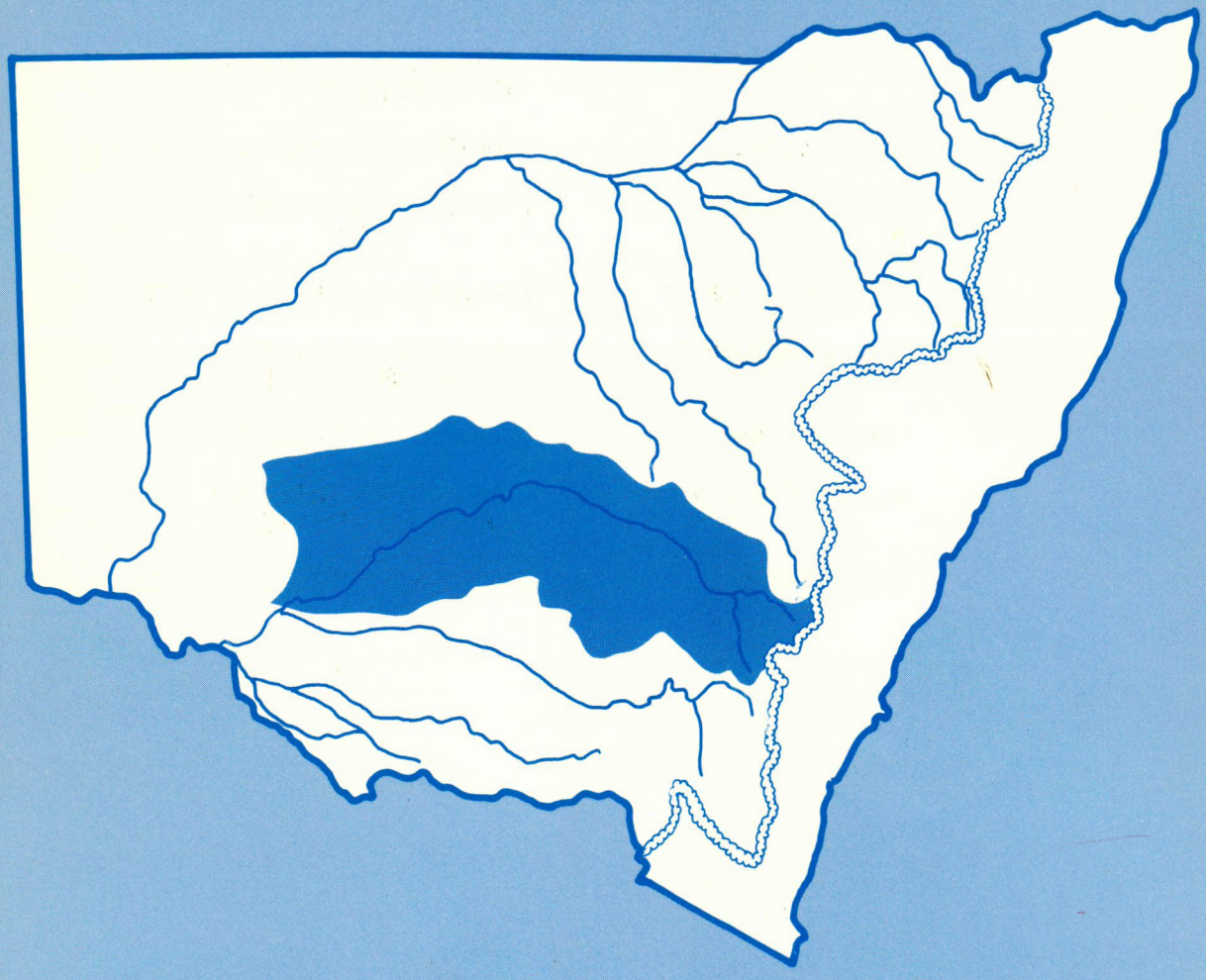
NEW SOUTH WALES INLAND RIVERS FLOOD PLAIN MANAGEMENT STUDIES

SUMMARY REPORT

LACHLAN VALLEY



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1.0 INTRODUCTION

1.1 GENERAL

In May 1979 the Water Resources Commission of New South Wales released a report entitled "Lachlan Valley Flood Mitigation Study", together with a companion volume "The Lachlan River Flood Plain Atlas" which contained maps to a scale of 1:100,000 showing flood affected land along the Lachlan River.

Subsequent to the 1979 report the Commonwealth and State Governments agreed to share the cost of more specific studies leading to the preparation of flood mitigation plans for selected inland rivers in New South Wales. A report entitled "New South Wales Inland Rivers Flood Plain Management Studies - Lachlan Valley" was prepared during 1980-81 and published in 1983. This document is a summary of that report.

The aim of the planning study was to recommend a programme of works and other measures that may form the basis of a Commonwealth/State/Local Government programme.

1.2 TERMINOLOGY - RECOMMENDATIONS AND SUGGESTIONS

Recommendations generally fall within the ambit of works and measures essentially directed at the purpose of flood mitigation and which generally require initiation at Local Government level or from the Water Resources Commission.

Suggestions generally cover such works and measures which appear desirable from a flood mitigation viewpoint but which concern programmes needing a wider viewpoint to assess overall priorities and which generally require initiation at State Government level.

1.3 FLOODING IN THE LACHLAN VALLEY

The Lachlan valley covers an area of about 84 700 square kilometres and stretches westward from the Great Dividing Range for 560 kilometres as a long and narrow basin. Figure 1/1 presents a general plan of the valley and Figure 1/2 shows the Local Government boundaries.

Wyangala Dam, a major water conservation storage is the principal man-made influence on the Lachlan River.

The Lachlan River passes from a relatively high rainfall area near its headwaters in the east to low rainfall areas in the west. In the middle and lower reaches flow from the main channel is lost to the many effluent streams.

In the autumn and winter high monthly rainfalls may result when a series of well developed troughs associated with southern depressions cross the region. This meteorological condition usually has the greatest influence on flooding within the valley.

The pattern and effects of flooding have wide variance along the main stem of the river. At Forbes major floods divide the town into three sections and cause financial losses and hardships. In the lower parts of the valley floods cause water to spread out through the many effluent streams and channels and promote subsequent growth. The flooding may therefore be viewed as beneficial in these parts.

2. PROGRAMME OF WORKS AND MEASURES

The recommendations and suggestions made throughout the report have been drawn together in Tables 2/1 and 2/2 respectively to form a programme of works and measures as called for in the terms of reference for the study.

As discussed in Section 1.2 a distinction has been drawn between 'Recommendations' and 'Suggestions'. The Recommendations are seen to be worthy of forming part of a joint flood mitigation programme where, in most cases, it would be appropriate for funding to be provided by Local, State and Commonwealth Governments. The Recommendations involve works and measures which are primarily of a flood mitigation nature. The Suggestions, on the other hand, include work such as road improvements the priority of which needs to be judged in the more general framework of a State-wide programme in which the effect of flooding is not likely to be the dominant factor. Works and measures not involving a contribution of funds by Local Governments have generally been categorised as Suggestions.

Priorities for implementation of the Recommendations and Suggestions have been expressed as high, medium or low, and, although considerations of cost effectiveness have been made, these priorities are essentially subjective judgments of merit within the context of the overall flood problem within the Lachlan Valley.

