified. Special attention to proper foundation design is required for buildings or roads.

The high plasticity indicates that additional site investigations are required for determination of road pavement thickness, for foundation design for buildings, and for installation of services. Due to their high clay content and the type of clay, they may be readily deformed underload as the particles move, relative to each other, to take up new equilibrium positions. These soils have a high moisture holding capacity.

The poor site drainage is related to the high clay content. Subsurface drains may not be wholly effective due to the low soil permeability. Surface drains would be moderately effective.

This soil type is unsuitable for septic absorption fields. If urban development proceeds, alternate methods of effluent disposal will be required.

Map Unit D - Red Brown Earth

This soil unit is confined to the low ridges on the third river terrace. It is the most stable soil in the area, having a well aggregated subsoil of moderate to low erodibility.

Soil in this unit consists of a loam, slightly acid A horizon which may or may not be separated,by a non-bleached A_2 horizon,from a bright red, well structured medium clay B horizon. The B horizon becomes more alkaline with depth and overlies a yellow plastic clay.

Minor erosion of bare soil surfaces is the only development problem expected.

Map Unit E - Red Brown Earth

This unit occupies a major portion of the second river terrace, fronting the lower terrace and the floodplain of the Murray River. It is well drained because of its high sand content.

The soil is characterised by a sandy loam, neutral, A horizon over a moderately thick, sporadically bleached A_2 horizon approximately 20 cm deep which becomes alkaline with depth.

This soil is moderately erodible. Surface drainage should avoid concentrations of runoff over the terrace bank, otherwise gully erosion may occur on the terrace slope (Figure 10).

Map Unit F - Yellow Solodic Soil

Yellow solodic soil predominates on the third river terrace and in drainage depressions.

This unit is readily recognised by a deep bleached A_2 horizon overlying a mottled yellow B horizon which contrasts strongly with the red and grey B horizons of soils in adjoining units.

The yellow solodic soil is composed of a poorly structured, slightly acid silt loam A horizon overlying a deep (50 cm), strongly bleached A_2 horizon which often contains iron and manganese nodules in its lowest 10 cm. The A_2 horizon lies abruptly on a yellow/grey mottled, medium clay B horizon. pH increases to 8.5 at about 125 cm depth.

Soil erodibility ranges from moderate to high. Areas stripped of vegetation can easily erode, causing siltation of drainage installations. Early revegetation of disturbed areas will be necessary following construction of subdivisions.

Drainage problems occur on those areas indicated on the landform map as drainage depressions.

TABLE 1.

SUMMARY - SOIL CHARACTERISTICS - HOWLONG

MAP UNIT	A	B	C	D	E	F
GREAT SOIL GROUP	Siliceous sand	Brown clay soil	Grey clay soil	Red-brown earth	Red-brown earth	Yellow solodic soil
NORTHCOTE CODING	Uc 1.22-1/0/20	Ug 3.3-5/2/10	Ug 5.23-6/3/25	Dr 2.33-3/2/30	Dr 4.23 2/1/30	Dy 3.43-3/1/40
TEXTURE OF 'B' HORIZON	Sand	Heavy clay	Heavy clay	Medium clay	Medium clay	Medium clay
PROFILE DRAINAGE	Good	Poor	Poor	Mod	Mod	Mod
VOLUME EXPANSION	0	17	35	12	10	17
PLASTICITY INDEX	NP [1]	40	40	22	17	17
QUALITY OF TOPSOIL	Mod	Mod	Mod	Mod	Mod	Mod
ERODIBILITY	Mod	Mod	Mod	Low	Mod	Mod
SPECIAL SITE FEATURES	Low cohesion	Periodic high water table	High water table			Some highly dispersible patches. Periodic high water table.

[1] - non - plastic.

URBAN CAPABILITY

The urban land capability map has been developed from an assessment of the interaction of the physical features of the site. A number of land classes have been delineated according to landscape stability and their assessed potential for urban development.

Five major classes of erosion/instability hazard are defined on the landscape evaluation map, these are:

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

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

0	-	No major constraint
1	-	Slope
2	-	Flooding/Drainage
3	-	Soil characteristic
6	-	Seasonal high water table

The combination of two numerals indicates two physical features which interact to restrict development. See map at rear, or original map SCS 11300/C.

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

The capability defined for each sub-class refers to the most intensive urban use which land in that sub-class will tolerate without the occurrence of serious erosion and siltation in the short term, and possible instability and drainage problems in the long term. In assessing this capability no account is taken of development costs, social implications, aesthetics, or other factors relating to ecology and the environment.

Development which is planned to minimise erosion hazard is, however, generally consistent with an aesthetically pleasing landscape and savings in long term repair and maintenance costs.

Capabilities as defined relate to the degree of surface disturbance involved in the various categories of urban development. Extensive building complexes refers to the development of shopping malls, industrial centres, institutions or other structures 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 600 square metre housing blocks. The development of reserves, on the other hand, may require shaping and modification of the ground surface and vegetative improvement, but no building and minimal roadway construction is envisaged.

The definition of a site capability for residential development or for extensive building complexes does not automatically imply the capacity of that site to support multistorey units or other major structures. Before such works are undertaken, a detailed analysis of soil engineering characteristics such as bearing capacity and shear strength may be necessary on each site.

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

Revegetation and general stabilisation requirements should be included in specifications drawn up for development contractors.

General Recommendations

A number of general recommendations aimed at the control of erosion and siltation during development apply to the total site. These recommendations are an integral part of the capability plan and adherence to them is necessary for successful implementation of that plan.

