SOIL CONSERVATION SERVICE OF NEW SOUTH WALES

RECONNAISSANCE LAND RESOURCES SURVEY

JINDERA

Prepared for

HUME SHIRE COUNCIL

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This report, and the original maps associated with it, have been scanned and stored on the custodian's intranet.
Original maps drafted at 1:10,000 were scanned and named "UC_Jindera Recon_Hume_theme". S.J. Lucas April 2014

C O N T E N T S

INTRODUCTION

The Village of Jindera is located 16 km north of Albury, on the Urana Road. It is experiencing increasing demand for residential and rural residential development.

Accordingly, the Hume Shire Council requested the Service to undertake a reconnaissance land resources survey of 610 ha area of land which lies north and north-west of the Village of Jindera (figure 1). This area is situated directly north of a previous study area (Junor *et al*, 1978).

The study is based on the collection and evaluation of physical resource data to assess the physical limitations of the area for rural residential use and based on the Service's urban and rural capability classification systems. Climate, landform, geology and soils characteristics have been collected for the inventory. Soils have been surveyed (Barker, 1984) and the characteristics of the soils relating to erodibility, drainage, stability and development limitations have been assessed.

These parameters were assessed to derive urban and rural land capabilities. The land capability assessments will assist Council in planning and management of the study area for rural residential land uses. They will also help Council to reach a balance between various land uses in the area, select the most suitable sites for development, and to minimise the erosion hazards associated with various forms of land use.

The soils, rural capability and urban capability maps of the Jindera study 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 land development within the survey area.