TABLE 2/1

SUMMARY OF RECOMMENDATIONS TO FORM PART OF A JOINT

FLOOD MITIGATION PROGRAMME

Recommendation	Local/State Government Authority	Description	Effect of Work or Measure	Sections of Report Containing Discussion of Recommendation	Estimated Cost ($ - mid 1981)	Suggested Priotity Ranking
6.7/1	Water Resources Commission and Forbes Shire	Detailed investigation of revised levee scheme, followed by implementation if shown to be justified	Complete elimination of flooding in protected area	6.4	2 900 000	High
7.9/2	Cabonne Shire	Implementation of town planning measures including acquisition of property - Eugowra	Prevent further undesirable development in critical areas, regulate future development in relation to flood hazard	7.7, 7.9	(not costed)	High
7.9/4	Cabonne Shire	Channel improvements to Mandagery Creek at Eugowra	Lower flood levels in minor to moderate floods	7.8, 7.9	110 000	High
7.9/5	Cabonne Shire	Programme of raising of floor levels of existing buildings which are frequently flooded - Eugowra	Lessen flood damage and distress in moderate to major floods	7.8, 7.9	100 000 (potential cost)	High
7.9/3	Water Resources Commission	Installation of telemetered streamgauge at Murga on Mandagery Creek	Improved flood warning	7.6	14 000	High
7.9/1, 8.2/1, 8.3/1, 8.4/1 8.5/1 9.1/1	Water Resources Commission	Prepare formal flood maps for the towns of Eugowra, Ungarie, Stockinbingal, Gooloogong, Cowra, Canowindra, Gunning, Condobolin, Boorowa and Blayney	Improved flood awareness and basis for planning	7.9, 8.2, 8.3, 8.4 8.5	360 000	High
8.2/2, 8.2/3	Bland Shire	Preparation of a formal planning scheme for the town of Ungarie and the setting of minimum floor levels for new development in flood affected areas (in consultation with the Water Resources Commission)	Reduce flood damage	8.2		High

Hampel, A. Ian (ed.)
An introduction to ski touring, compiled by the Touring Committee of the N.S.W. Ski Association and edited by A. Ian Hampel. 3rd ed. (Sydney), the Associaltion, 1978.

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1. Skiing. I. Hampel, A. Ian (ed.) II. N.S.W. Ski Association.

TABLE 2/1 (CONTINUED)

SUMMARY OF RECOMMENDATIONS TO FORM PART OF A JOINT

FLOOD MITIGATION PROGRAMME

Recommendation	Local/State Government Authority	Description	Effect of Work or Measure	Sections of Report Containing Discussion of Recommendation	Estimated Cost ($ - mid 1981)	Suggested Priority Ranking
8.3/2	Cootamundra Shire	Channel improvements to Dudauman Creek and minor banking works at Stockinbingal	Reduce the severity of flooding in the town	8.3	25 000	Medium
8.3/3, 8.3/4	Cootamundra Shire	Alterations to Planning scheme for town of Stockinbingal and the setting of minimum floor levels for new development in flood affected areas (in consultation with the Water Resources Commission)	Reduce flood damage	8.3		High
8.4/2	Cowra Shire	Preparation of a formal planning scheme for the town of Gooloogong and the setting of minimum floor levels for new development in flood affected areas (in consultation with the Water Resources Commission)	Reduce flood damage	8.4		High
8.5/2	Cowra Shire	Implementation of 'restricted' sub-zone for Cowra. Set minimum floor levels for new development.	Reduce flood damage	8.5		Medium
9.2/1	Cabonne Shire	Implementation of 'restricted' sub-zones within proposed planning scheme for Canowindra	Minimise flood hazard and flood damage	9.2		Medium
9.3/1	Gunning Shire	Rezone areas along Gunning Creek as 'Rural (floodway)' (Gunning)	Preclude unsuitable urban land use	9.3		Medium
9.4/1	Lachlan Shire	Incorporate flood prone holdings in 'restricted' sub-zone. Set minimum floor levels (Condobolin)	Minimise flood hazard and flood damage	9.4		Medium

TABLE 2/1 (CONTINUED)

SUMMARY OF RECOMMENDATIONS TO FORM PART OF A JOINT

FLOOD MITIGATION PROGRAMME

Recommendation	Local/State Government Authority	Description	Effect of Work or Measure	Sections of Report Containing Discussion of Recommendation	Estimated Cost ($ - mid 1981)	Suggested Priority Ranking
9.5/1	Boorowa Shire	Incorporate flood prone holdings in 'restricted' sub zone and set minimum floor levels (Boorowa)	Minimise flood hazard and flood damage	9.5		Medium
9.6/1	Blayney Shire	Formal flood mapping to form basis of zoning of flood prone areas as 'Rural (floodway)' (Blayney)	To give Council stronger control of development	9.6		Medium
10.11/1	Water Resources Commission	Comprehensive State-wide study of rural floodway scheme economics	Facilitate acceptance by all landholders involved; also assist investigation and design	10.9		Medium
10.11/2	Local Government Authorities Department of Environment and Planning	Local Government Authorities to more actively apply planning scheme provisions to rural areas	Reduce flood damage	10.3		Medium
10.11/3	Water Resources Commission	Amend legislation to give Water Resources Commission overriding powers to prevent undue obstruction of the flood plain	Preserve the hydraulic capacity of the flood plain	6.6, 10.3, 10.9		High
11.4/1	General	Provision of funds for minor works on rural and local roads to solve severe local access problems	Improvement of access to properties in minor to moderate floods	11.4	500 000	Medium
11.4/2	Forbes Shire	Raise 3 kilometres length of North Condobolin Road	Provide access to Forbes Airport in minor to moderate floods (cost approximately $150 000)	11.4		High

TABLE 2/2 (CONTINUED)

SUMMARY OF SUGGESTIONS

Suggestion	Authorities to Which Suggestion is Directed	Description	Effect of Work or Measure	Sections of Report Containing Discussion of Suggestion	Suggested Priority Ranking
11.4/4, 11.4/7, 11.4/9	Department of Main Roads	Reconstruction work on Gooloogong Bridge approaches - MR 237 ($300 000), Forbes - Gooloogong Road - TR 56 ($50 000), Forbes - Eugowra Road - MR 377 ($30 000)	General improvement to trafficability of road system in minor to moderate floods	11.4	Medium
11.4/5	Lachlan Shire	Reconstruction of low level Kiacatoo Bridge (approximate cost $800 000)	Provide trafficable crossing of the floodplain in minor to moderate flooding	11.4	Medium
11.4/6	Department of Main Roads	Replacement of bridge over Wallaroi Creek and 2 kilometres of road reconstruction on South Condobolin Road (MR377)	Extend trafficable sections of important route in east-west direction in minor to moderate floods	11.4	Medium
11.4/8	Forbes Shire	Raise 2 kilometre length New Grenfell Road	Prevent disruption to traffic between Forbes and Grenfell (cost approximately $200 000)	11.4	Medium
11.4/10, 11.4/11	Department of Main Roads	Reconstruction of approximately 2.4 kilometres of South Condobolin Road (MR377) at '17 mile' and '21 mile' breakouts with provision of extensive culverts (approximate cost $380 000)	Provide important trafficable route in east-west direction in minor to moderate floods	11.4	High
12.4/3	Water Resources Commission	Reconstruction of telemetered streamgauge system upstream of Wyangala Dam	Improved flood forecasts and additional flood mitigation effect of Wyangala Storage	12.2, 12.5	High
12.4/4	Water Resources Commission	Coordinated programme of flooding data acquisition	Improved basis for planning	12.3, 12.5	High

TABLE 2/1 (CONTINUED)

