SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

RECONNAISSANCE LAND RESOURCES SURVEY

TABLE TOP

Prepared for

HUME SHIRE COUNCIL

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C O N T E N T S

INTRODUCTION

This report has been compiled for the Hume Shire Council in response to the high demand for residential and rural residential development on land surrounding Table Top. The survey area lies approximately 15 km north of Albury and to the west of the Hume Highway. It adjoins the north western corner of the designated area of the Albury-Wodonga Development Corporation (Figure 1). This designated area has been previously described in Junor, Emery and Crouch (1977). Data from this previous study have been utilised in this report.

Physical resource data have been collected in the survey area. This includes data relating to climate, landform, geology and soils. The characteristics of the soils relating to erodibility, drainage, stability and development limitations have been assessed. The Service's rural and urban capability classifications have been used to evaluate the physical limitations of the Table Top area for rural residential use. This capability information will help Council to reach a balance between various land uses in the area, select the most suitable sites for development, and minimise the erosion hazards associated with various forms of land use.

This survey and accompanying maps are intended to form a basis upon which planning considerations should be imposed to help in land use allocation in the Table Top survey area.

The soils, rural capability and urban capability maps of the Table Top survey area have been prepared at a scale of 1:10 000. The maps should not be enlarged for use at a scale larger than 1:10 000 nor should they be regarded as providing a detailed appraisal of individual development areas within the survey area.

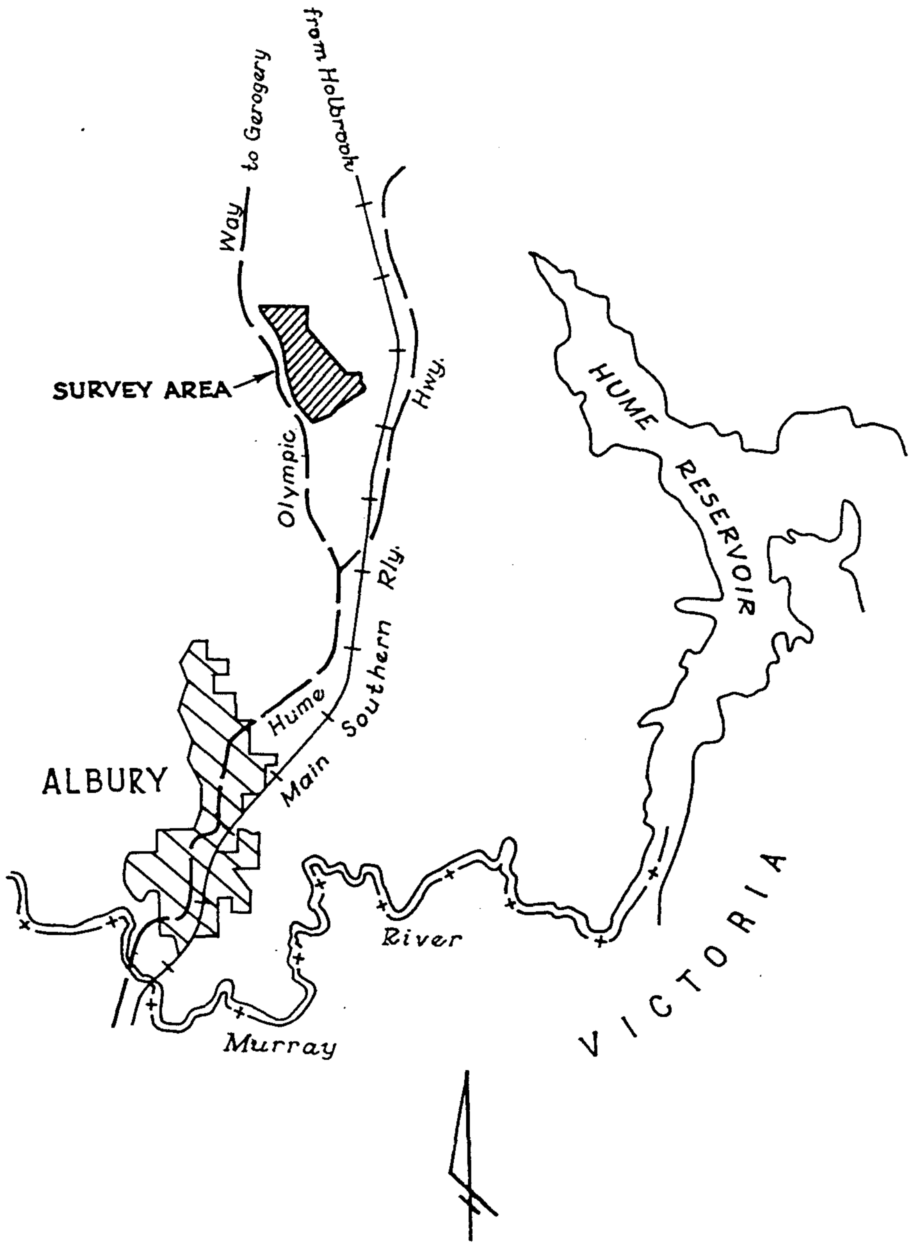
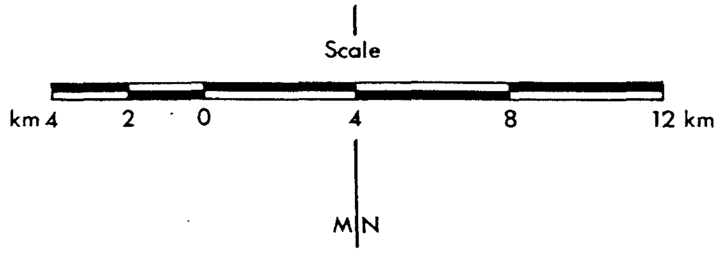


FIGURE 1
Locality Diagram
RECONNAISSANCE LAND RESOURCES SURVEY
TABLE TOP
HUME SHIRE



PHYSICAL FEATURES

CLIMATE

The annual median rainfall at Table Top is approximately 650 mm, and is winter dominant. Winter rainfall is more reliable than summer rainfall. Further, during winter, prolonged wet periods cause saturated soil conditions on poorly drained soils. This necessitates the incorporation of drainage and other soil conservation works.