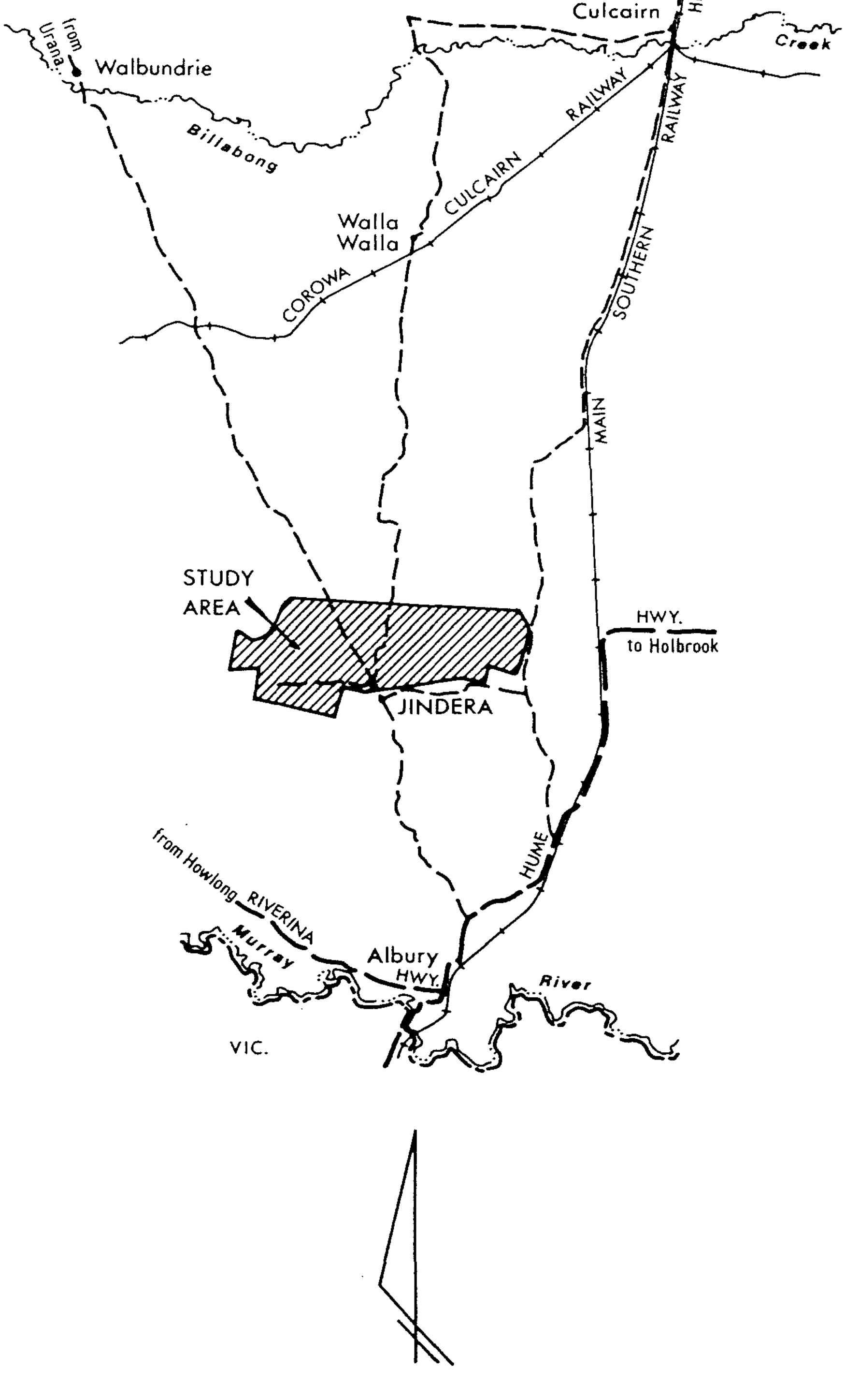

FIGURE 1

LOCALITY MAP

RECONNAISSANCE LAND RESOURCES SURVEY

JINDERA

SCALE

km 5 0 5 10 15 20 25 km

G N

PHYSICAL FEATURES

CLIMATE

The annual median rainfall at Jindera is approximately 600 mm and is winter dominant. Winter rainfall exhibits less variability than summer rainfall. Further, during winter, prolonged wet periods cause saturated conditions on poorly-drained soils which will hamper construction operations. Drainage and soil conservation works are required in order to protect land from high intensity summer rainfall.

Low temperatures restrict growth during the winter months. 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 of the study area is a large central plain, adjacent to Bowna Creek. It is characterized by gilgais and isolated large depressions. Bowna Creek traverses the study area in a north-easterly direction and eventually flows into the Hume Weir at Bowna.

The low (50m relief) granite hills in the north-western corner of the study area dominate the skyline. They have slopes of up to 20 per cent gradient. Their footslope areas are separated from Bowna Creek by the large central plain.

A very low (<20 m relief and <10% slope gradient) granite ridge is situated at the eastern end of the study area.

GEOLOGY AND SOILS

The hills, ridges, sideslopes and footslopes of the study area are covered by both *in situ* residual material and colluvial deposits derived from Silurian granite. The remaining, low-lying areas are comprised of unconsolidated sedimentary deposits of clay and silt.

Soil map units were delineated by both field investigation using auger sampling to a depth of approximately 50 cm and interpretation of aerial photographs. At selected sites soils were examined to a depth of 200 cm. Laboratory analyses were carried out in order to assess the physical properties of these soils.

Five major soil map units have been identified in the study area (see the attached Soils Map). The distribution of soil map units is related to the local terrain and associated geological materials as outlined below.

Map Unit A - *Red Duplex Soils*

The red duplex soils are associated with the low (<50 m relief), moderately inclined (<20% gradient) granite hills in the north-western corner of the study area.

Surface soils have sandy clay loam textures and are 5 to 20 cm deep. The subsoils are red, light medium to heavy clays. They are moderately plastic, with a low to moderate shrink - swell potential. Soil depths are generally greater than 150 cm. The profile has slow internal drainage due to the low permeability of the subsoil.

This map unit has a moderate to high soil erosion hazard because the soils are moderately erodible and they occur on moderately inclined slopes. The major constraints to development are the moderately inclined slopes and scattered rock outcrops. The efficiency of on-site effluent disposal systems may be restricted by slow subsoil drainage.

Map Unit B - *Yellow Duplex Soils*

The yellow duplex soils are generally associated with the very low (<20 m relief), gently inclined (<10% gradient) granite ridge in the north-eastern corner of the study area, however there are also small discrete areas in the south-western corner.

Surface soils are typically brown, approximately 20 cm deep, and have sandy clay loam textures. Subsoils are generally yellowish brown, medium to heavy clays. The subsoils are moderately plastic with a low shrink-swell potential. Soil depths are generally greater than 200 cm.