SUMMARY OF RECOMMENDATIONS TO FORM PART OF A JOINT

FLOOD MITIGATION PROGRAMME

Recommendation	Local/State Government Authority	Description	Effect of Work or Measure	Sections of Report Containing Discussion of Recommendation	Estimated Cost ($ - mid 1981)	Suggested Priority Ranking
12.4/1	General	Promotion of a flood hazard awareness campaign through community organisations and local media which if initially successful should be repeated at intervals of 2 to 3 years. (In conjunction with State Emergency Services and Water Resources Commission).	Reduce flood damage and hazard to life	12.1, 12.4	50 000	High
12.4/2	Boorowa and Cowra Shires	Construction of a telemetered flood-gauge on the Boorowa River at Bennett Springs Bridge	Improved flood warnings	12.2, 12.4	12 000	Medium

TABLE 2/2

SUMMARY OF SUGGESTIONS

Suggestion	Authorities to Which Suggestion Directed	Description	Effect of Work or Measure	Sections of Report Containing Discussion of Suggestion	Suggested Priority Rankine
5.2	Water Resources Commission	Programme of stream channel improvements to meet needs identified in Water Resources Commission Survey	Reduce flood damage in minor to moderate floods in upper reaches of valley. Reduce bank erosion and flood channel scour	5.0	Low to Medium as a flood mitigation measure
Note: Suggestions 6.7/2 to 6.7/5 become unnecessary if Recommendation 6.7/1 is implemented					
6.7/2	Forbes Shire	Reconstruction of Johnny Woods crossing on Lake Forbes ($30 000)	Lower flood levels upstream in minor to moderate floods	6.3, 6.7	High
6.7/3	Department of Main Roads	Reconstruction of Newell Highway Bridge over Lake Forbes ($900 000)	Lower flood levels upstream in major floods	6.3, 6.7	High
6.7/4	Department of Main Roads	Construction of the Newell Highway deviation and ancillary roadworks at Forbes ($2 330 000)	Maintain access and escape routes throughout the town in major floods	6.5, 6.7	High
6.7/5	Forbes Shire	Implementation of town planning measures including preparation of 'action plan', revision and zoning, and acquisition of property - Forbes	Prevent further undesirable development in critical areas, regulate future development in relation to the flood hazard	6.6, 6.7	High
8.2/4	Bland Shire	Investigate further levee protection for Ungarie	Reduce urban flooding	8.2	Medium
9.4/2	Lachlan Shire	Prepare a formal planning scheme for town of Condobolin	Provide for improved development control of flood prone areas	9.4	Medium
10.11/4	Water Resources Commission	Prepare preliminary plans for a floodway scheme in the Condobolin to Lake Cargelligo reach of the floodplain	Reduce rural flood losses	10.8, 10.12	Low
10.11/5	Department of Main Roads, State Rail Authority	Examine the adequacy of drainage provisions under road and rail embankments in the Bogan Gate - Condobolin area with a view to improvement	Reduce flood damage	10.8, 10.10	Medium
11.4/3	Forbes and Cabonne Shires	Raise approaches to Paytens Bridge - approximately 10 km of road reconstruction	Trafficable crossing of floodplain in moderate to major floods (cost approximately $500 000)	11.4	Medium

3.0 FLOOD MAPPING

Figure 3/1 shows the extent of flooding throughout the valley. The total area of flood affected land mapped is 28 440 square kilometres which represents some 34 per cent of the valley area.

The extent of flooding, obtained by considerable interpolation for areas between locations where firm information is available, represents the envelope of flood inundation experienced during major floods. All the areas mapped are not necessarily flooded in any one major flood event. LANDSAT satellite imagery will provide an opportunity for future accurate recording of the flood extent.

4.0 LAND USE

Land use, obtained by visual interpretation of Landsat imagery is shown in Figure 4/1 and summarised in Table 4/1. Field interviews were conducted with a sampling of landholders to obtain "groundtruth" information and an approximate check was made using information on areas under irrigation collated by the Water Resources Commission.

TABLE 4/1

LAND USE IN FLOOD AFFECTED AREAS

Zone (See Figure 4/1)	General Location	Areas (square kilometres) Dry Land Grazing	Dry Land Crops	Irrigated Pastures	Irrigated Crops	Total Flood Affected Area
1	Lower Lachlan below Hillston	19 237	7	43	13	19 300
2	Hillston-Condobolin	2 460	185	100	75	2 820
3	Crowie + Murga Creeks	478	112	-	-	590
4	Humbug (Euglo) Creek	213	17	-	-	230
5	Condobolin-Jemalong Gap	1 815	235	56	64	2 170
6	Bland Creek	1 602	228	-	-	1 830
7	Jemalong Gap-Cowra including Belubula River & Mandagery Creek	921	279	8	72	1 280
8	Lachlan River upstream of Wyangala Dam, Boorowa River, Koorawatha and Hovells Creeks	180	31	2	7	220
Valley Total		26 906	1 094	209	231	28 440

The results are approximate but provide a reasonable indication of land use throughout the flood-liable areas of the valley.

5.0 STREAM CHANNELS

A very large proportion of the flow occurring in the Lachlan River Basin is generated within the 18 000 square kilometres of catchment upstream of the Mandagery Creek confluence between Gooloogong and Forbes. Downstream tributaries are generally poorly defined and the capacity of the main channel is reduced markedly.

A Water Resources Commission survey has identified works considered to be desirable for long term management. The costs of the suggested stream channel clearing works are summarised in Figure 5/1 and total $12 261 000. The costs include an allowance for construction and maintenance work but exclude protection work for bank erosion.

Suggestion

5.2 Implement a defined programme of stream channel improvements to meet the identified needs.

6.0 URBAN AREA FLOODING - FORBES

6.1 DESCRIPTION OF FLOODING

General

Forbes, population 7471 (1976 census), is one of the major urban centres within the valley. Figure 6/1 gives an overview of the town. At Forbes floodwaters spread across an 11 kilometre wide floodplain within which the main hydraulic capacity is provided by the Lachlan River, Bundaburrah Creek and the Lake Forbes and Battye Street floodways. The town experiences severe flooding with heavy damage to residential and commercial areas. Floodwaters separate the town into three sections and isolate the Forbes District Hospital.

Flood Behaviour

Hydraulic conditions on the Forbes floodplain are complex and conditions from one flood to another may be markedly different for the same flood level on the Iron Bridge gauge, which is the main reference point for flooding. Figure 6/2 shows part of the Water Resources Commission flood inundation map of Forbes.

6.2 FLOOD DAMAGE

General

A comprehensive analysis of flood damage costs in Forbes has been carried out by Higgins and Robinson (1981). This analysis has been utilised in the study report and the principal findings are summarised below.

Residential Damage

The critical stage for residential damage is when floodwaters reach floor level. Higgins and Robinson identified 360 houses in Forbes which would be affected by a flood of 100 years average recurrence interval and of these 265 would have floodwaters above floor level. For a 20 year event the numbers are 105 and 45 respectively.

Damage to Business Premises

Many business premises are badly affected by flooding. It was estimated that for a 20 year average recurrence interval flood about 27,000 square metres of business floor area is flooded and for a 100 year event flood about 62 000 square metres.

Disruption to Trade

The losses estimated relate to isolation at the time of the flood and are local as business is to some extent diverted to other centres such as Parkes. Allowance was made for recovery of trade after flooding had receded.

Damage to Services

Higgins and Robinson also collected historical information on damage to services such as roads, culverts, water and electricity supplies.