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

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

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

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

(d) Areas that remain bare for long periods during subdivision development should be afforded temporary protection by sowing a cover crop - such as Japanese millet in spring-summer or cereal rye in autumn-winter, - or by treatment with a surface mulch of straw or a chemical stabiliser.

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

(f) On hillslopes particular care is required with cut and fill and general grading operations, whether for roadways or building sites.

(i) Such operations should be restricted to a practical minimum. Deep cuts and excessive fill should be avoided as far as possible.

(ii) Low angles of cut are desirable on siliceous sandy soils. Batters should be designed to a gradient no steeper than 1 in 4.

(g) Where possible development should be designed to minimise alteration of the natural landscape. In this context cut and fill and general grading operations should be limited to the minimum necessary for development.

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

(i) Vehicular traffic should be controlled during subdivision development, confining access, where possible, to proposed or existing road alignments.

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

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

(l) Early stabilisation of exposed soil and of cut and fill batters is essential. Specific recommendations on seed and fertilizer mixtures and application rates will be provided, on request, by the Albury Soil Conservation Office.

(m) Following roadway construction and the installation of services, all disturbed soil 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 the soil is very wet or very dry when respread.

(iii) Grasses and legumes should be sown into a prepared seed bed.

Autumn sowings will generally be most successful. If spring sowing is necessary, irrigation may be required during summer to ensure successful establishment.

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

(n) 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.

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

Sub-Class A-0 : Low hazard - No major constraints - Suitable for extensive building complexes.

This sub-class contains broad areas of gently sloping land on the second and third river terraces. Slope gradients range from level to 5%.

Soils are predominantly siliceous sands that have good profile drainage. Other units include the red-brown earths and yellow solodic soils. All three soils have moderate profile drainage and are moderately erodible.

This sub-class can tolerate the most site disturbance of any land in the area. It is suitable for extensive building, shopping or educational complexes, involving large scale ground disturbance and levelling, without serious erosion hazard. Where this form of land development occurs, particular attention should be paid to provisions (a), (b), (h), and (m) of the general recommendations.

Land in this class is also suitable for residential subdivision or for recreational development.

Sub-Class A-3 : Low hazard - Plastic soils constraint - Suitable for extensive building complexes.

A significant area of sub-class A-3 land occurs on the second river terrace and is confined to the brown clay soil unit. This soil type has a high plasticity and a moderate shrink/swell potential. These characteristics will impose a constraint on urban development. Individual soil tests should be made before designing roads and building foundations, so that possible damage to these structures may be avoided.

Profile drainage varies from moderate to poor and periodic waterlogging may occur during protracted wet conditions in winter. The heavy clay soils are generally unsuitable for septic tank absorption fields. Site investigations should be made to determine if the soil has an acceptable percolation rate for this form of waste disposal.

Land in this class may be used for industrial/commercial development, residential subdivision and recreation without serious erosion being generated. To minimise any erosion hazard, attention should be paid to the general recommendations, particularly items (a), (c), (h), (i) and (m).

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

This sub-class contains three small areas with slope gradients ranging from 5% to 10% on the southern edge of the second river terrace. Soils are moderately erodible and excessive excavation or levelling is not recommended.

(i) Commercial or industrial development requiring large scale levelling is not recommended on land in this sub-class. Problems may arise from erosion of cut and fill embankments and the occurrence of seepage areas. If, however, such development is undertaken, the erosion hazard should be minimised by adhering closely to items (a), (b), (c), (d), (e), (g), (k), (l) and (m) of the general recommendations.

(ii) These areas will accept residential development without a severe erosion hazard being generated, provided the general recommendations are followed.

(iii) Due to the limited areas of this sub-class possible development of active recreational facilities would be restricted.

Figure 8.

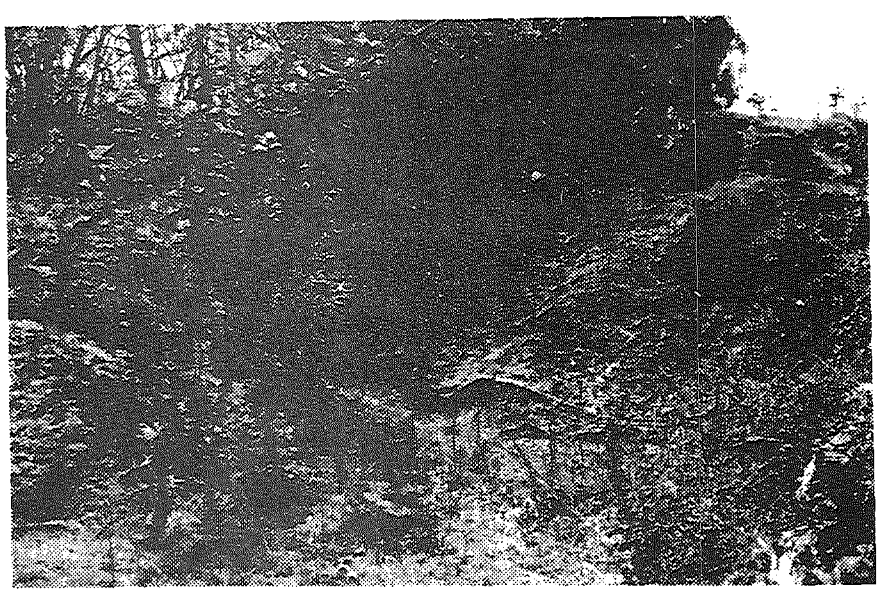
Waterlogged areas on the third river terrace are classed as D-2,3,6. Residential development should not encroach onto these areas.

Figure 9.

A drainage depression that has been incised into the second river terrace. It should be developed as a drainage reserve to carry runoff from the town onto the floodplain.

Figure 10.