The soils of this map unit grade into the yellow duplex soils of Map Unit E, and adjoin the shallow red duplex soils of Map Unit C. This unit has been described by Junor *et al* (1978).

The soil erosion hazard of this map unit is moderate to high due to the moderate to high erodibility of the soils. The high soil erodibility and isolated rock outcrops are the major physical constraint to urban development.

Map Unit C - *Mottled Yellow Duplex Soils on Footslopes*

These soils mainly occur on gently inclined footslope areas which dominate the western part of the study area.

Surface soils are typically light sandy clay loam to sandy clay loam in texture and approximately 30 cm deep. Subsoils are usually yellowish brown, mottled, light to medium clays. Soil depths are greater than 200 cm. The subsoils are of low to moderate plasticity, with a low shrink-swell potential.

Soil erodibility is high due to the dispersible nature of the soils. The soil erosion hazard of this soil map unit is high to very high because of the high soil erodibility and the high water run-on rate. Erosion and sediment control measures must be incorporated during construction activity.

Seasonal waterlogging particularly during winter, and following periods of protracted rainfall, is a characteristic of the lower footslope areas of these soils. Several local landholders have installed drains in up-slope positions to alleviate this problem. In addition, lateral drainage through lower surface and upper subsoil layers also occurs because of the low permeability of the lower subsoils. Effluent absorption systems may cause pollution of lower footslopes within this unit and lower drainage lines.

Map Unit D - *Mottled Yellow Duplex Soils*

These soils occur on the large central plain which adjoins Bowna Creek. It is the most variable map unit in the study area. Gilgais and large isolated depressions occur over approximately 40 per cent of its area. In general, the soils are similar to the mottled yellow duplex soils of Map Unit F and as described by Junor *et al* (1978).

This unit generally has a sandy clay loam topsoil, 35 to 50 cm deep, overlying a predominantly yellow, mottled, medium clay subsoil. Soil depths are greater than 200 cm. There are also areas of yellow duplex soils similar to those of map unit B within this map unit, as well as small areas of uniform cracking clay soils (Junor *et al*, 1978).

Soil erodibility is high due to the dispersible nature of the soils. However, the erosion hazard associated with urban development is not high as most slope gradients are less than 5%. However, a high soil erosion hazard will occur in areas of concentrated water flow such as along watercourses.

These soils generally have very slow to slow internal drainage and are subject to periodic waterlogging. Hence, the effectiveness of on-site effluent disposal will be markedly reduced.

Laboratory testing carried out, for both this study and Junor *et al* (1978), indicate that highly plastic soils with a high shrink-swell potential occur in this unit. It is recommended that further investigations be undertaken to identify shrink-swell constraints to determine appropriate foundation design.

Map Unit E - *Alluvial Soils*

The alluvial soils are restricted to Bowna Creek. They are highly variable in soil type. The topsoils generally have a sandy loam to sandy clay loam texture and extend to a depth of 50-100 cm before reaching older buried soils.

The unit has an extreme erosion hazard because of the high erodibility of the soils and the high frequency of flooding.

RURAL CAPABILITY

The Soil Conservation Service's rural capability classification provides information on the optimum potential use of the land and its long term viability when used for various agricultural purposes (Anon, 1975). The classification involves consideration of the environmental factors that may limit the use of the land. These factors include climate, terrain, slope, soil erodibility, soil depth, water holding capacity, wetness, rockiness, existing soil erosion, salinity and pH.

The study area has been classified into a number of rural capability classes, according to the capacity of the land to sustain different levels of permanent rural production. In order to achieve these production levels, specific soil conservation and land management measures are recommended to maintain the soil resource. The capability classes are shown on the attached Rural Capability Map.

Land which is used beyond its capability can be expected to degrade rapidly. The consequent soil erosion can be rapid, adversely affecting not only the immediate area but adjoining lands by the deposition of sediment resulting in loss of production and the permanent loss of the soil resource.

The classification system used in this study is one which is used State-wide by the Soil Conservation Service of New South Wales (Anon, 1975).

LAND SUITABLE FOR REGULAR CULTIVATION

Class II

Class II land is found on plains and footslopes with map unit B soils. It is situated mainly in the south-west corner and eastern border regions of the survey area. Slope gradients are below 5 per cent.