Total Flood Damages

Table 6/1 shows the total urban damages for Forbes (after Higgins and Robinson), adjusted to mid 1981 values. Flood damages for the 1 in 200 year flood were extrapolated from costs incurred within the area defined by the 100 year floodline and as such are conservative. The total equivalent annual flood damage in Forbes is estimated at $102 400 in mid 1981 values. Floods larger than the 1 in 100 year event are responsible for $36,800 of this amount.

TABLE 6/1

FLOOD DAMAGES IN FORBES ($)

(after Higgins and Robinson, 1981)

Average Recurrence Interval (years)	Residential	Business Premises	Trade Loss	Services	Total
5	14 500	13 200	2 600	0	30 300
10	21 300	49 100	9 000	6 600	86 000
20	93 500	182 000	71 700	72 600	419 800
50	250 000	477 000	471 000	284 000	1 482 000
100	450 000	695 000	926 000	409 000	2 480 000
200	594 000	889 000	1 750 000	462 000	3 695 000
Equivalent Annual Damage	20 200	33 900	33 000	15 300	102 400

6.3 HYDRAULIC ANALYSIS

The flows in the main channels are interrelated in that obstruction of one will cause a redistribution of flow towards the others.

The effects of the following possible actions or works were calculated:

- closing Battye Street and Lake Forbes floodways, June 1952 flood.
- Johnny Woods crossing on flood levels in Lake Forbes.
- Newell Highway Bridge on flood levels in Lake Forbes.
- increasing the waterway area of the Newell Highway Bridge on flood levels in Lake Forbes.
- obstructions in Battye Street and Lake Forbes floodways for a flood of similar size to that of June 1952.

Results were utilised in formulating the various recommendations and suggestions for flood mitigation at Forbes.

6.4 LEVEE SCHEMES

Previous Proposal

A review of the Water Resources Commission's 1960 levee scheme was made. The scheme is now considered inadequate because 1974 flood gaugings show that severe underestimates of flows were made.

Revised Scheme

The scheme examined, being one of many possible layouts, is shown in Figure 6/6. The crest height has been set at 1.0 metre above the level of the June 1952 event and the estimated cost of the scheme is $2 900 000. Although the scheme would give the enclosed area complete protection there would be significant adverse effects in surrounding areas due to the redistribution of flows on the flood plain.

The estimated equivalent annual flood damage is $102 400 which at a discount rate of 10 per cent gives a present worth to the benefits accruing to the levee of $1 015 000 over a 50 year economic life. The present worth of costs including 1 per cent per year maintenance is $3 188 000.

The limitations of such an economic analysis are obvious in that the benefits and costs do not reflect the social aspects of flooding. If the levee scheme were to be developed further a more rigorous analysis including a physical hydraulic model would be necessary. Since the levee scheme is the only measure that would eliminate the direct effects of flooding on the urban community in general, its further investigation is recommended. The other flood mitigation measures referred to only

become necessary if the levee scheme is not to be implemented.

6.5 NEWELL HIGHWAY DEVIATION

The Newell Highway bridge is above the 1952 flood level from Brown Street to south of Oxford Street. Figure 6/7 shows the location of the highway deviation as proposed by the Department of Main Roads.

A deviation of the highway to avoid the commercial centre of town, apart from easing the traffic problems could also provide a high level connection between the three sections of town that are isolated in times of flood.

This would be achieved by:

either

- providing a ramp access of minimal geometric design standard from Union Street to the new work just south of the railway line. The road levels in Oxford Street would also be raised.

or by

- raising the northern section and the road levels in Oxford Street.

Cost estimates for the ramp proposal and the reconstruction of the northern section of the work 0.3 metres above the June 1952 flood level are $3 380 000 and $3 230 000 respectively. The total cost of the flood mitigation inclusions is estimated at $150 000 for the latter proposal.

The benefits of the flood mitigation measures include greatly reduced disruption to traffic and business, reduced hazard to life, improved emergency evacuation routes and traffic access to the hospital.

6.6 PLANNING ISSUES

General

Planning is a basic flood mitigation measure. Development controls and zoning can be used to identify flood hazards, deter unwise development and prevent further obstruction of floodways.

State Government policy is expressed in Circulars 15, 22 and 31 issued by the Department of Environment and Planning in 1977, 1978 and 1982 respectively.

Present Planning Scheme

The present Village zoning is shown on Figure 6/9. Development within this zone is subject to the consent of Council. It appears that flooding problems were not taken into account in the formulation of the

zone. There is a large extent of flood prone land presently undeveloped but included in the zone.

Suggested Planning Approach - Village Zone Boundaries

Intensive development of the rural areas within the present Village zone may hinder flood flows and cause higher flood levels in adjoining areas.

A suggested relocation of the Village zone boundary is shown on Figure 6/9. The boundary would become a clear expression of intent to direct development to the flood free north side of Forbes. The revised planning scheme map should also indicate the area flooded by a 1 in 100 year flood, as defined by the Water Resources Commission. Within this flood prone area it is recommended that floor levels be set 0.5 metres above the 1 in 100 year flood level.

Development in the flood prone areas should be subject to Council's consent with Council having the power to impose conditions in respect of:

- the restriction of sub-divisions
- the use of particular building materials
- the restriction of activities likely to interfere with the movement of floodwaters
- the making of orders with respect to the siting of buildings
- the making of orders with respect to the design of those parts of the buildings which are below the designated minimum floor level
- the provision of safe access during floods.

Suggested Planning Approach - Special Sub Zones

It is essential that the hydraulic capacity of the floodways through Forbes be preserved and therefore explicit sub-zoning within the amended Village zone should be carried out.

Figure 6/9 shows these sub-zonings and it is recommended that:

- Zone A be reserved for open space.
- Zone B be a 'restricted' sub-zone with only reasonable maintenance and repairs to existing buildings, continued use and possibly temporary use permitted.
- Zone C should be a 'restricted' sub-zone with no further development, including filling of land, permitted.

Suggested Planning Approach - Fringe Areas

The most realistic approach is perhaps to leave these areas with the standard rural zoning such as the Non-Urban 'A' and Non-Urban 'B' zones adjoining the present village zone. Such zonings would preclude urban type development.

The prevention of large scale obstructions such as spoilbanks on the flood plain is more appropriately controlled by the Water Resources Commission under existing or amended powers.

6.7 RECOMMENDATION TO FORM PART OF A JOINT FLOOD MITIGATION PROGRAMME - FORBES (FORBES SHIRE)

6.7/1 Further investigation of the levee scheme as discussed in Section 6.4, and implementation if shown to be justified.

Note: If the levee scheme is implemented the following suggestions become unnecessary.

SUGGESTIONS - FORBES

6.7/2 Reconstruction of the Johnny Woods crossing on Lake Forbes. The footway to be removed and the embankment lowered to a level sufficient to maintain present lake levels. The estimated cost of the work is $30 000.

6.7/3 Reconstruction of the Newell Highway Bridge over Lake Forbes. Additional waterway area equivalent to 5 extra spans is required for acceptable performance in major floods. The estimated cost of the work is $900 000.

6.7/4 Construction of the Newell Highway deviation and ancillary roadworks as discussed in the text to provide access throughout the town in floods of up to 100 years return period. The estimated cost is $3 230 000 of which about $150 000 is directly attributable to work to serve flood mitigation purposes. Joint funding of this marginal flood mitigation component cost is envisaged with the remainder of funds coming from the State roadworks programme.