Disposal of runoff over the second river terrace has led to gully erosion. This erosion will become severe as urban development in the town increases runoff. Planning and development of drainage reserves should receive priority in a development programme.



Drainage Depression on the Third Terrace

This is an ancient riverine feature on the high terrace. It is a closed depression with no outlet to the Murray River. It collects local runoff which lies for many months and appears to drain slowly into the sandy soils near Kennedy and Hovell Streets.

Residential development should not be allowed on this area. Filling the depression may cause water to be impounded on adjacent land.

It is recommended that the area be developed as a drainage reserve. Use as yard space for residential allotments would be acceptable, provided no fill or structures were placed to obstruct the free drainage of water along the depression.

Sub-Class E-1 : Extreme hazard - Slope constraint - Not recommended for development.

This sub-class has slope gradients greater than 20% and includes vertical embankments caused by undercutting and erosion by the Murray River. These areas occur on both the second and third river terraces with soils as described in map units A, B and E.

Under grass cover, these banks are stable at a slope angle of 30% or less. However, most slopes have been undercut by the river and their stability is maintained only by willows or river red gums. Where trees are not present, erosion and undercutting is continuing.

On the heavier clay soils in this sub-class susceptibility to mass movement may be aggrevated as the moisture content of the soil profile increases.

Severe river bank erosion exists on the western edge of Howlong and is causing extreme instability problems for adjoining land. Control of this erosion is required to ensure land stability, and for this purpose the advice of the River Improvement Branch of the Water Resources Commission should be obtained.

It is recommended that no form of development be undertaken on this land and that it be retained under a dense cover of vegetation.

Sub-Class C-1 : High hazard - Slope constraint - Suitable for residential development.

This sub-class is confined to a small area in the reserve between High Street and Bank Street. It forms the slope between the first and second river terraces, with gradients ranging from 10% to 20%. Soils are red-brown earths of map unit E.

This land is best suited to residential development or passive recreation. Commercial or industrial development, involving extensive cut and fill to obtain level sites, is not recommended.

The recommendations for development of sub-class B-1 land also apply to construction on this sub-class, but the erosion hazard is greater because the gradients are steeper. Particular attention should be paid to the formation and stabilisation of batters.

Sub-Class C-1, 3 : High hazard - Slope/plastic soils constraints - Suitable for residential development.

This sub-class is located on the sideslopes of a drainage depression incised into the second river terrace. Slope gradients range from 5% to 20%.

Soils are heavy brown clays with high plasticity and poor profile drainage. They are moderately erodible and soil erosion will occur if uncontrolled development takes place on the steeper slopes.

(i) These lands are not considered suitable for development of extensive building complexes requiring large scale cut, fill and levelling operations.

(ii) Residential development is considered the highest capability of this land. Due to the highly plastic soils, specific attention should be paid to foundation design for houses and roads. Individual site investigations for septic tank absorption fields are also required to determine if the soil has an acceptable percolation rate. Development of these areas can be achieved without severe soil erosion occurring by paying particular attention to provisions (a), (b), (c), (d), (e), (f), (g), (h), (k), (l) and (m) of the general recommendations.

Figure 1.

Sub-class A-O, contains level to undulating land that is suitable for the maximum intensity of urban development.

Figure 2.

Subdivision has been allowed on the floodplain of the Murray River. Urban development is not recommended on this sub-class (D-2,3), as it is liable to flooding and has a poor soil type.

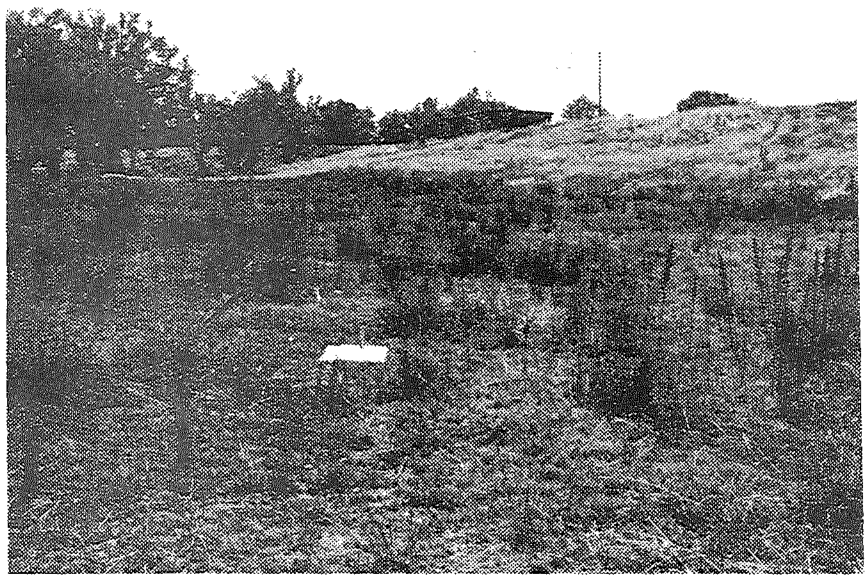


Figure 3.

The steeply sloping land is sub-class E-1. This separates sub-class D-2,3 on the floodplain and sub-class A-O on the second river terrace. Development on sub-class E-1 should not be attempted, as it may threaten the stability of the better land.

(iii) Extensive site levelling for active recreation facilities is not recommended. Development for passive recreation will not present problems of site instability.

Sub-Class C-3 : High hazard - Volume expansion and plastic soils constraint - Suitable for residential development.

This class is located on heavy grey clay soils on the second river terrace, and in the north eastern section on the third river terrace. Slope gradients range from level to 2%.

The soil imposes the major constraints to development. It has a volume expansion of 35%, a plasticity index of 40 and poor profile drainage. During a normal winter, a high water table is maintained for prolonged periods.