Soil erosion on Class II land can be controlled by simple land management practices including contour cultivation on the steeper slope segments, conservation cropping techniques (stubble retention, direct drilling, etc.) and adequate crop rotations including a pasture phase.

LAND SUITABLE FOR GRAZING WITH OR WITHOUT OCCASIONAL CULTIVATION

Class IV

Class IV land is comprised of plains and footslopes with map unit C and D soils which have slope gradients up to 5 per cent. It also occurs on the footslopes, sideslopes and ridges with map unit A soils and the sideslopes and ridges with map unit B soils where slope gradients are less than 15 per cent. This class includes a number of minor watercourses which are discussed under urban class D-fw in the latter section of this report.

Existing and potential soil erosion on Class IV land can be controlled by land management practices such as the establishment of improved pastures, stock control and the application of fertilizer. The land is suitable for occasional cultivation; it cannot produce two consecutive annual crops without significant soil degradation. When cultivation occurs, it is essential that it is part of a rotation system which will minimize soil erosion and maintain soil structure and fertility.

Stocking rates should be at a level suitable for the maintenance of vegetative ground cover and prevention of soil erosion. Overgrazing could lead to further gully erosion of this land, particularly on the steep slopes in the western part of the survey area.

Class V

Land placed in Class V includes the major watercourse of Bowna Creek. The class is also discussed under urban class D-fw. It is essential that intensive soil conservation measures are incorporated on this land to mitigate soil erosion. Grazing on Class V land should be limited in order to minimize stream bank erosion.

Bowna Creek is listed as a Prescribed Stream under Section 26D of the Water Act, 1912. See the Recommendations section of this report for conditions relating to Prescribed Streams.

OTHER LAND

Class VII

This class is comprised of small isolated swamps on map unit D soils. The best method to control soil erosion on Class VII land is to retain the native tree cover. It is unsuitable for cultivation. Limited grazing is possible during extended dry periods.

URBAN CAPABILITY

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

Three primary urban capability classes, including a number of sub-classes have been defined on the attached Urban Capability Map. The constraints to urban development for the various soils are outlined the preceding 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 on:

* all areas with map unit B soils - slope gradients are less than 15 per cent
* isolated footslope areas with map unit A soils which have slope gradients of less than 10 per cent
* footslopes with map unit C soils which are not affected by seasonal waterlogging and with slope gradients of less than 5 per cent.

The major limitations to urban development are the poor soil permeability of the subsoils and, on some areas with map unit A and B soils, the moderate slope gradients.

An effective effluent disposal system will need to be designed for this class. Extensive use of on-site effluent disposal systems may lead to emergence of effluent on these and adjoining lands because of lateral drainage through lower surface and upper subsoil layers.

Provision must be made for surface water management in the design and placement of future roads to more effectively convey and dispose of storm runoff which emanates from road pavements and house areas. Adoption of suitable road and table drain gradients will assist the movement of surface runoff to drainage disposal areas.

All of this class is suitable for residential development. However, extensive building complexes should be restricted to areas with slope gradients less than 5 per cent. Sections 2, 4.5 and 6 of Quilty *et al* (1978) provide further guidelines for development of this class.

Class C

This class occurs on sideslopes and footslopes with map unit A soils. Slope gradients range between 10 and 15 per cent.

The major limitations to urban development are the moderately steep slope gradients and the relatively poor subsoil permeability. Planning and development of this class should include provision for appropriate drainage and an effective effluent disposal system. Scattered rock outcrop will restrict urban development.

The potential for runoff is high and extensive surface disturbance is not recommended. A good vegetative cover should be maintained as any exposure of the soil surface will lead to rapid erosion and siltation of local water bodies.

The most intensive urban land use recommended for this class is residential development. Soil erosion and sediment control measures appropriate to this development are outlined in Sections 2, 4.5 and 6 of Quilty *et al* (1978).

Class C-w

This class occurs on:

* the plains and isolated footslopes areas with map unit D soils

* isolated areas of map unit C soils adjacent to Bowna Creek.

Slope gradients are less than 5 per cent.

One of the major limitations to urban development is that Class C-w the soils are subject to seasonal waterlogging. The combination of the low slope gradients and their location at the base of footslopes which shed large volumes of runoff, leads to a build up of surface and subsurface moisture during wet seasons. Provision should be made for the management of runoff and soil drainage contraints. The poor internal drainage of the soil profile will lead to effluent pollution if septic effluent pits are used.