6.7/5 General implementation of the town planning measures discussed in the text. Funding to be provided for detailed planning work including the preparation of action plans for the 'restricted' sub-zonings and also for necessary acquisition of property.

7.0 URBAN AREA FLOODING - EUGOWRA

7.1 GENERAL

Eugowra, population 651 (1976 census), is located 35 kilometres east of Forbes and lies alongside Mandagery Creek, approximately 18 kilometres upstream of its confluence with the Lachlan.

7.2 MANDAGERY CREEK CATCHMENT

The catchment encompasses some 1880 square kilometres of rural land. Land use within the catchment is mainly dry land farming with some supplementary irrigation used on a small number of properties.

7.3 EXISTING DEVELOPMENT IN THE TOWN

Eugowra is divided by Mandagery Creek. The western section is more severely affected by flooding and includes residential and some older commercial development. Existing development is shown on Figure 7/2. A Draft Local Environemental plan prepared by Cabonne Shire Council is presently under review.

7.4 CHARACTERISTICS OF FLOODING

Eugowra is susceptible to flooding from both Mandagery Creek and the local catchments east of the town.

The main influence is Mandagery Creek and the extent of flooding from the Creek is shown on Figure 7/2.

Calculations indicate that approximately 25 per cent of a total major flow passing the town is carried by the floodway through the western part of the town as indicated on Figure 7/2.

7.5 FLOOD DAMAGE

An assessment has been made of the cost of damage caused by floods of similar magnitude to the 1950 and 1973 events.

Unit costs have been based on flood damages determined at Forbes and elsewhere (Higgins and Robinson 1981) subjectively adjusted to reflect local conditions.

7.6 FLOOD WARNINGS AND COMMUNITY SELF HELP

General

The susceptibility of Eugowra to frequent flooding has resulted in a high degree of flood awareness in local residents. An effective State Emergency Services flood warning system is an integral part of a self-reliant community coping with a recurring natural hazard.

Flood Warnings

The system relies on monitoring the Murga gauge and it is recommended that a 'Telemark' type device be installed to facilitate easier collection of flood height data.

Evacuation

Evacuation procedures are well established with sufficient area of high land on the western side of town available as a refuge. The evacuation of the eastern side of town is only required for major flooding similar to that experienced in 1950.

7.7 PLANNING ISSUES

No formal planning scheme exists. The proposed Village zone from the Draft Local Environmental plan is shown on Figure 7/2 together with areas which are the subject of submissions to the Department of Environment and Planning from interested parties.

Although the proposed Village zone boundaries do not address the problem of flooding the Council is intending to amend the boundaries as appropriate when detailed flood mapping is available. The presence of the western floodway is recognised.

It is recommended that:

- the proposed environmental plan be amended with the existing undeveloped lots within the floodway zoned as 'Reserved for open space'.

- where the structural integrity of existing buildings in the floodway is adversely affected, Council acquire the properties then re-zone as open space.

- the extent of inundation of the 1 in 100 year flood be delineated on the environmental plan. All new residential development within the area should have floor levels set 0.5 metres above the 1 in 100 year flood level.

7.8 FLOOD MITIGATION MEASURES

General

The recommendation regarding amendments to the Draft Environmental Plan are flood mitigation measures. Further possibilities are listed below.

Levee Protection

Two arrangements were considered:

- Protection to the entire town caused by the 100 year average recurrence interval flood would promote severe constriction of flood flows with resulting increase in flow velocities and hence extensive scour protection. The cost would be in the order of $800 000.

- Protection to the western area most frequently flooded. Hydraulic calculation indicated significant increases in flood levels on the eastern side of town.

Therefore levee protection is not at present considered an acceptable flood mitigation option. This should be reviewed when the results of the current investigation by the Water Resources Commission are made available.

Channel Improvements - Mandagery Creek

The channel capacity of the Creek is significant in relation to flood flows. Some clearing and improvements have been carried out recently.

Raising of floor levels of existing buildings

Considerable mitigation of flood losses would result from the raising of floor levels of existing buildings. Approximately 20 houses and 17 commercial buldings had water above floor level in the February 1973 flood which was approximately a once in 10 year event.

In older homes a few residents have been able to raise floors internally by about 0.3 metres because of the high ceilings.

A scheme currently exists whereby loans of up to $5000 are available for the purpose of moving houses to a flood free site or raising them above flood level. This scheme does not appear to have attracted much attention within the Lachlan Valley.

7.9 RECOMMENDATIONS TO FORM PART OF A JOINT FLOOD MITIGATION PROGRAMME - EUGOWRA (CABONNE SHIRE)

7.9/1 The Water Resources Commission to complete a detailed flood map of the town.

7.9/2 Amendments to be made to the planning scheme for the town (see Section 7.7) with funding of acquisition of undeveloped land in the floodway following its zoning as 'reserved for open space'.

7.9/3 Installation of telemetering equipment at the Murga gauge on the Mandagery Creek at an estimated cost of $14 000.

Note: Implementation of the following recommendations should be delayed pending the completion of the Water Resources Commission flood map for the town. Part of the flood mapping investigations will be to evaluate the suitability of levees as a flood mitigation option. If the provision of levees is recommended by the Water Resources Commission the implementation of the following measures may need to be reassessed.

7.9/4 Channel improvements to Mandagery Creek at an estimated cost of $110 000.

7.9/5 Funding of a programme of raising of floor levels of existing buildings in frequently flooded areas where possible and where desired by owners (see Section 7.8). The potential cost of the programme is of the order of $100 000.

8.0 URBAN AREA FLOODING - OTHER CENTRES WHERE EXISTING DEVELOPMENT IS SIGNIFICANTLY AFFECTED BY FLOODS

8.1 GENERAL

In this section Ungarie, Stockinbingal, Gooloogong, and Cowra, in which existing development is flooded to a significant extent are discussed. Figures 8/1, 8/2, 8/3, and 8/4 show plans of each of the towns, extent of major flooding, formal planning scheme where applicable and a possible levee scheme. Table 8/1 summarises the flood damage in each town.

TABLE 8/1

URBAN FLOOD DAMAGE

	Location			
	Ungarie	Stockinbingal	Gooloogong	Cowra
Population 1976 Census	456	263	218	7586
Date of Major Floods	1928 1962	1919 1956 1974	1952	1870 1916 1952
Flood Damage				
Date of Flood	1962	1974	1952	1952
No. of buldings affected by flood	71	30	31	70
No. of buildings having water above floor level	25	18	Most	20
Approximate cost of flood damage mid 1981 values	$140 000	$60 000	$55 000	$100 000

8.2 UNGARIE

Recommendations Forming Part of a Joint Flood Mitigation Programme - Ungarie (Bland Shire)

8.2/1 Preparation by the Water Resources Commission of a detailed flood map.

8.2/2 A formal planning scheme to be prepared by the Bland Shire Council for the town.

8.2/3 Minimum floor levels for new development to be set after consultation with the Water Resources Commission.

Suggestions - Ungarie

8.2/4 Survey, preliminary design and costing of levees as shown in Figure 8/1 to be carried out. Final commitment to proceed dependent on this preliminary assessment. (A tentative cost is $640 000).

8.3 STOCKINBINGAL

Recommendations Forming Part of a Joint Flood Mitigation Programme - Stockinbingal (Cootamundra Shire)

8.3/1 A detailed flood map to be prepared by the Water Resources Commission taking into account the likely effects of banking work carried out since 1974.

8.3/2 Flooding from Dudauman Creek be restricted by the provision of additional minor banking where appropriate. The cost would be of the order of $25 000.