Any development in this sub-class will require additional soil tests to aid the design of road pavements and building foundations. This is necessary to prevent damage to structures resulting from these adverse physical soil properties.

Septic absorption systems are not recommended in this soil type.

This land is not suitable for extensive building complexes but will accept residential or recreational use provided adequate building foundations are provided. The development of active recreational facilities will require such site modifications as improvement of surface and subsurface drainage and spreading of sandy loam fill to reduce the effects of cracking in the grey clay soils. Gilgaies and local poorly drained areas will reappear after levelling due to the shrink/swell characteristic of the soil.

This area receives runoff from adjacent land. Improvement of surface drainage facilities is required prior to development to collect and dispose of this water.

Sub-Class D-2, 3 : Very high hazard - Flooding/soil constraints - Suitable for reserves.

This sub-class is confined to the lower river terrace and is subject to regular inundation from the Murray River. It consists of swamps, lagoons, old river channels and broad depositional areas. The soils are layered alluvium, deep uniform sands and silty clays overlying sand.

Industrial or residential land use is not recommended. There is a major risk of structural damage, flooding and waterlogging.

To retain land stability, the most suitable urban use is for passive recreation.

Roads required for access to recreation areas should be located on elevated land to allow adequate site drainage. Suitable crossings should be designed over flood channels to allow unrestricted passage of flood water.

Sub-Class D-2,3,6 : Very high hazard - Flooding/soil/high water table constraints - Suitable for drainage reserves.

This sub-class includes the drainage depressions located on the second and third river terraces.

Drainage Depressions on the Second River Terrace

A drainage depression has been incised into the second terrace with a base slope gradient ranging from level to 5%. Soils are predominantly brown clays.

This area is not suited for building construction. It should be developed as a drainage and recreation reserve to carry runoff from the town onto the floodplain without causing gully erosion on the sideslopes of the terrace. A grassed waterway in combination with a small underground pipe is recommended.

Minimal site modification should precede sowing of suitable plant species. These will provide a permanent vegetative cover. The underground pipe will carry small, frequent flows, allowing the grassed waterway to be maintained to carry high storm flows with minimal erosion damage. This area will also serve as recreational space.

A large drainage depression also occurs on the second terrace in Lowe Square. This area is level and is regularly inundated by runoff from the town. The soil is a grey clay with poor profile drainage, so that the area is waterlogged for long periods.

This land will be suited to passive recreation after improvements to surface drainage facilities and minor levelling of the ground surface to facilitate site maintenance.

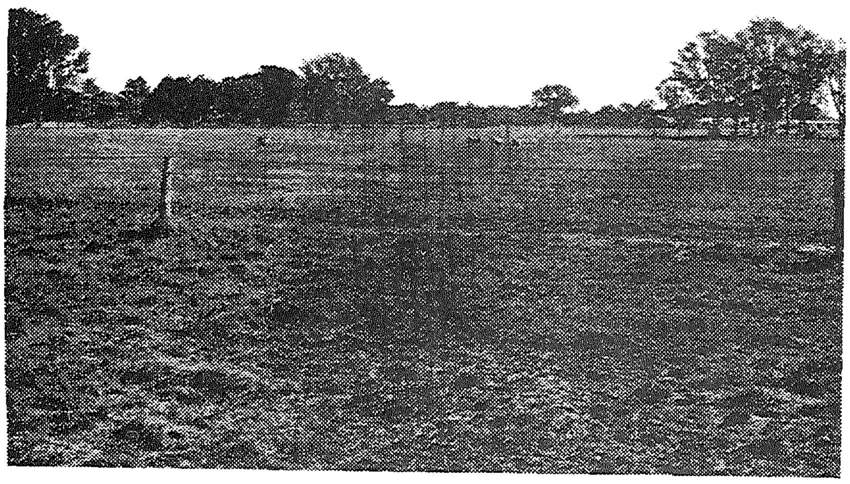
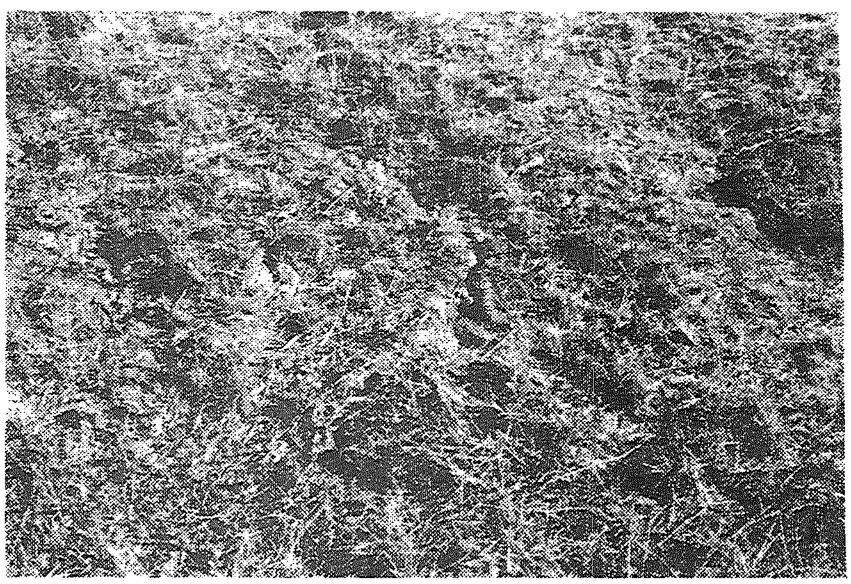


Figure 4.

Figure 5.