Other major limitations are soil erodibility due to the dispersible nature of the soil, and the high shrink-swell potential of some map unit D soils. It is recommended that further investigations be undertaken to identify shrink-swell conditions of map unit D soils prior to any form of urban development.

Class c-w land is capable of extensive building complexes, as well as residential development, if the various constraints defined above are overcome. This land is probably most suitable for recreation purposes or as yard space for housing on areas where there are adjoining footslopes. Sections 2, 4.5, 5.1, 5.3 and 6 of Quilty *et al* (1978) provide appropriate guidelines for development.

Class D-fw

Natural drainage areas and waterways, including Bowna Creek, comprise this class. Slope gradients are generally less than 5 per cent except in the steeper western area where slope gradients range up to 10 per cent.

Due to periodic flooding and seasonal waterlogging of Class D-fw land, the minor drainage areas and watercourses should be retained as part of an open grassed drainage system for the control and disposal of runoff from the study area. Flooding of the low-lying sections of the survey area may be reduced by the development of retarding basins within the drainage reserves. Retarding basins impound and regulate the flow of runoff waters so that the time of concentration of runoff is increased and peak discharges are reduced. In the north-western section it may be possible to redirect water from several minor drainage areas and watercourses to form a single large, open drainage system. However, any redirection of water flow should be subject to further hydrological investigation. Bowna Creek is listed as a Prescribed Stream under Section 26D of the Water Act, 1912.

If further development of Class D-fw land is undertaken, significant hydrological changes will occur. These changes involve an increase in runoff volume, increase in peak discharges, erosion of the drainage channels and sedimentation and flooding of the lower-lying terrain. Urban development should not encroach onto the drainage reserves, otherwise flood flows will be impeded.

Class D-y

This class occurs on the small isolated swamps in the central part of the study area and should be retained as reserves. Swamps function as natural retarding basins, storing runoff, filtering sediment and play a role in attenuating flood peaks downstream. If they are reclaimed, this natural storage is lost and the level of flow peaks and erosion hazard downstream may be increased.

RECOMMENDATIONS FOR SUBDIVISION PLANNING AND LAND MANAGEMENT

1. RURAL LAND USE

* Class II can be used for regular cultivation while Classes IV and V are suitable for grazing with or without occasional cultivation. Class VII requires the retention of its tree cover.

* Other recommended land management practices in the Rural Capability Section of this study (e.g. conservation cropping techniques and suitable stocking rates) must be followed in order to minimize soil erosion.

2. 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 (e.g. banks) should be planned on a sub-catchment basis. This becomes critical where closely spaced allotment boundaries occur - they will, otherwise, create difficulties for design and maintenance of soil conservation structural 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 subdivision design. Poorly located boundaries can lead to difficulty in the design and implementation of practical systems land use.

* Lots must be of a sufficient size to allow workable lot layout and design. The smaller the allotments and the more difficult the terrain then the more critical it is to have a workable lot layout and design. Options for fencing, access, building sites, earth dams, effluent disposal, fire management and erosion control works are more 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. The placing of covenants in titles will ensure the maintenance of these works where they affect nearby landholders.

* Intensive land use activities must be subject to controls in order to minimize 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 diagonal to slopes or along intermittent flow lines are undesirable.

3. URBAN LAND USE

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

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

* Further investigations must be undertaken to identify shrink-swell conditions of map unit D soils prior to any form of urban development.

* No building construction should be permitted on Class D-fw. This land should be retained for drainage reserves and open space.

* Class D-y land should be retained for reserves or 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 study area to avoid downstream damage from flooding and excessive sedimentation.

  Runoff flow velocities and peak discharges should be controlled by:

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

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

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

4. 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 taken.

* Roads should avoid unstable areas such as steep slopes and locations 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 maintenance of stable flow lines rather than initiate or aggravate erosion and sedimentation within them. (See discussion under urban class D-fw, Appendix II 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 and Section 2.8 of Quilty *et al* (1978)).

* Batters should be properly formed and subsequently stabilized by revegetation or by structural measures. (See Appendix I 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 and Section 6 of Quilty *et al* (1978)).

5. PRESCRIBED STREAMS

Bowna 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 fown, 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 applied.