Low temperatures restrict growth during the winter months. The spring and autumn months are the most favourable for plant growth due to the combination of moderate temperatures and adequate soil moisture regimes.

LANDFORM

The dominant landform feature of the survey area is a granite hill, which is located on the southern boundary, west of the Hume Highway. Landform relief decreases to the northwest and southeast of this hill. To the north, landform relief decreases towards Sandy Creek which flows, in a north easterly direction, into Bowna Creek and then into the Hume Weir.

Most of the survey area is comprised of footslopes which are traversed by natural drainage areas and watercourses.

GEOLOGY AND SOILS

The survey area is comprised of residual and colluvial deposits derived from underlying Silurian granite. These deposits occur on the hills, ridges and footslopes in association with scattered outcrops of Silurian granite. The remaining low-lying areas are comprised of unconsolidated deposits of clay and silt.

Six major soil map units have been identified in the survey area, (Figure 2) and five of these have previously been described Junor *et al* 1977. One new soil map unit was identified during the survey of the Table Top survey area. Soil map unit boundaries were delineated by field investigation using auger sampling to a depth of approximately 50 cm. At selected sites soils were examined to a depth of 150 cm.

The soils descriptions, with the exception of map unit F soils, are based on those soil groups in Junor *et al* (1977), with minor modifications. Soils have been classified using the Northcote Factual Key (Northcote, 1979).

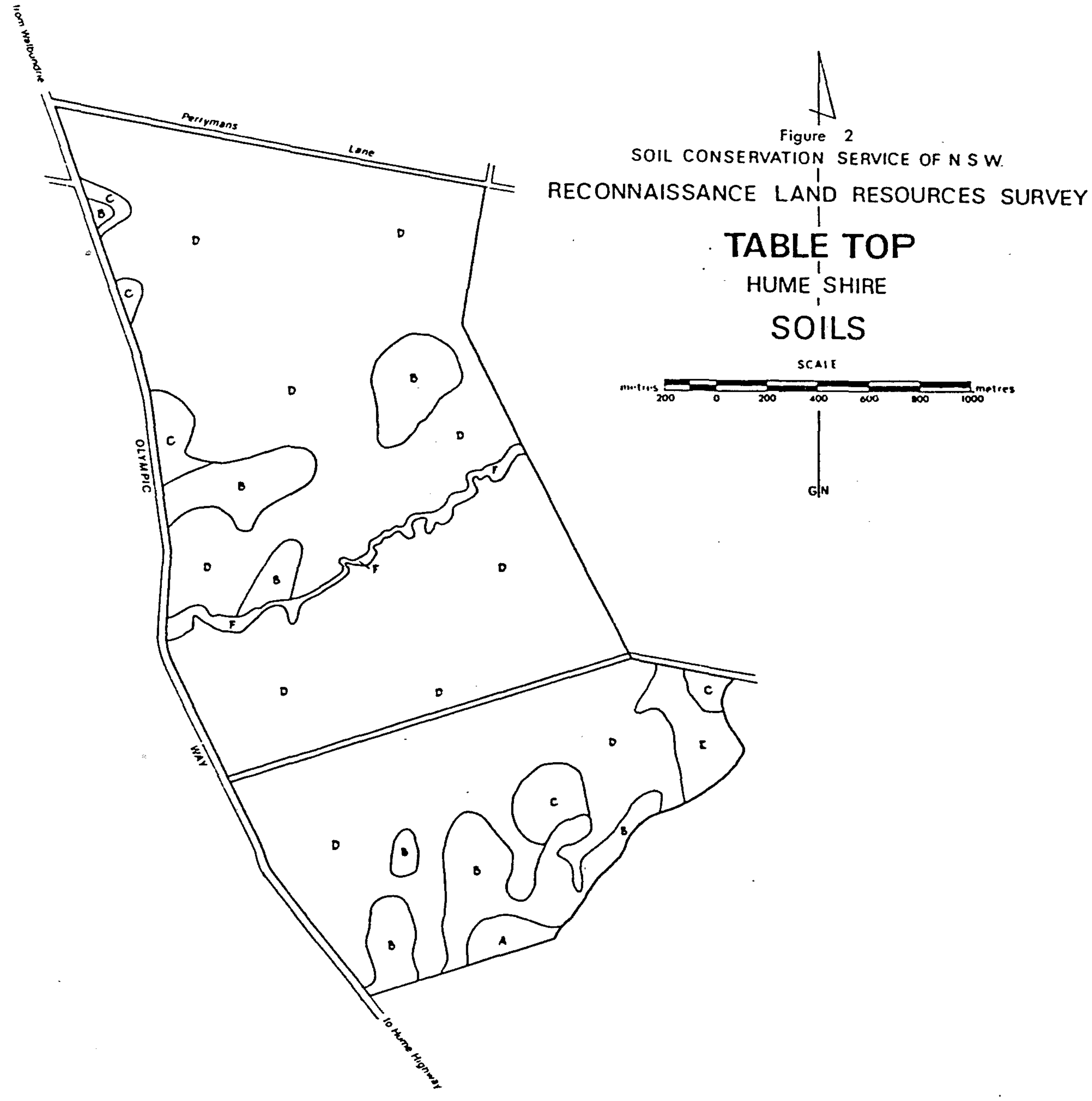


Figure 2
SOIL CONSERVATION SERVICE OF N S W.
RECONNAISSANCE LAND RESOURCES SURVEY

TABLE TOP

HUME SHIRE

SOILS

LEGEND

DOMINANT SOILS	NORTHCOTE SOIL CLASSIFICATIONS	MAJOR LIMITATIONS	MAP UNIT
Variable	Uc 2 21, Uc 1·21, Dy 3·41	Slope Rock outcrops Soil erodibility Seasonal waterlogging Mass movement hazard	A
Red Massive Earths	Gn 2 12, Dr 2·12	Slope Shallow soil depth (in areas) Isolated areas of map unit E soils	B
Yellow Duplex Soils	Dy 2·22, Dy 2 12, Dy 3 22	Slope	C
Mottled Yellow Duplex Soils	Dy 3 22, Dy 3·32, Dy 3·42 Dy 3 12	Soil erodibility Isolated areas of map unit E soils Subsoil permeability.	D
Mottled Yellow Duplex Soils	Dy 3 42	Soil erodibility Seasonal waterlogging Topographic limitation Wet soil strength	E
Alluvial Soils		Flooding	F

Map Unit A - Granite Hill Soils Group - *Sands and Siliceous Sands*

Occurrence:

These soils occur on a small area of rounded granite hills, situated on the southern boundary of the survey area.