Sub-class C-3 contains soils that have a high volume expansion, a high plasticity and poor profile drainage. The land is waterlogged for prolonged periods during winter and cracks on drying during summer.

Figure 6.

Figure 7.

Sub-class E-1 has an extreme erosion/instability hazard that may eventually affect development of adjoining land. Severe river bank erosion (Figure 6) requires stabilisation before any development is allowed on the third river terrace above. Stabilisation can be achieved by planting willows (Figure 7).

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TABLE 2.

APPENDIX A

LABORATORY ANALYSES OF SOILS - HOWLONG

Sampling Site	Sample		Particle Size Analysis											
	No.	Depth	Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	LL	PI	USCS	D	S/S	Crumb Test
	1	0-20	22	37	37	4	0	0	-	-	-	2.3	-	3
1	2	20-50	50	24	20	5	0	0	33	20	CL	3.5	11	33
	3	50-120	44	42	13	1	0	0	47	20	CL	3.1	14	2
	4	0-10	15	26	55	3	0	0	-	-	-	3.3	-	2
2	5	10-35	21	28	33	17	0	0	-	-	-	1.9	-	2
	6	35-50	36	36	19	9	0	0	30	10	CL	2.8	4	2
	7	50-120	33	31	27	9	0	0	39	17	CL	3.5	8	2
	8	0-10	13	35	42	8	2	0	-	-		2.3	-	7
3	9	10-25	36	28	31	4	0	0	29	11	CL	13.8	3	7
	10	25-120	42	40	17	1	0	0	45	20	CL	2.2	17	2
	11	0-10	13	14	42	13	0	0	-	-	-	25.0	-	2
4	12	10-30	15	19	38	29	0	0	15	NP	ML	2.6	5	-
	13	30-50	30	16	33	22	0	0	26	10	CL	-	6	2
	14	50-120	27	35	36	2	0	0	43	19	CL	6.6	14.6	2
	15	0-20	26	33	34	7	0	0	-	-	-	43	-	7
5	16	20-50	44	30	23	3	0	0	36	15	CL	4.2	sh	2
	17	50-120	48	32	18	2	0	0	57	31	CH	2.8	15	-
	18	0-10	7	3	43	46	0	0	-	-	-	14	-	3
6	19	10-30	7	5	38	50	0	0	NL	NP	-	2.4	1.5	3
	20	30-70	19	6	34	42	0	0	NL	NP	ML	4.2	12	2
	21	70-120	22	2	40	37	0	0	19	NP	ML	5.9	6	2
7	22	70-120	22	5	41	32	0	0	-	-	-	4.8	-	2
	23	120-150	31	4	32	32	0	0	-	-	-	-	-	2

TABLE 2. (Continued) LABORATORY ANALYSES OF SOILS - HOWLONG

Sampling Site	Sample No.	Sample Depth	Particle Size Analysis: Clay	Silt	Fine Sand	Coarse Sand	Gravel	Stones	LL	PI	USCS	D	S/S	Crumb Test
8	25	10-30	18	21	46	14	0	0	-	-	-	2.5	-	2
	26	30-70	29	18	41	12	0	0	25	10	CL	4.9	12	2
	27	70-120	39	15	36	10	0	0	47	23	CL	4.0	9	2
9	28	0-10	14	20	46	19	2	0	-	-	-	1.9	-	3
	29	10-30	10	21	42	15	8	4	NL	NP	ML	1.6	sh	2
	30	30-70	37	23	21	15	5	0	30	14	CL	3.5	15	2
	31	70-120	35	15	38	11	1	0	35	17	CL	4.4	17	2
10	32	0-10	18	22	51	10	0	0	-	-	-	3.0	-	2
	33	10-30	28	17	47	8	0	0	-	-	-	4.0	8	2
	34	30-70	45	22	31	2	0	0	34	22	CL	2.1	14	2
	35	70-120	20	17	53	11	0	0	48	24	CL	2.7	20	2
11	36	0-10	20	20	36	17	7	0	-	-	-	2.0	-	3
	37	10-30	39	20	26	15	1	0	19	2	ML	1.2	sh	2
	38	30-70	64	6	16	4	1	0	28	12	CL	1.0	NW	1
	39	70-120	69	14	12	5	0	0	68	43	CH	3.5	NW	1
12	40	0-20	64	13	19	5	0	0	-	-	-	3.5	-	2
	41	20-50	81	5	12	2	0	0	72	40	CH	1.2	15	1
	42	50-120	73	7	18	2	0	0	71	35	MH	1.1	33	1

Notes sh = shrink
NW = not wet up after 48 hours

TABLE 3. PROPERTIES OF MAJOR SOILS - HOWLONG

MAPPING UNIT	A		B		C	
Northcote Coding	Uc 1.22 - 1/0/20		Ug 3.3 - 5/2/10		Ug 5.25 - 6/3/25	
Great Soil Group	Siliceous sand		Brown clay		Grey clay	
Underlying Material	-		-		-	
Depth to bedrock	-		-		-	
Profile drainage	Good		Poor		Poor	
Texture B horizon	Sand		Heavy clay		Heavy clay	
Sample depth (cm)	30-70	70-120	30-70	70-120	20-50	50-120
Liquid Limit	NP	NP	28	68	72	71
Plastic Limit	NP	NP	16	25	32	36
Plasticity Index	NP	NP	12	43	40	35
U.S.C.S.	ML	ML	CL	CH	CH	MH
Shrink/swell potential	Low	Low	Mod	High	High	High
D.I.	4.8	-	1.3	3.5	1.2	1.1
Erodibility	Mod	Mod	High	Mod	Mod	Mod
pH	7.5	8.5	5.5	8.5	5.5	8.5
Suitability for Ponds	Poor		Good		Moderate	
Topsoil quality	Moderate		Moderate		Moderate	
Ease of revegetation	Moderate		Poor		Poor	
Special features	Unconsolidated sand. Highly permeable		High water table. Low permeability		High water table + High shrink/swell.	