REFERENCES

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APPENDIX I

GUIDELINES FOR SEDIMENT AND EROSION CONTROL

A range of general recommendations aimed at the control of erosion and sedimentation during development should be applied to the proposed rural residential development. 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) 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, where possible. In this context, 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 most critical on steep slopes.

(d) Where development necessitates removal of topsoil, this soil 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) The location of temporary sediment filters around stormwater inlets and the channelling of runoff through sediment basins below construction zones will assist the control of erosion during construction.

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

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

Finally topsoil is 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 on 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.

   (i) 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.

   (ii) Establishment of vegetation on batters is greatly assisted by spreading topsoil over the surface.

   (iii) 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 fertilizer. Specific advice on suitable mixtures can be obtained from the Albury office of the Soil Conservation Service.

   (iv) Batters may be treated with a chemical or an organic mulch following sowing. This provides early stability.

   (v) Hydroseeding is an alternative batter stabilisation technique. A mixture of seed, fertilizer, wood or paper pulp and water is sprayed onto the batter through a specially designed applicator. It is a simple and effective technique.

   (vi) Once vegetation is established on batters, regular topdressing with fertilier encourages the persistance of a vigorous groundcover of vegetation.

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

(i) The surface should be scarified prior to topsoil return.

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

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

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

(v) 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.

(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) The poor soil drainage qualities of a large proportion of the study area will limit effluent disposal options. In particular, shallow, low soil depth, permeability, presence of watertables and seepage from higher areas will render onside effluent disposal difficult.

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

APPENDIX II

DRAINAGE MANAGEMENT

Existing channels should be shaped into a broad trapezoidal or parabolic waterway. This 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, or by locating a half-round pipe or a lined invert along the centre of reserves. It is suggested that these should 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 stabilized 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 scour occurs. A heavy dressing of fertilizer should be applied at establishment and follow up applications of fertilizer may be necessary. Further advice on suitable species for waterway stabilization in the Jindera survey area can be obtained from the Albury office of the Soil Conservation Service.

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

Where roadways cross drainage reserves, floodways and culverts should be stabilized 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.

By designing road layout consistent with natural contours of the land, table drains can be used effectively as part of the disposal system for local surface water. Both road runoff and lot runoff should be conveyed via such 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. Their effect is to reduce peak discharges by increasing the time for runoff to occur. They should have provision for flows greater than their flood storage capacity in the form of an emergency spillway.

In the survey area, retarding basins could provide the solution to some channel erosion problems, while some permanent 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 depend upon the location of the drainage area, soil characteristics and rainfall pattern of the Jindera survey area.

The primary function of sediment basins is to hold runoff temporarily and trap the 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.

To retain effectiveness of the basins, sediment should be regularly removed. Therefore, good access is required to facilitate sediment removal from the basin floor. They should be as close as practical to the major source of sediment.

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

SOIL CONSERVATION SERVICE OF N. S. W.