Characteristics:

These soils strongly reflect the grain size and mineralogical composition of their granitic parent material. The predominant soils are sandy throughout. A bleached A_2 soil horizon overlies a white or yellow grey mottled B soil horizon (Uc 2.21), or a deep light brown sand with minimal soil profile development (Uc 1.21). These soils are slightly acidic throughout. They are highly erodible, and in some situations, subject to failure by mass movement.

Variability:

These soils are usually sandy. Soil profile development varies from uniform sands (Uc 1.21) to duplex, bleached soils (Dy 3.41) with sandy clay B soil horizons.

Identifying Features:

1. Rounded hills with granite outcrops

2. Coarse, sandy textured soils derived from granitic parent material

Current Land Use:

Grazing, recreation

Physical Constraints to Development:

1. Slope gradient
2. Rock outcrop
3. Soil erodibility
4. Seasonal waterlogging
5. Mass movement hazard

Map Unit B - St. Johns Soils Group - *Massive Red Earths*

Occurrence:

These soils dominate the crests of low hills throughout the survey area. They are generally associated with small granite rock outcrops near the ridge tops and overlie yellow clays further downslope.

Characteristics:

Low ridges in an undulating landscape define this soil map unit. Soils are predominantly massive red earths (Gn 2.12). Red duplex soils (Dr 2.12) also occur, having A_2 soil horizon development and greater texture contrast within the soil profile.

The main soil textures are clay loam, or sandy clay loam A horizons over silty clays or light clays. The clay content increases with depth. The C bedrock horizon consists of weathered granite near the crests. Yellow, medium clay B_2 soil horizons occur further downslope. The soil is slightly acidic (6.5) throughout the profile.

Variability:

The soil predominantly consists of massive red earths (Gn 2.12). These are bordered downslope by map unit C soils, yellow duplex soils. Small areas of map unit E soils, mottled yellow duplex soils, with a moderate to high shrink-swell potential occur in depressions; these areas impose additional developmental constraints.

Identifying Features:

1. Red clay B soil horizons
2. Minimal A_2 soil horizon development
3. Clay loam or sandy clay loam A_1 horizons

Current Land Use:

Grazing, cropping in selected areas

Physical Constraints to Development:

1. Slope gradient
2. Shallow soil depth near the ridge crests
3. Isolated areas of map unit E soils

Map Unit C - Thurgoona Soils Group - *Yellow Duplex Soils*

Occurrence:

These soils occur below map unit B soils on low ridges throughout the survey area.

Characteristics:

Yellow duplex soils (Dy 2.22 with areas of Dy 2.12 and Dy 3.22) occupy midslope areas below map unit B soils. The dominant soil has a clay loam to loam A horizon overlying a light clay, yellow, B soil horizon. An A_2 soil horizon may or may not be present.

Variability:

There is considerable variation within the soil profiles. The development of the A_2 soil horizons and the presence of mottles in the B soil horizons vary. The colour of the B soil horizons is also variable, and may sometimes be orange rather than yellow.

Identifying Features:

1. Clay loam to loam A soil horizons
2. Bright yellow B soil horizons
3. The A_2 soil horizons, if present, are relatively shallow - less than 20 cm

Current Land Use:

Grazing, cropping in selected areas

Physical Constraints to Development:

1. Slope gradient

Map Unit D - Ettamogah Soils Group - *Mottled Yellow Duplex Soils*

Occurrence:

These soils occur over the majority of the survey area. They are found on large areas of footslopes.

Characteristics:

Soils are mottled yellow duplex soils (Dy 3.22 with areas of Dy 3.32, Dy 3.42 and Dy 3.12). They are located lower downslope than map unit B and C soils. Loam A soil horizons overly yellow, light to medium clay, B soil horizons that usually contain red or orange mottles. Unbleached, shallow A_2 soil horizons are usually present.

Variability:

There is considerable variation in the development of the A_2 horizons in these soils. Towards the lower boundary of these soils and in poorly-drained areas, the A_2 soil horizons become deeper and bleached, and the colour becomes duller.

At the upper soil boundary, mottles in the B soil horizons and A_2 soil horizon may be absent. Small areas of map unit E soils occur in drainage depressions, imposing a development constraint.

Identifying Features:

1. Loam A horizons
2. A_2 soil horizons which are usually unbleached
3. Red or orange mottles in the B soil horizons

Current Land Use:

Grazing

Physical Constraints to Development:

1. Soil erodibility
2. Isolated areas of map unit E soils
3. Subsoil permeability

Map Unit E - Wirlinga Soils Group - *Mottled Yellow Duplex Soils*

Occurrence:

These soils occur on gently sloping areas below map unit D soils. They receive extensive seepage water from adjoining upslope areas.

Characteristics:

These soils are mottled yellow duplex soils (Dy 3.42). They are readily recognised by the presence of deep, bleached A_2 soil horizons which overlie olive brown, medium to heavy clay B soil horizons which usually exhibit grey mottles.

The A_2 soil horizons are always greater than 40 cm in depth, strongly bleached, and contain ironstone nodules.

Variability:

Although these soils are relatively consistent throughout, there is variation in mottle development and the concentration of ironstone nodules in the A_2 soil horizons.

Identifying Features:

1. Very deep A_2 soil horizons
2. Olive brown mottled B soil horizons

Current Land Use:

Grazing, cropping in selected areas

Physical Constraints to Development:

1. Soil erodibility
2. Seasonal waterlogging
3. Topographic location
4. Low wet strength of the A soil horizons

Map Unit F - Sandy Creek Alluvium Soils Group - *Alluvial Soils*

Occurrence:

These soils occur on the floodplain of Sandy Creek.

Characteristics:

These soils are typical layered alluvial soils, with textures ranging from sand to light sandy clay loam. The bedload of Sandy Creek consists mainly of coarse sand.