TABLE 3 (continued) PROPERTIES OF MAJOR SOILS - HOWLONG

MAPPING UNIT	D		E		F	
Northcote Coding	Dr 2.33 - 3/2/30		Dr 4.23 - 2/1/30		Dy 3.42 - 3/1/40	
Great Soil Group	Red-brown earth		Red-brown earth		Yellow solodic	
Underlying material	-		-		-	
Depth to bedrock	-		-		-	
Profile drainage	Moderate		Moderate		Moderate	
Texture B Horizon	Medium clay		Medium clay		Medium clay	
Sample depth (cm)	30-70	70-120	35-50	50-120	30-70	70-120
Liquid Limit	25	47	30	39	30	35
Plastic Limit	15	24	70	22	16	18
Plasticity Index	10	23	10	17	14	17
U.S.C.S.	CL	CL	CL	CL	CL	CL
Shrink/swell potential	Low	Low	Low	Low	Mod	Mod
D.I.	4.9	4.0	2.8	3.5	3.5	4.2
Erodibility	Low	Low	Mod	Low	Mod	Mod
pH	7.0	8.5	7.0	8.5	6.0	8.5
Suitability for Ponds	Moderate		Moderate		Good	
Topsoil quality	Moderate		Moderate		Moderate	
Ease of revegetation	Good		Good		Poor	
Special features	-		-		Periodic high water table. Low permeability.	

GLOSSARY OF TERMS FOR TABLE 3.

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.), (1975).

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.

Great Soil Group

The Great Soil Group is a soil classification based on the morphological features of the total soil profile. It infers the formation of that soil in the presence of certain soil-forming processes. A full description of the Great Soil Groups originally devised by Stephens (1962) is given in Stace, Hubble et al (1968).

Northcote Grouping

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

Particle Size Analysis

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

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 parent 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.

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

Volume Expansion (V.E.)

The volume expansion of a soil when wetted is measured by the Keen-Raczowski (1921) Volume Expansion Test. It measures the shrink-swell potential of a soil sample. The modified computation procedure of Wickham and Tregenza (1973) is used to calculate the volume expansion by comparing the mass of a saturated expanded portion of soil with the mass of a saturated residual portion.

Suitability for Ponds

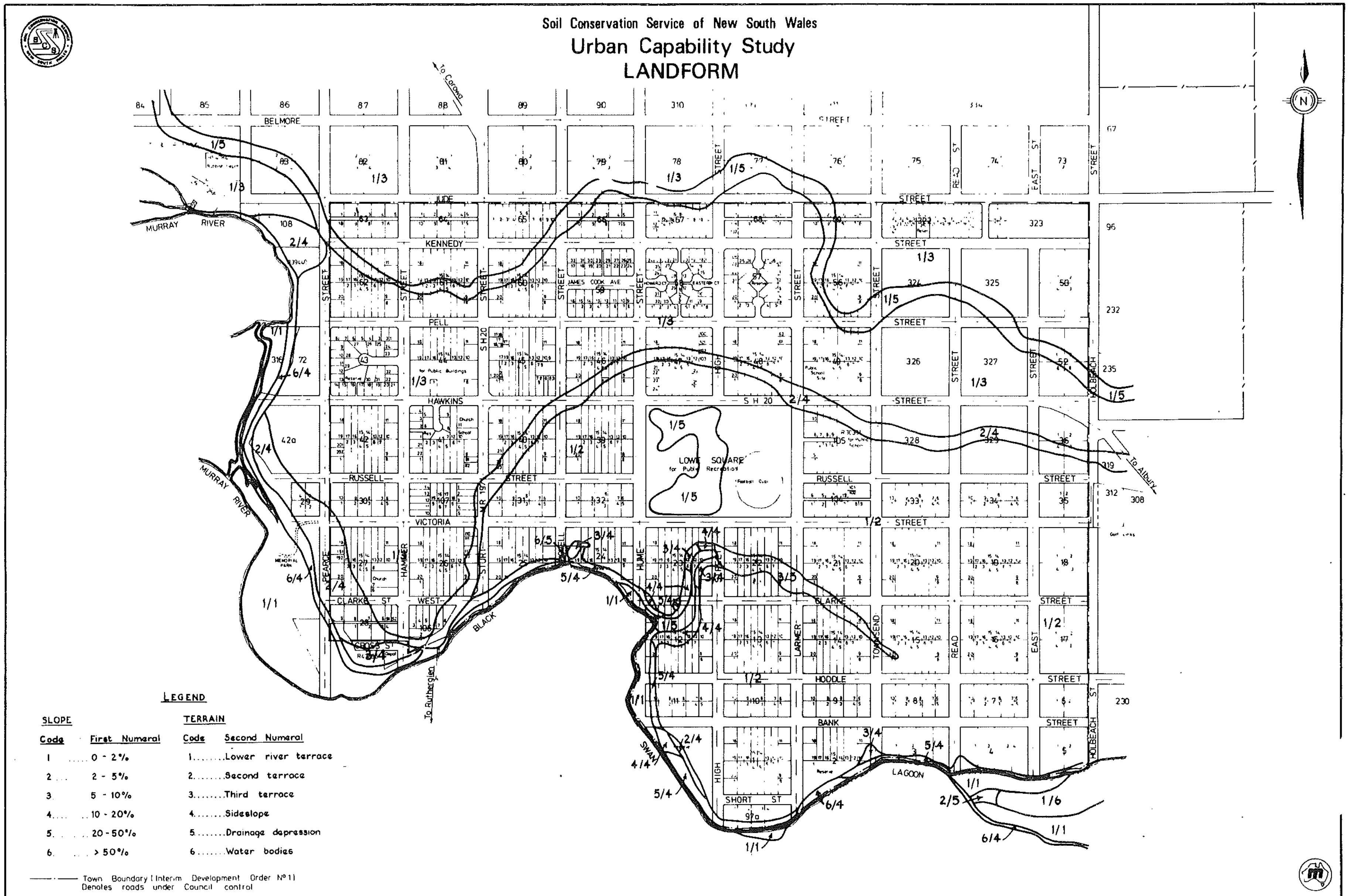
Possible values: Good, Moderate, Poor.