8.3/3 Cootamundra Shire Council to set minimum floor levels for new development on the advice of the Water Resources Commission following the detailed flood mapping.

8.3/4 The Shire Council to amend Village zone boundaries to exclude flood prone areas to the north and west of Wood and Dudaumen Streets.

8.4 GOOLOOGONG

Recommendations Forming Part of a Joint Flood Mitigation Programme - Gooloogong (Cowra Shire)

8.4/1 A detailed flood map be prepared for the town by the Water Resources Commission.

8.4/2 A formal planning scheme be instituted to deflect new development away from the lower, more flood prone areas. A requirement of the scheme should be that minimum floor heights for new development be set at 0.5 metres above the June 1952 flood level.

8.5 COWRA

Recommendations Forming Part of a Joint Flood Mitigation Programme - Cowra (Cowra Shire Council)

8.5/1 A detailed flood map to be prepared for the town by the Water Resources Commission.

8.5/2 The implementation of a 'restricted' sub zone of the Village zone covering the flood prone portions of West Cowra. Council to set minimum floor levels for new development in the flood prone areas 0.5 metres above the 100 year flood level as determined by the Water Resources Commission.

9.0 URBAN AREA FLOODING - OTHER CENTRES WHERE NEARBY FLOODING MAY AFFECT PLANNING OF FUTURE DEVELOPMENT

9.1 GENERAL

The urban centres previously discussed have a flood problem in that a significant part of the development in each town experiences flooding. Other towns have development not significantly affected by flooding but which flanks flood prone areas. Towns falling into this category include Canowindra, Gunning, Condobolin, Boorowa and Blayney. Figures 9/1, 9/2, 9/3, 9/4 and 9/5 show the existing development, approximate flood extent, proposed or existing Village zone for each town, respectively.

Recommendation Forming Part of a Joint Flood Mitigation Programme - General

9.1/1 The Water Resources Commission to prepare flood maps for the towns of Canowindra, Gunning, Condobolin, Boorowa and Blayney.

9.2 CANOWINDRA

Recommendation Forming Part of a Joint Flood Mitigation Programme - Canowindra (Cabonne Shire Council)

9.2/1 Implementation of 'restricted' sub zones within the flood prone areas proposed for inclusion in the planning scheme for Canowindra to control future development.

9.3 GUNNING

Recommendation Forming Part of a Joint Flood Mitigation Programme - Gunning (Gunning Shire Council)

9.3/1 Council to rezone the flood prone areas along Gunning Creek as 'Rural (floodway)' in order to preclude unsuitable urban land uses.

9.4 CONDOBOLIN

Recommendation Forming Part of a Joint Flood Mitigation Programme - Condobolin (Lachlan Shire Council)

9.4/1 Implementation of town planning measures. Aim of measures is minimisation of future flood damages and flood hazard.

Suggestion - Condobolin

9.4/2 A formal planning scheme be prepared for the town of Condobolin.

9.5 BOOROWA

Recommendation Forming Part of a Joint Flood Mitigation Programme - Boorowa (Boorowa Shire Council)

9.5/1 Implementation of town planning measures. Council to confer with Water Resources Commission concerning determination of 1952 flood levels.

9.6 BLAYNEY

Recommendation Forming Part of a Joint Flood Mitigation Programme - Blayney (Blayney Shire Council)

9.6/1 Implementation of planning measures. Purpose is to control future development in the flood prone areas of Blayney.

10.0 RURAL AREA FLOODING

10.1 EFFECTS OF FLOODING ON RURAL INDUSTRY

The flood peak as it moves downstream has varying effects on rural industry. Above Cowra crop damage and livestock losses are small. Below Gooloogong, although livestock losses are small, significant long term losses occur from noxious weed infestation, extensive damage to pastures and crop losses.

10.2 RURAL FLOOD DAMAGES

Higgins and Robinson's results for the Forbes Shire were extrapolated for the whole valley.

The total equivalent annual cost for the valley for floods of up to 100 years average recurrence interval is $1 300 000.

10.3 RURAL PLANNING ISSUES

Away from urban centres land use zonings generally have little to offer as flood mitigation measures. However, it would seem desirable that new rural dwellings have floor levels set 0.5 metres above the largest flood for which information is available and be located clear of floodways which have high flow velocities.

The existing powers of the Water Resources Commission are not clear in respect to obstructions located some distance from a waterway. Obstructions may take the form of levee, road and railway embankments and spoil banks along irrigation and drainage channels.

At present, these private works may proceed without reference to the Water Resources Commission.

It is suggested that the Water Act be appropriately amended or new legislation enacted, to ensure that the Water Resources Commission has overriding powers in regard to development on the floodplain which has adverse effects on flooding.

10.4 THE FLOODWAY SCHEME CONCEPT

The Water Resources Commission has devised a strategy for limiting flood damage by construction of low levees which confine most floodwaters to the flood runners and other natural flow paths.

Existing floodway schemes based on this strategy include the Belubula Valley and the Lachlan Valley over the two reaches from Jemalong Gap to Condobolin and from Gooloogong to Jemalong Gap.

For optimum efficiency, such schemes need to be constructed in their

entirety. In the past levees have been built by individual landholders with little co-ordination.

10.5 FLOODWAY SCHEMES BENEFITS - A CASE STUDY

Part of the Gooloogong to Jemalong Gap scheme was studied to identify the benefits resulting from the floodway works. The estimated cost of construction is $60 000 and assuming annual maintenance costs at 1.5 per cent and 10 per cent reconstruction following a flood of 35 years average recurrence interval, the present worth of the costs at 10 per cent discount rate is $70 700. The estimated equivalent annual benefit accruing to the scheme is $6 800 which assuming a discount rate of 10 per cent and an economic life of 50 years gives a present worth of $68 000.

The benefit cost analysis indicates that the works are marginally uneconomic. Weighting of the flood damage with respect to probability has a marked effect on the estimated average annual benefit.

Work undertaken by Higgins and Robinson indicated more favourable economics at the regional study level.

10.6 POSSIBLE FLOODWAY SCHEME - CONDOBOLIN TO LAKE CARGELLIGO

The area subject to flooding is approximately 1200 square kilometres and the land use is mainly dryland grazing with irrigated crops and pasture occupying less than 10 per cent of the area.

Equivalent annual flood losses along the river reach are of the order of $150 000.

Feasibility of the floodway scheme has not been examined in detail, however it appears to be of sufficient merit to warrant further examination.

10.7 FURTHER ECONOMIC STUDY OF FLOODWAY SCHEMES

The financial implications of floodway schemes on their acceptance by landholders, in a situation where general acceptance and cooperation is desirable, has been noted.

A small case study gave a marginally uneconomic result, but this was sensitive to the assumptions adopted.

Accordingly a more comprehensive study of the economics of floodway schemes, on a State-wide basis, is recommended. This is expected to lead to less uncertainty and therefore more ready acceptance by landholders, as well as assisting the investigation and design of such schemes.

10.8 IMPROVED FLOOD DRAINAGE IN THE BOGAN GATE-CONDOBOLIN AREA

A particularly severe drainage problem occurs on the northern side of Trunk Road No.61 between Bogan Gate and Condobolin (See Figures 3/1 and 11/1). About 800 hectares of land are adversely affected.

It is suggested that the adequacy of drainage structures under the road and the rail embankment be reviewed.