Variability:

While the textures of these soils are usually sandy loam or light sandy clay loam, areas of deep sands also occur.

Identifying Features:

1. Layered alluvium
2. Textures ranging from sand to light sandy clay loam
3. Location - the floodplain of Sandy Creek

Current Land Use:

Grazing

Physical Constraints to Development:

1. Flooding

RURAL CAPABILITY

The rural capability classification used State-wide by the Service provides information on the optimum potential use of the land and its long term viability when used for various agricultural purposes (Anon, 1975). It accounts for the environmental factors that may limit the use of the land. These factors include those of widespread influence such as climate, terrain, slope and soil erodibility, and those of a more local influence such as soil depth, water holding capacity, wetness, rockiness, existing soil erosion, salinity and pH.

The survey area has been classified into a number of rural capability classes, according to the capacity of the land to sustain permanent rural production. In order to achieve this potential, specific soil conservation and land management measures are required to maintain the soil resource. These classes are shown on the Rural Capability Map (Figure 3).

Land which is used beyond its capability can be expected to deteriorate. The consequent soil erosion can be rapid, adversely affecting the immediate area and adjoining lands by the deposition of sediment. This results in loss of production and permanent damage to the soil resource.

LAND SUITABLE FOR REGULAR CULTIVATION

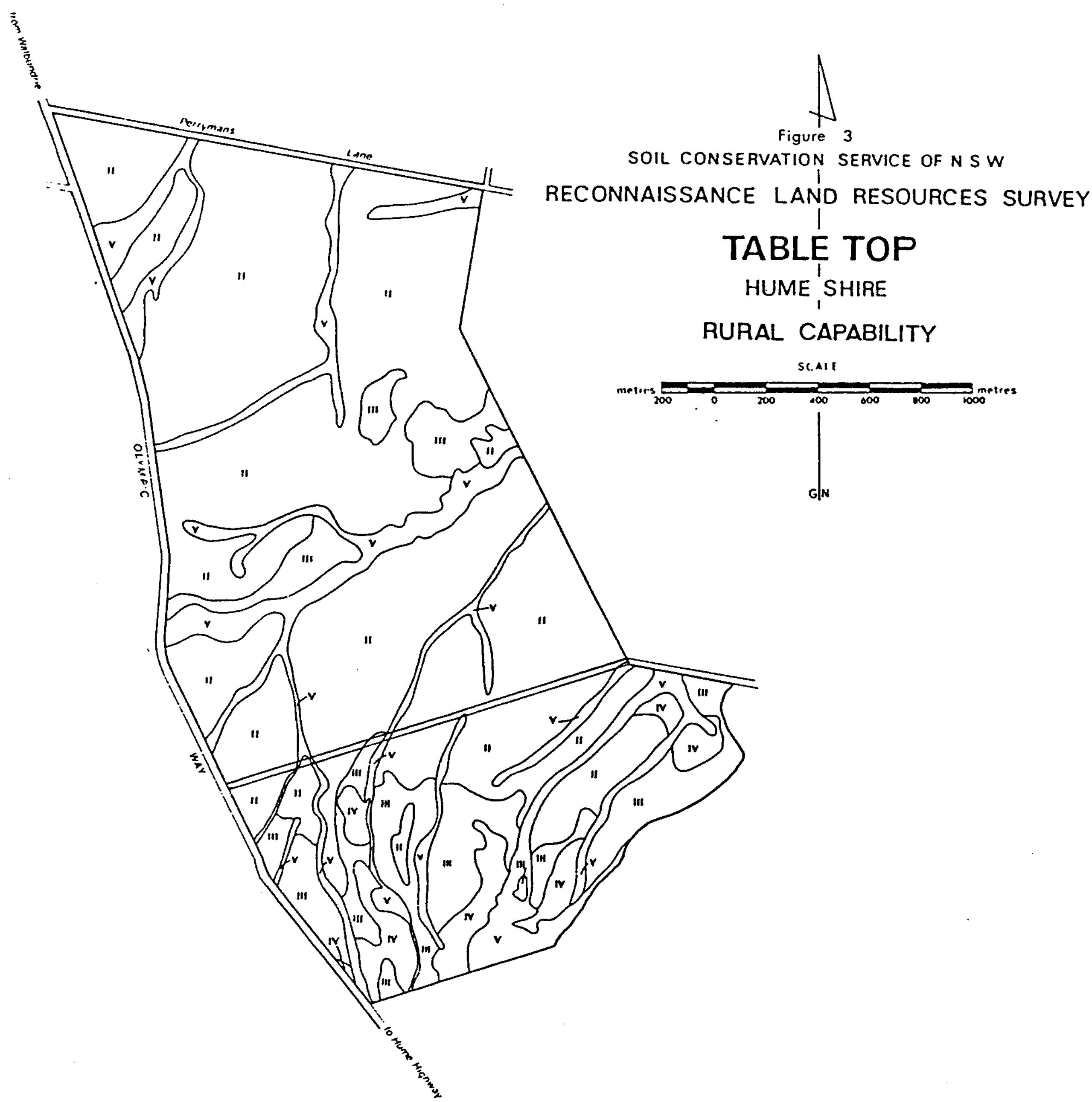
Class II

Land in this class accounts for most of the survey area. It is found on footslopes with slope gradients below 5 per cent, usually with map unit D soils.

Soil erosion can be controlled by simple land management practices. These include contour cultivation on the steeper slope segments, conservation cropping techniques (e.g. stubble retention and direct drilling) and adequate crop rotations which include a pasture phase.

Class III

This class is mostly comprised of sideslopes and footslopes in conjunction with map unit B and D soils. Slope gradients range from 5 to 10 per cent.