RECONNAISSANCE LAND RESOURCES SURVEY

JINDERA

HUME SHIRE

SOILS

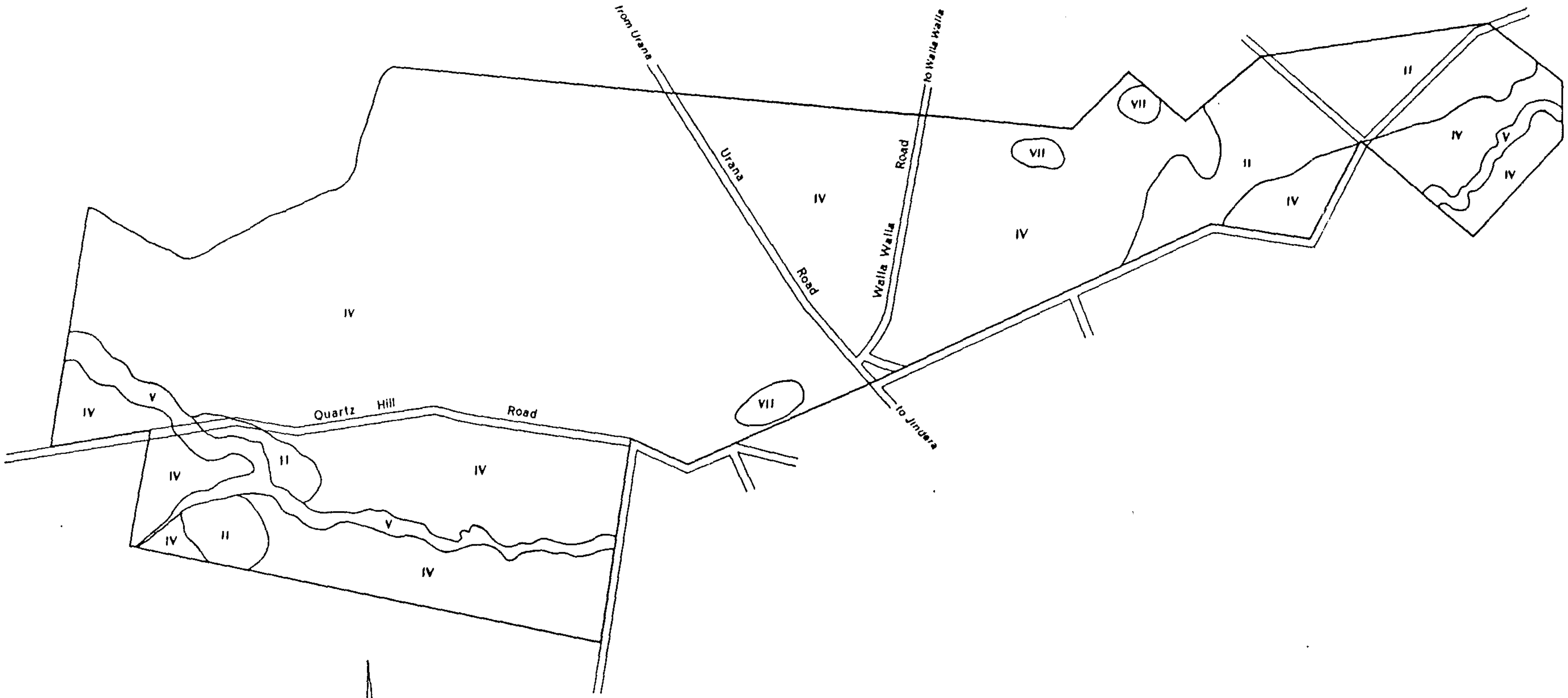
SCALE

metres 200 0 200 400 600 800 1000 metres

G|N

LEGEND

DOMINANT SOILS	NORTHCOTE SOIL CLASSIFICATION	MAJOR LIMITATIONS	MAP UNIT
Red duplex	Dr 2·12, Dr 2·22	Slope, rock outcrops (in areas), subsoil permeability	A
Yellow duplex	Dy 2·32, Dy 2·22, Dr 2·22	Rock outcrops (isolated)	B
Mottled yellow duplex on footslopes	Dy 3·43, Dy 3·23	Seasonal waterlogging, soil erodibility, subsoil permeability	C
Mottled yellow duplex	Dy 3·43, Dy 3·22, Dy 2·12, Ug 5·6	Soil erodibility, seasonal waterlogging, soil shrink-swell potential	D
Alluvial	—	Flooding	E



SOIL CONSERVATION SERVICE OF N.S.W.

RECONNAISSANCE LAND RESOURCES SURVEY

JINDERA

HUME SHIRE

RURAL CAPABILITY

SCALE

metres 200 0 200 400 600 800 1000 metres

GN

SOIL CONSERVATION SERVICE OF N.S.W.

RECONNAISSANCE LAND RESOURCES SURVEY

JINDERA

HUME SHIRE

URBAN CAPABILITY

SCALE

metres 200 0 200 400 600 800 1000 metres

G N

LEGEND

DEGREE OF LIMITATION	MAJOR LIMITATIONS	CAPABILITY	CLASS
Minor to moderate....	Poor soil permeability, slope....	E.B.C.*/ Residential Development	B
Moderate..........	Slope, poor soil permeability...	Residential Development	C
Moderate	Seasonal waterlogging, soil erodibility, soil shrink-swell potential ...	E.B.C.*	C-w
Severe	Flooding, seasonal waterlogging..	Drainage Reserve	D-fw
Severe	Permanently high water table ...	Reserve..................	D-y

*Extensive Building Complexes