10.9 RECOMMENDATIONS AND SUGGESTIONS

Recommendations to Form Part of a Joint Flood Mitigation Programme - Rural Flooding

10.11/1 Carry out a comprehensive study leading to improved knowledge of the economics of floodway schemes. It is suggested the study be undertaken in the overall NSW context, while ultimately having specific applicability in the Lachlan Valley (and other valleys). (See Section 10.7)

10.11/2 Local Government authorities to more actively use planning scheme provisions to deter unwise flood prone development and to reduce potential flood hazards. In particular proposed residences in flood prone areas should have minimum floor levels set 0.5 metres above the record flood at the site. (See Section 10.3).

10.11/3 Legislative changes to be carried out to ensure that the Water Resources Commission has overriding powers in regard to development on the floodplain which has adverse effects on flood patterns or is subject to excessive hazard. (See Section 10.3).

Suggestions - Rural Flooding

10.11/4 The Water Resources Commission to prepare preliminary plans for a floodway scheme in the Condobolin to Lake Cargelligo section of the floodplain. (See Section 10.6).

10.11/5 The adequacy of drainage structures under Trunk Road No.61 and the main western railway line to Broken Hill in the Bogan Gate to Condobolin area to be reviewed by the responsible authorities in conjunction with the Water Resources Commission. (See Section 10.8).

11.0 COMMUNICATIONS AND TRANSPORT

11.1 GENERAL

Air, rail, road transport and telecommunication systems within the Lachlan Valley are all affected to some extent by flooding.

In the case of roads and railways the effects extend beyond the local and regional level. In flood situations key local airstrips assume vital importance as supply by air is often the only possibility.

The continuity of telecommunication links is important for the operation of emergency services and the dissemination of flood warnings.

Figure 11/1 shows the transport links within the Lachlan Valley.

11.2 AIR TRANSPORT

There are flooding problems associated with some landing facilities which have operational importance in flood emergencies and these problems are as follows:

- the Forbes authorised landing area was partly flooded in the June 1952 flood but remained usable for flood relief work. The important landing facilities are unaffected in minor and moderate floods but in such floods road access is cut.

- the authorised landing area at Booberoi is partly covered by floodwaters during major flooding.

- road access to the Hillston and Condobolin air strips is affected by flooding.

11.3 RAIL TRANSPORT

Table 11/1 summarises the available information on disruptions to the rail network brought about by major floods.

TABLE 11/1

DISRUPTIONS TO RAIL SERVICES IN MAJOR FLOODS

TYPE OF SERVICE	DISRUPTION LOCATED BETWEEN		COMMENTS
Passenger & Freight	Condobolin	Bogan Gate	Cut at Ootha Creek (3 days in 1976), under water at various locations.
Passenger & Freight	Parkes	Forbes	Cut at Daroobalgie north of Forbes.
Passenger & Freight	Lake Cargelligo	Barmedman	Cut by Euglo Creek 9.5 km west of Ungarie and also cut 8.0 km north of Barmedman.
Passenger & Freight	Barmedman	Cootamundra	Cut north-west of Temora by Barmedman Creek.
Freight	Forbes	Cootamundra	Cut at Bland Creek north of Stockinbingal. Cut at Red Bend south of Forbes by Bundaburrah Creek (6 days in 1974).
Passenger & Freight	Cowra	Young	Cut at Cowra by the Lachlan River due to risk of scouring of bridge trestles. Cut at Koorawatha, Back and Crooker Creeks.

11.4 ROAD TRANSPORT

In major floods much of the road system on the floodplain is under water resulting in severe disruption to both local and interstate traffic. Figure 11/2 shows a schematic layout of the major road system together with the road closure - frequency information.

Rough cost estimates were prepared for the work involved in upgrading roads to ensure trafficability in floods having an average recurrence interval of up to 10 years. It was obvious that with the large sums of money involved such a scheme of works is impractical and possibly inappropriate in terms of general roadwork priorities. However there are locations where it appears that improvements of a more modest aim

and cost would appear to be justified and these have been identified in suggestions.

There appear to be many locations where expenditure of small amounts by a Shire Council would greatly ease local access problems in minor to moderate flooding.

Recommendations to Form Part of a Joint Flood Mitigation Programme - Roads

11.4/1 Funding of minor roadworks on rural and local roads to alleviate severe local access problems caused by flooding. Councils to submit details of works they feel should be considered for inclusion in a joint flood mitigation programme.

11.4/2 Forbes - Condobolin via North Condobolin Road (Shire Road - Forbes Shire)
- Access to Forbes Airport
A 1 kilometre section of road requires raising by 0.6 metres to provide access to Forbes Airport during minor and moderate flooding. The estimated cost of this work is $150 000. This is considered to be especially important in view of the value of transport in flood relief work.

Suggestions - Roads

11.4/3 Payten's Bridge - Lachlan River (Shire Road - Cabonne and Forbes Shires)
Approximately 10 kilometres of approach road reconstruction is required at an estimated cost of $500 000 to provide a trafficable crossing of the floodplain in moderate to major floods.

11.4/4 Gooloogong Bridge - Lachlan River (MR 237)
Bridge approach roads require raising for approximately 1 kilometre. Extensive culvert drainage in the abutments will be required. Estimated cost of this work which will provide a trafficable crossing of the floodplain in moderate to major flooding is $300,000.

11.4/5 Kiacatoo Bridge - Lachlan River (Shire Road - Lachlan Shire)
This low level bridge is the only crossing of the Lachlan River between Eubalong and Condobolin. Construction of a new bridge and reconstruction of 2 kilometres of approach road is required at a total estimated cost of $800 000 to provide a trafficable north-south route in minor to moderate floods.

11.4/6 South Condobolin Road (MR 377)- bridge over Wallaroi Creek
Replacement bridge and 2 kilometres of road reconstruction is required at a total estimated cost of $700 000 to make the road trafficable during minor and moderate flooding.

11.4/7 Forbes - Gooloogong Road (TR 56)
A 1 kilometre section of road at Pilgrims Hill approximately 21

kilometres from Forbes requires raising by 0.3 metres. This would provide access to areas south east of Forbes during minor and moderate flooding at an estimated cost of $50 000.

11.4/8 Forbes - Grenfell, via New Grenfell Road (Shire Road - Forbes Shire)
Raising a 2 kilometre length of road by 0.15 metres with provision of extensive drainage works would prevent disruption to traffic between Forbes and Grenfell. The estimated cost is $200 000.

11.4/9 Forbes - Eugowra (MR 377)
Raising the road level at the Southern Cross breakout approximately 6 kilometres east of Forbes by 0.3 metres for a length of 400 metres would make the road trafficable during minor and moderate flooding. The estimated cost is $30 000.

11.4/10 Forbes - Condobolin via South Condobolin Road (MR377)
17 mile Breakout
A 2 kilometre section of road requires raising by 0.75 metres. This would make the road trafficable during minor and moderate flooding at a cost of approximately $300 000.

11.4/11 Forbes - Condobolin via South Condobolin Road (MR 377)
21 mile Breakout.
Raising a 400 metre section of road by 0.25 metres would considerably reduce the frequency of closure of this road. The estimated cost of the work is $50 000.

11.5 TELECOMMUNICATIONS

Telecommuncation cables within the valley are now almost entirely located underground and this has greatly increased reliability of service.

Flooding has little effect, in general, on telecommunications within the valley.

12.0 FLOOD WARNING SYSTEMS AND FLOODING DATA ACQUISITION

12.1 FLOOD WARNING SYSTEMS GENERAL

The existence of an adequate flood warning system is perhaps the most basic and cost effective of possible flood mitigation measures. Response to warnings is a major determinant of final damage.