Depth to Bedrock

If encountered before 180 cm. Also indicates minimum depth of soil.

Profile drainage

Estimated from site characteristics and soil appearance. Possible values: Poor, Moderate, Good.



SCALES

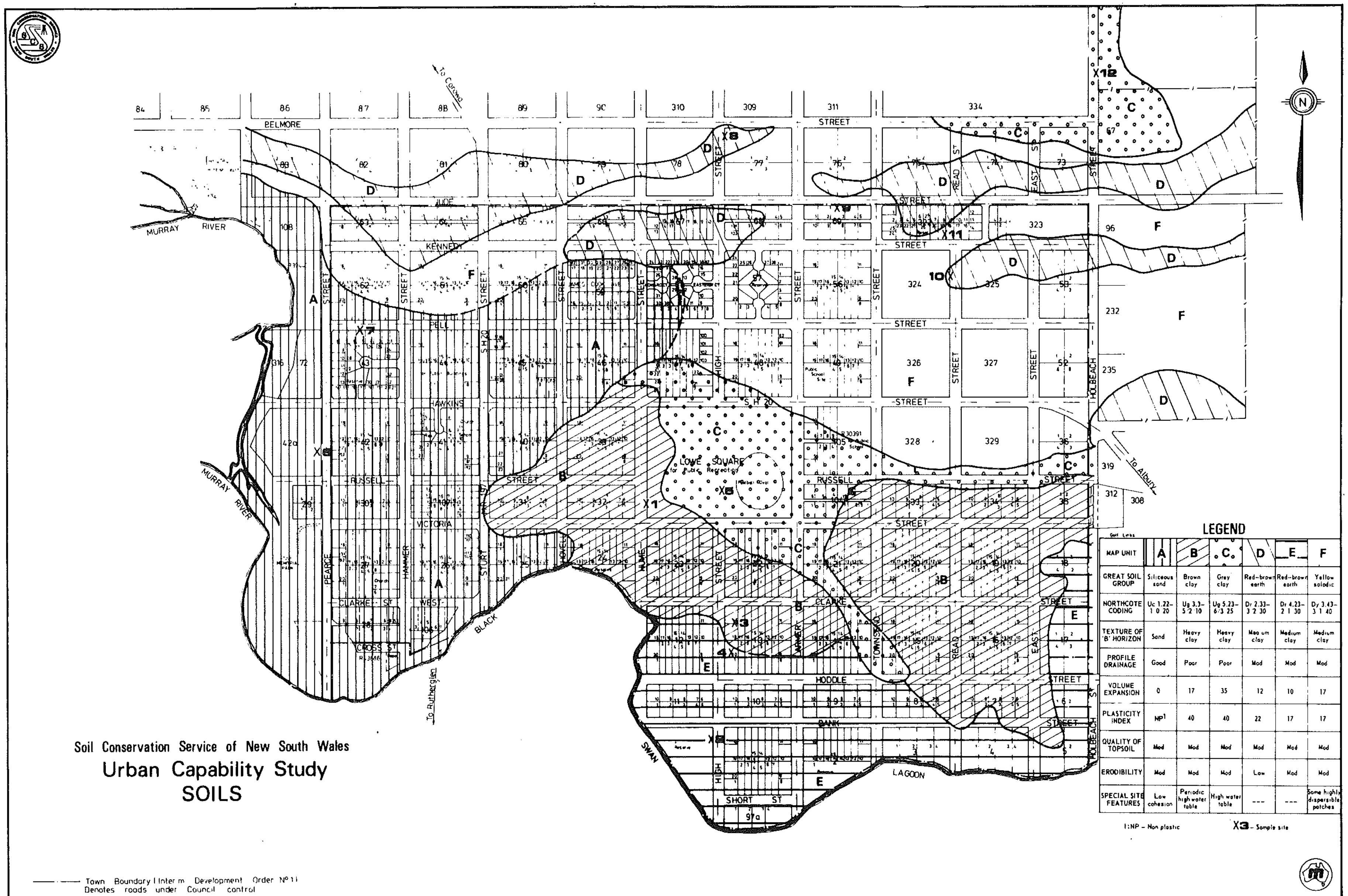
Plan

Longitudinal Section

Cross Sections

SHIRE OF HUME

TOWN OF HOWLONG



Soil Conservation Service of New South Wales

Urban Capability Study

SOILS

LEGEND

MAP UNIT	A	B	C	D	E	F
GREAT SOIL GROUP	Siliceous sand	Brown clay	Grey clay	Red-brown earth	Red-brown earth	Yellow solodic
NORTHCOTE CODING	Uc 1.22-1 0 20	Ug 3.3-5 2 10	Ug 5.23-6 3 25	Dr 2.33-3 2 30	Dr 4.23-2 1 30	Dy 3.43-3 1 40
TEXTURE OF 'B' HORIZON	Sand	Heavy clay	Heavy clay	Medium clay	Medium clay	Medium clay
PROFILE DRAINAGE	Good	Poor	Poor	Mod	Mod	Mod
VOLUME EXPANSION	0	17	35	12	10	17
PLASTICITY INDEX	NP1	40	40	22	17	17
QUALITY OF TOPSOIL	Mod	Mod	Mod	Mod	Mod	Mod
ERODIBILITY	Mod	Mod	Mod	Low	Mod	Mod
SPECIAL SITE FEATURES	Low cohesion	Periodic high water table	High water table	---	---	Some highly dispersible patches