NOTE: See page 12 for legend

RURAL CAPABILITY

LAND CLASSIFICATION AND SOIL CONSERVATION PRACTICES				INTERPRETATIONS AND IMPLICATIONS
SUITABLE FOR REGULAR CULTIVATION		I	No special soil conservation works or practices.	Land suitable for a wide variety of uses. Where soils are fertile, this is land with the highest potential for agriculture, and may be cultivated for vegetable and fruit production, cereal and other grain crops, energy crops, fodder and forage crops, and sugar cane in specific areas. Includes "prime agricultural land".
		II	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.	Usually gently sloping land suitable for a wide variety of agricultural uses. Has a high potential for production of crops on fertile soils similar to Class I, but increasing limitations to production due to site conditions. Includes "prime agricultural land".
		III	Structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.	Sloping land suitable for cropping on a rotational basis. Generally used for the production of the same type of crops as listed for Class I, although productivity will vary depending upon soil fertility. Individual yields may be the same as for Classes I and II, but increasing restrictions due to the erosion hazard will reduce the total yield over time. Soil erosion problems are often severe. Generally fair to good agricultural land.
SUITABLE FOR GRAZING	Occasional Cultivation	IV	Soil conservation practices such as pasture improvement, stock control, application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture.	Land not suitable for cultivation on a regular basis owing to limitations of slope, gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Comprises the better classes of grazing land of the State and can be cultivated for an occasional crop, particularly a fodder crop, or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal and selection of safe building sites and access roads.
		V	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.	Land not suitable for cultivation on a regular basis owing to considerable limitations of slope gradient, soil erosion, shallowness or rockiness, climate, or a combination of these factors. Soil erosion problems are often severe. Production is generally lower than for grazing lands in Class IV. Can be cultivated for an occasional crop, particularly a fodder crop or for pasture renewal. Not suited to the range of agricultural uses listed for Classes I to III. If used for "hobby farms" adequate provision should be made for water supply, effluent disposal, and selection of safe building sites and access roads.
	No Cultivation	VI	Soil conservation practices including limitation of stock, broadcasting of seed and fertilizer, prevention of fire and destruction of vermin. May include some isolated structural works.	Productivity will vary due to the soil depth and the soil fertility. Comprises the less productive grazing lands. If used for "hobby farms", adequate provision should be made for water supply, effluent disposal, and selection of safe building sites and access roads.
OTHER		VII	Land best protected by green timber.	Generally comprises areas of steep slopes, shallow soils and/or rock outcrop. Adequate ground protection must be maintained by limiting grazing and minimising damage by fire. Destruction of trees is not generally recommended, but partial clearing for grazing purposes under strict management controls can be practised on small areas of low erosion hazard. Where clearing of these lands has occurred in the past, unstable soil and terrain sites should be returned to timber cover.
		VIII	Cliffs, lakes or swamps and other lands unsuitable for agricultural and pastoral production.	Land unusable for agricultural or pastoral uses. Recommended uses are those compatible with the preservation of the natural vegetation, namely: water supply catchments, wildlife refuges, national and state parks, and scenic areas.
		U	Urban areas	
		M	Mining and quarrying areas	

CLASS SUBSCRIPTS	SPECIAL USES
c	Terrain developed for a specific crop (capability class range IV to VII) as a result of the combination of particular soil, terrain climatic and economic conditions. The class includes such crops as grapes, bananas, avocados and pineapples.
d	Terrain developed for intensive agricultural production and associated with flood irrigation. The class includes land developed for cotton and rice production.

NOTE – ALL CLASSES MAY NOT OCCUR ON THIS MAP

Soil erosion can be controlled by the use of structural soil conservation measures. Alternately, very strict land management practices can be implemented to mitigate erosion. In the latter case, this will involve manipulating the cropping or rotation phases to avoid periods of high soil erosion hazard.

LAND SUITABLE FOR GRAZING WITH OR WITHOUT OCCASIONAL CULTIVATION

Class IV

Land of this class is found on sideslopes with map unit B and D soils. Small areas of footslopes with map unit E soils are also class IV land. Slope gradients range between 0 and 15 per cent, usually being in the range of 10 to 15 per cent on the sideslopes.

Soil erosion can be controlled by certain land management practices. These include the establishment of improved pastures, stock control (limiting stock numbers and movement) and the application of fertiliser. The land is suitable for occasional cultivation; it cannot produce two consecutive annual crops without significant soil degradation. Where crops are grown, it is necessary to establish a rotation system which will minimise soil erosion and maintain soil structure and fertility.

Stocking rates should be at a level suitable for the maintenance of vegetative ground cover and mitigation of soil erosion.

Class V

(i) All natural drainage areas and waterways, including Sandy Creek, are included in this class. These areas are discussed under urban class D-fw.

It is important for Council to recognise the need to apply intensive soil conservation measures on this class to mitigate and control soil erosion. Use of this class for grazing should be minimised.

Sandy Creek is listed as a Prescribed Stream under Section 26D of the Water Act, 1912. Section 26D of the Act provides that a person shall not, except with the authority of the Catchment Areas Protection Board:

(a) ringbark, cut down, fell, poison or otherwise destroy or cause to be ringbarked, cut down, felled, poisoned or otherwise destroyed; or

(b) top, lop, remove or injure, or cause to be topped, lopped, removed or injured

any tree situated within, or within 20 metres of the bed or bank of any river or lake or section of a river to which this Section applies.

(ii) There are small areas of this class comprised of sideslopes as well as isolated crests and footslopes on map unit A, B and D soils.

These areas require the same type of land management practices as outlined for class IV land.

URBAN CAPABILITY

The Service uses an urban land capability classification system State-wide. It is based upon an assessment of the interaction between landform, soils and surface drainage characteristics and the influence of these physical features on land use for urban development. An outline of the system is presented in Hannam & Hicks (1980).

Three primary urban capability classes have been defined on the Urban Capability Map (Figure 4). The constraints to development for the various soils are outlined in the Geology and Soils Section of this report. These should be carefully considered during the planning and development phases of any proposed urban development.

Class B

This class occurs over most of the survey area. It is found predominantly on footslopes with map unit D soils. Slope gradients range up to 5 per cent. This class also occurs on crests, sideslopes and footslopes with map unit B, C and D soils with slope gradients up to 10 per cent.

The major constraints to urban development are high soil erodibility, the generally poor permeability of the subsoils and isolated areas of poorly drained, map unit E soils.

The poor permeability of the subsoils will impose limitations regarding septic absorption systems. Any effluent which collects in the subsoil and moves laterally through it will finally enter local drainage lines or rise to the land surface in downslope positions. An appropriate effluent disposal system needs to be provided.

Careful design and placement of roads across the class will assist in the control of surface water movement from road pavements and allotments.

To mitigate erosion, construction techniques which avoid cut and fill earthworks and minimise ground disturbance are recommended. A good groundcover of vegetation should be maintained to prevent erosion of bare soil surfaces.

Areas of this class with slope gradients below 5 per cent are capable of supporting both extensive building complexes and residential development. Areas within this class that have slope gradients between 5 and 10 per cent are capable of supporting residential development.

Adequate precautions such as those outlined in Sections 2, 4.5, 5.3 and 6 of Quilty, Hunt and Hicks (1978) should be followed during development of this land.

Figure 4

SOIL CONSERVATION SERVICE OF N.S.W

RECONNAISSANCE LAND RESOURCES SURVEY

TABLE TOP

HUME SHIRE

URBAN CAPABILITY

SCALE

metres 200 0 200 400 600 800 1000 metres

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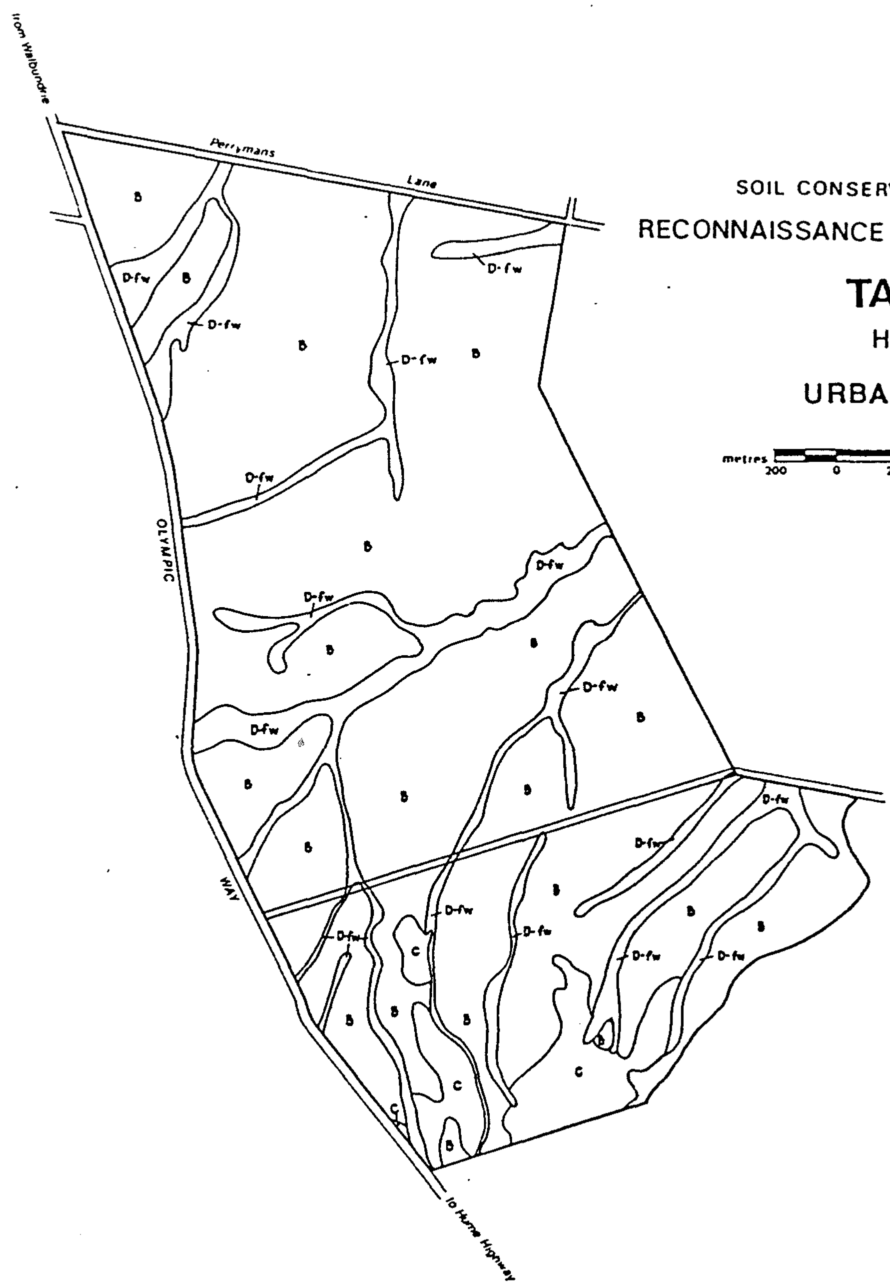

LEGEND

DEGREE OF LIMITATION	MAJOR LIMITATIONS	CAPABILITY	CLASS
Minor to Moderate	Soil erodibility, isolated areas of seasonal waterlogging, poor soil permeability.	E.B.C.*/Residential Development	B
Moderate	Slope	Residential Development	C
Severe	Flooding	Drainage Reserve	D-fw

*Extensive Building Complexes

Class C

This class occurs mainly on sideslope areas with map unit A and B soils and slope gradients between 10 and 15 per cent. There are also small areas of this class which are comprised of sideslopes on map unit D soils with slope gradients between 10 and 20 per cent.

The principal constraint to urban development is the slope gradient of this class. Uncontrolled development will lead to sheet and gully erosion and scouring of cut and fill batters. Care should be taken with surface drainage and the disposal of stormwater. Road batters and embankments should be formed to stable grades and adequately protected by vegetative and structural measures.

To minimise erosion, construction techniques which avoid cut and fill earthworks and minimise ground disturbance are recommended. A good groundcover of vegetation should be maintained to prevent erosion of bare soil surfaces.

This class is capable of supporting residential development. Sections of Quilty *et al* (1978) relevant to development of this class include 2, 3, 4.5 and 6.

Class D-fw

Natural drainage areas and watercourses, including Sandy Creek, comprise this class. Most slope gradients are less than 5 per cent. However, in the southern part of the survey area, slope gradients up to 15 per cent occur.