1:NP – Non plastic

X3 – Sample site

Town Boundary (Interim Development Order Nº 1)
Denotes roads under Council control

SCALES

Plan

Longitudinal Section

Cross Sections

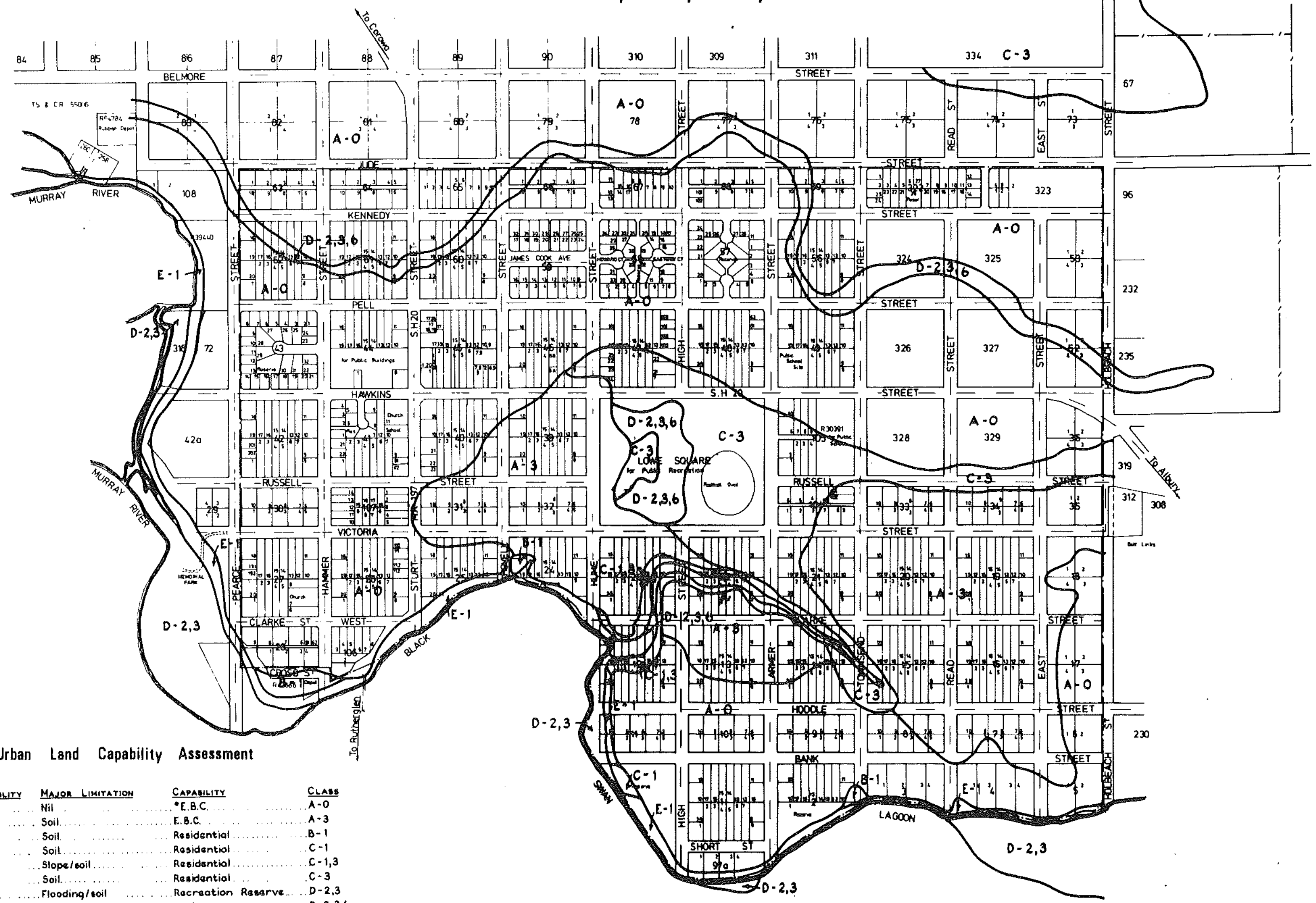
SHIRE OF HUME

TOWN OF HOWLONG

Incorporating amendments up to 1.10.75

Soil Conservation Service of New South Wales

Urban Capability Study



Urban Land Capability Assessment

Erosion / Instability	Major Limitation	Capability	Class
Low	Nil	*E.B.C.	A-O
Low	Soil	E.B.C.	A-3
Moderate	Soil	Residential	B-1
High	Soil	Residential	C-1
High	Slope/soil	Residential	C-1,3
High	Soil	Residential	C-3
Very high	Flooding/soil	Recreation Reserve	D-2,3
Very high	Flooding/soil/drainage	Drainage reserve	D-2,3,6
Extreme	Unstable slope	No development	E-1

——·—— Town Boundary (Interim Development Order Nº 1) *E.B.C. denotes Extensive Building Complexes

- - Denotes roads under Council control

SCALES

Plan 0 100 200m

Longitudinal Section

Cross Sections

SHIRE OF HUME

TOWN OF HOWLONG

Incorporating amendments up to 1.10.75