This class of land is subject to periodic flooding and seasonal waterlogging. Hence it should be retained as part of an open natural drainage system for the control and disposal of runoff from the survey area. It may be possible to redirect water from some minor drainage areas and waterways to form a large, open drainage system. However, any redirection of water flows should be subject to further hydrological investigation. Sandy Creek is listed as a Prescribed Stream under Section 26D of the Water Act, 1912, and must be treated accordingly.

Significant hydrological changes will occur in the catchment area of a watercourse when it is developed. These changes involve increases in runoff volume and peak discharges, erosion of the drainage channels and sedimentation and flooding of the lower-lying terrain. The recommended approach to control these problems involves the development and management of grassed drainage reserves. Urban development should not encroach onto drainage reserves or flood flows will be impeded.

Flooding of the low-lying sections in the survey area may be reduced by installing retarding basins within the drainage reserves. These impound and regulate the flow of runoff waters. Hence the time of concentration of runoff is increased and peak discharges are reduced.

RECOMMENDATIONS FOR SUBDIVISION PLANNING AND LAND MANAGEMENT

RURAL LAND USE

* Classes II and III can be used for regular cultivation while Classes IV and V are suitable for grazing with or without occasional cultivation.

* For each specific class, recommended land management practices as outlined in the Rural Capability section of this report, should be adhered to so that soil erosion is minimised.

RURAL RESIDENTIAL LAND USE

* All roads and access tracks require the application of soil erosion control techniques. Apart from cultivation, roads and access tracks are the greatest contributors to accelerated soil erosion in the rural environment. They contribute to erosion by destroying ground cover, breaking down the soil surface, increasing runoff, diverting and concentrating runoff, and causing unstable sections to develop in watercourses.

* Structural soil conservation measures such as banks should be planned on a sub-catchment basis. The placement of these structures becomes critical where closely spaced allotment boundaries occur. Boundaries should be placed to ensure effective design and maintenance of structural soil conservation systems.

* Land should be sub-divided into lots that are economically viable and which suit the needs of the landholder. Economic constraints in small land units can lead to neglect, rejection, or long term delays in implementation of necessary erosion control measures. Neglect can result where land is held primarily as an investment or for a weekend retreat. Rejection may occur where economic necessity demands that land be used beyond its capabilities. Long term delay in implementation of erosion control measures may be due to the inability of holders of small parcels of land to finance necessary conservation measures.

* Potential land use activities must be considered in the sub-division design. Poorly located boundaries can lead to difficulty in the design and implementation of practical systems of land use.

* Lots must be of a sufficient size to allow workable lot layout and design. This is critical with small allotments and steep terrain. Options for fencing, access, building sites, earth dams, effluent disposal, fire management and erosion control works are limited on small allotments.

* Subdivision design should allow essential erosion control works to be effectively installed and maintained. These works should be installed before subdivision is completed.

* Intensive land use activities must be subject to controls in order to minimise soil erosion.

* Each allotment must have a reliable and adequate water supply. Suitable sites should be available on each allotment to permit the construction of stable dams of adequate capacity that will not aggravate erosion hazard.

* Allotment boundaries are ideally located along ridges, approximately on the land contour. Permanent creeks can provide suitable boundaries in places, but fencing maintenance is generally costly in such areas. Boundaries along intermittent flow lines are undesirable.

URBAN LAND USE

* Extensive building complexes should be confined to Class B, where slope gradients are less than 5 per cent.

* Urban residential development can be undertaken on Classes B and C provided development is consistent with the physical constraints and erosion potential of these classes. An effective effluent disposal system must be provided. Road and lot runoff must be adequately managed to avoid pollution of low-lying land and Sandy Creek.

* Construction should not be permitted on Class D-fw. This land should be retained for drainage reserves and open space.

* Hydrological Management:

  The existing sub-catchment layout and natural drainage network should be retained in the planning and design of any development within the survey area. This avoids downstream damage from flooding and excessive sedimentation.

Runoff flow velocities and peak discharges should be controlled by:

- carefully controlling development on the margins of watercourses and within the respective catchment areas, and

- use of retarding and sediment basins as part of the planning and development process.

* Sediment and erosion control techniques and guidelines outlined in Quilty *et al* (1978) and Appendix I of this report should be adopted.

PUBLIC ROADS, DRAINAGE FACILITIES AND INDIVIDUAL ALLOTMENT CONSTRUCTION ACTIVITIES

* Stable all-weather roads should be provided to a point on each allotment from which stable internal access roads can be made.

* Roads should not be placed on unstable areas such as steep slopes or located where seasonally high water tables occur.

* Water should not be concentrated by roadways or other works on unstable or erodible areas.

* A drainage system should be designed that will assist in the maintenance of stable flow lines rather than initiate or increase erosion and sedimentation within them. (See discussion under urban class D-fw and Appendix II in this report and Section 3.3 of Quilty *et al* (1978)).

* Sediment basins should be installed on watercourses to reduce the movement of sediment out of subdivisions during the construction phase. (See Appendix II of this report and Section 2.8 of Quilty *et al* (1978)).

* Batters should be properly formed and subsequently stabilised by revegetation or by structural measures. (See Appendix I of this report and Sections 2.1 and 6.3.2 of Quilty *et al* (1978)).

* The general principles of saving and respreading topsoil, and revegetating disturbed areas should be followed. (See Appendix I of this report and Section 6 of Quilty *et al* (1978)).

PRESCRIBED STREAMS

Sandy Creek needs to be managed in accordance with the requirements outlined in Section 26D of the Water Act, 1912.

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APPENDIX I

GUIDELINES FOR SEDIMENT AND EROSION CONTROL

Guidance in the implementation of these recommendations should be sought from the Albury office of the Soil Conservation Service as planning and construction proceed.

A range of general recommendations aimed at the control of erosion and sedimentation during development should be applied to the proposed rural residential development. These are as follows:

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

(b) Development should be designed to minimise alteration of the natural landscape. Cut and fill and general grading operations should be limited to the minimum necessary for development.

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

(d) Where development necessitates removal of topsoil, it should be stockpiled for later respreading. The stockpiles should not be deposited on or adjacent to watercourses. If the topsoil is to be stored for lengthy periods (six months or longer), a vegetative cover should be established to protect against erosion.

(e) Exposed areas such as construction sites should be protected by locating temporary banks and ditches upslope to contain and divert runoff, where necessary.

(f) Temporary sediment filters should be located around stormwater inlets. Runoff should be channelled through sediment basins below construction zones. This will assist in the control of erosion during construction.

(g) Areas that remain bare for lengthy periods during subdivision development should be afforded temporary protection. Cover cropping with fast growing species (e.g. millet in spring and summer and cereal rye, oats or barley in autumn and winter), or treatment with a surface mulch of straw or a chemical stabiliser would achieve this.

(h) When excavations are made for conduits, topsoil and subsoil should be stockpiled separately. Subsoil should be replaced in the trench first and thoroughly compacted. If the soil is very wet or very dry, compaction may be difficult and the risk of subsequent erosion along the trench line is increased.

Topsoil should then be replaced to a level above the adjacent ground surface to allow for subsequent settlement.

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

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

(j) Areas of fill should be thoroughly compacted before construction.

(k) Cut and fill batters should be formed to a stable slope.

(l) Where vegetative rather than structural stabilisation of batters is proposed, early revegetation is essential.

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

* Establishment of vegetation on batters is greatly assisted by spreading topsoil over the surface.

* Possible plant species for this purpose include couch, ryecorn, phalaris, cocksfoot and rye grasses for autumn-winter establishment, and couch, fescue, perennial rye and japanese millet for spring-summer establishment. These should be sown at a heavy rate with a liberal dressing of fertiliser. Specific advice on suitable mixtures can be obtained from the Albury office of the Soil Conservation Service.

* Batters may be treated with a chemical, or an organic mulch following sowing. This provides early stability.

* Hydroseeding is an alternative batter stabilisation technique. A mixture of seed, fertiliser, wood or paper pulp and water is sprayed onto the batter through a specially designed applicator. This is a simple and effective technique.

* Once vegetation is established on batters, regular topdressing with fertiliser encourages the persistance of a vigorous groundcover of vegetation.

(m) All disturbed ground should be revegetated as soon as possible.

* The surface should be scarified prior to topsoil return.

* Topsoil structure will be damaged if it is very wet or very dry when respread.

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

* All revegetated sites should receive an adequate dressing of fertiliser at sowing to assist vigorous establishment and growth. Specific recommendations on seed and fertiliser mixtures and application rates will be provided on request, to the Albury office of the Soil Conservation Service.

* Correct maintenance of all areas which are to remain under a permanent vegetative cover will ensure a persistent and uniform sward. Regular topdressing with fertiliser is necessary in the early years of establishment. Mowing will assist in weed control and promote a vigorous turf.

(n) Vehicular traffic should be confined to proposed or existing road alignments, where possible. Temporary culverts or causeways should be provided across major drainage lines.

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

(p) As a large proportion of the survey area is subject to seepage from higher areas and presence of water tables, effluent disposal options should be given due consideration.

(q) Permanent drainage works should be provided as early as possible during subdivison construction.

APPENDIX II

DRAINAGE MANAGEMENT

Existing channels should be shaped into broad trapezoidal or parabolic waterways. These should have sufficient cross-section to allow passage of flows at a velocity not exceeding 2 metres per second. Flows exceeding this velocity will scour vegetated channels unless a concrete lining is installed. Stepped weirs or another form of suitable structure may be needed in the watercourses of steeper catchments to prevent scouring.

Trickle flows should be channelled into an underground pipe. Alternatively, a half-round pipe or lined invert could be located along the centre of reserves. It is recommended that these have sufficient capacity to accommodate a one in one year run-off event. Without this provision, continuous trickle flows will erode the floor of the reserves, while rushes, sedges and other water loving species will proliferate along the trickle path.

The channel should be stabilised with introduced grasses and legumes. Best results will be achieved if couch and paspalum are sown in spring. Turf may be laid to protect local areas where scouring occurs. A heavy dressing of fertiliser should be applied at establishment and follow up applications of fertiliser may be necessary. Further advice on suitable species for waterway stabilisation in the Table Top survey area can be obtained from the Albury office of the Soil Conservation Service.

Stabilisation will be assisted if a surface binding agent such as jute mesh and bitumen, straw and bitumen, or another suitable chemical or organic mulch is applied at sowing. This will impart temporary surface stability until vegetation is established. It is a particularly desirable measure where reserves are developed after subdivision works commence. If possible, however, the drainage reserves should be formed and stabilised before any major urban development occurs.

Where roadways cross drainage reserves, floodways and culverts should be stabilised to withstand damage from high flows. Rock grouting, hay and wire netting, jute mesh and bitumen or structural energy dissipators should be used below culvert outlets to alleviate potential erosion problems.

Road layout should be designed to be consistent with natural contours of the land. Table drains can then be used effectively as part of the disposal system for local surface water. Both road and lot runoff should be conveyed via these waterways to the major watercourses.

Installation of Retarding Basins and Sediment Basins

(a) Retarding Basins

Retarding basins are large storages designed to impound runoff and regulate its flow through a pipe outlet. The result is to reduce peak discharges by increasing the time of concentration of runoff. Provision should be made for flows greater than the flood storage capacity of the basin. This could be achieved by installing an emergency spillway.

Retarding basins could provide the solution to some channel erosion problems in the survey area. Some permanent water storage within them might also serve as a recreational amenity. A full discussion of these aspects is provided in Section 3.2 of Quilty *et al* (1978).

(b) Sediment Basins

Sediment basins are temporary storages located on flow lines. They can be a barrier or dam constructed across a waterway, an excavated basin, or both. Design of sediment basins is discussed more fully in Section 2.8 of Quilty *et al* (1978). The size of the structure will be determined by the location of the drainage area, soil characteristics and the rainfall pattern of the Table Top survey area.

The primary function of sediment basins is to impound runoff temporarily and trap sediment. A potential secondary function is to provide mitigate flooding. They are designed to drain completely through a perforated drop inlet attached to a discharge pipe. Sediment should be regularly removed from the basins to maintain their effective operation. Therefore, good access is required to facilitate sediment removal from the basin floor. Basins should be as close as practical to the major source of sediment.

The whole structure may be removed after the development area is stabilised, or sediment can be removed and the structure can be retained as a retarding basin.