12.2 IMPROVEMENTS TO THE FLOOD WARNING SYSTEM

There is a high level of satisfaction within the valley with the flood warning services provided by the State Emergency Services organisation in conjunction with the Bureau of Meteorology and the system appears to work quite well.

With the influx of new residents there is a need to improve the individuals perception of the flood hazard. The Water Resources Commission's flood maps are an important part of this process but there appears to be a need for an active education programme, operational exercises and the review and updating of contact lists and procedures.

There are particular data needs which would greatly assist in the preparation of accurate and timely flood forecasts

12.3 FLOODING DATA ACQUISITION

The State-wide programme of flood mapping of urban centres being carried out by the Water Resources Commission is a concerted effort to consolidate and display available flood information.

Landsat imagery may become available in future years. Aerial photography is used by the Water Resources Commission to obtain coverage of major flood events.

Even with the ongoing data acquisition there is, it appears, never enough data on flood levels and flows to satisfy the needs associated with the preparation of flood maps, setting of minimum floor levels, preparation of town planning schemes, design of levee and floodway schemes and various other flood mitigation related activities.

It is unreasonable to expect that the Water Resources Commission will ever be in a position to gather all the data required. Local Government authorities should take up the responsibility for part of this work. Such data gathering will directly benefit the communities the Councils represent.

There is a great deal of uncertainty about the distribution of flood flows across the floodplain in many actual locations such as in the vicinity of Forbes, and such major flood breakouts as 'Southern Cross' upstream of Forbes and '17 mile' and '21 mile' downstream of the town. In future floods efforts should be made to gauge such flows or to estimate them from peak flood marks indicated on simple recording

devices.

12.4 RECOMMENDATIONS AND SUGGESTIONS

Recommendations to Form Part of a Joint Flood Mitigation Programme

12.4/1 The joint sponsoring by the Water Resources Commission, Local Government Authorities, and the State Emergency Services of a flood hazard awareness campaign directed at the rural and urban communities in the valley which are subject to a high flood hazard. Promotion should be through local community organisations, newspapers and electronic media. A funding level of, say, $50 000 is recommended and if the results are encouraging the campaign should be repeated at intervals of two or three years. Detailed planning of the campaign and evaluation of awareness generated should be entrusted separately to experts, such as reputable advertising agencies.

12.4/2 Construction of a telemetered flood gauge on the Boorowa River at an estimated cost of $12 000.

Suggestions

12.4/3 The Water Resources Commission to proceed with plans to replace and improve the telemetered river gauge network upstream of Wyangala Dam.

12.4/4 The Water Resources Commission to implement a coordinated programme of flood data acquisition in future floods. The assistance of Local Government authorities to be sought in gathering of flood level information during and immediately following floods.

13.0 THE RIVERINE ENVIRONMENT

The study included an 'overview' of the key areas of natural vegetation and identified four main riverine communities. These were dense timber, scattered timber, swamps and lakes.

Figure 13/1 presents a map of the four communities associated with the Lachlan River. The distribution of these communities depends upon their closeness to permanent water and the amount of inundation occurring during flooding.

Several specific areas are listed as important representatives of wetlands in the Lachlan Valley. Some of these areas, Lake Cowal, Lake Merrimajeel and Murrumbidgil Swamp have been studied, however the other areas require a similar degree of study, particularly the Great Cumbung Swamp near Oxley.

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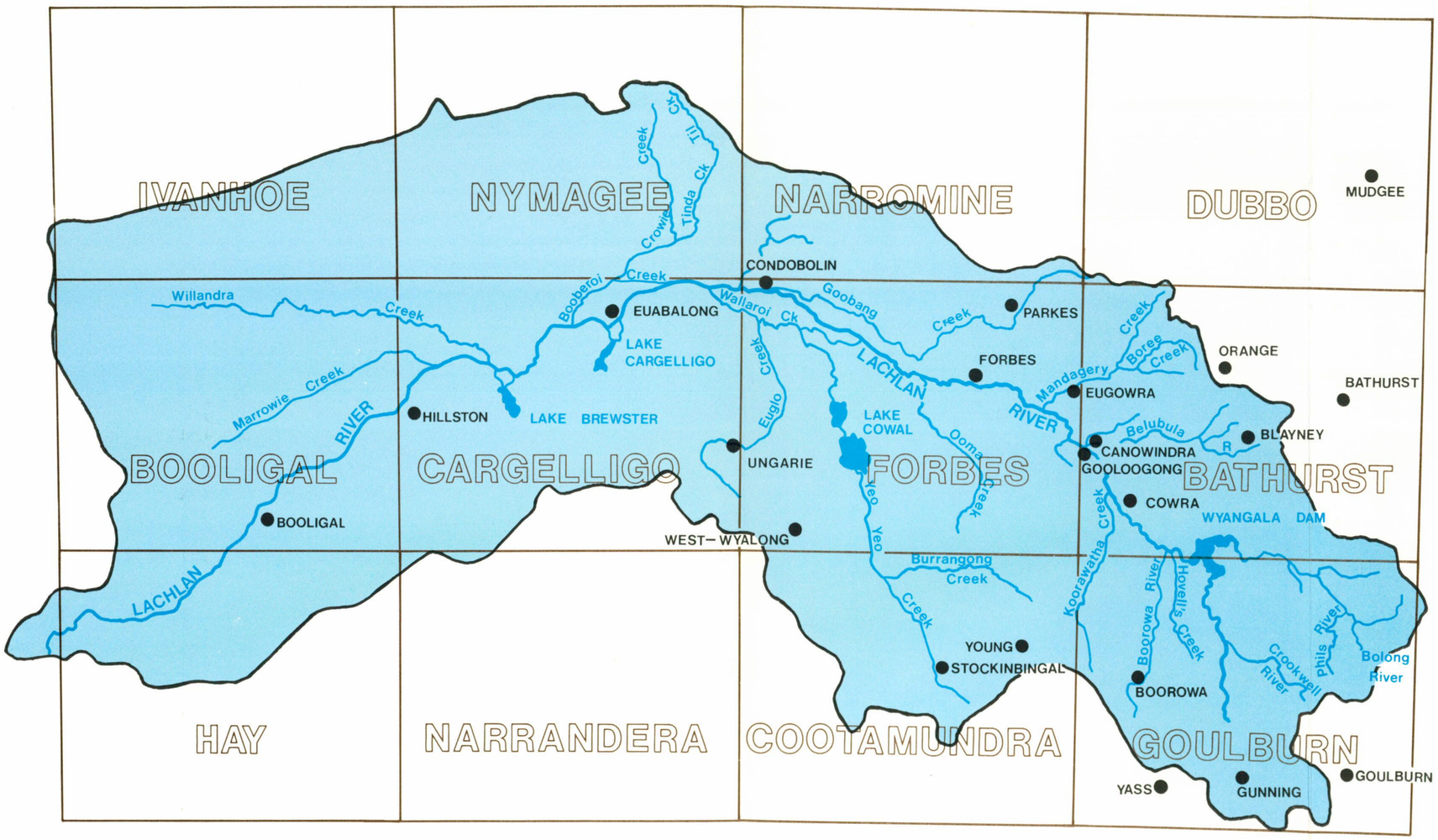
FIGURE 1/1

LACHLAN VALLEY — GENERAL PLAN



NOTE. Map index shown is for Division of National Mapping. 1: 250,000 Series

50 0 50 100 150 Km

A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

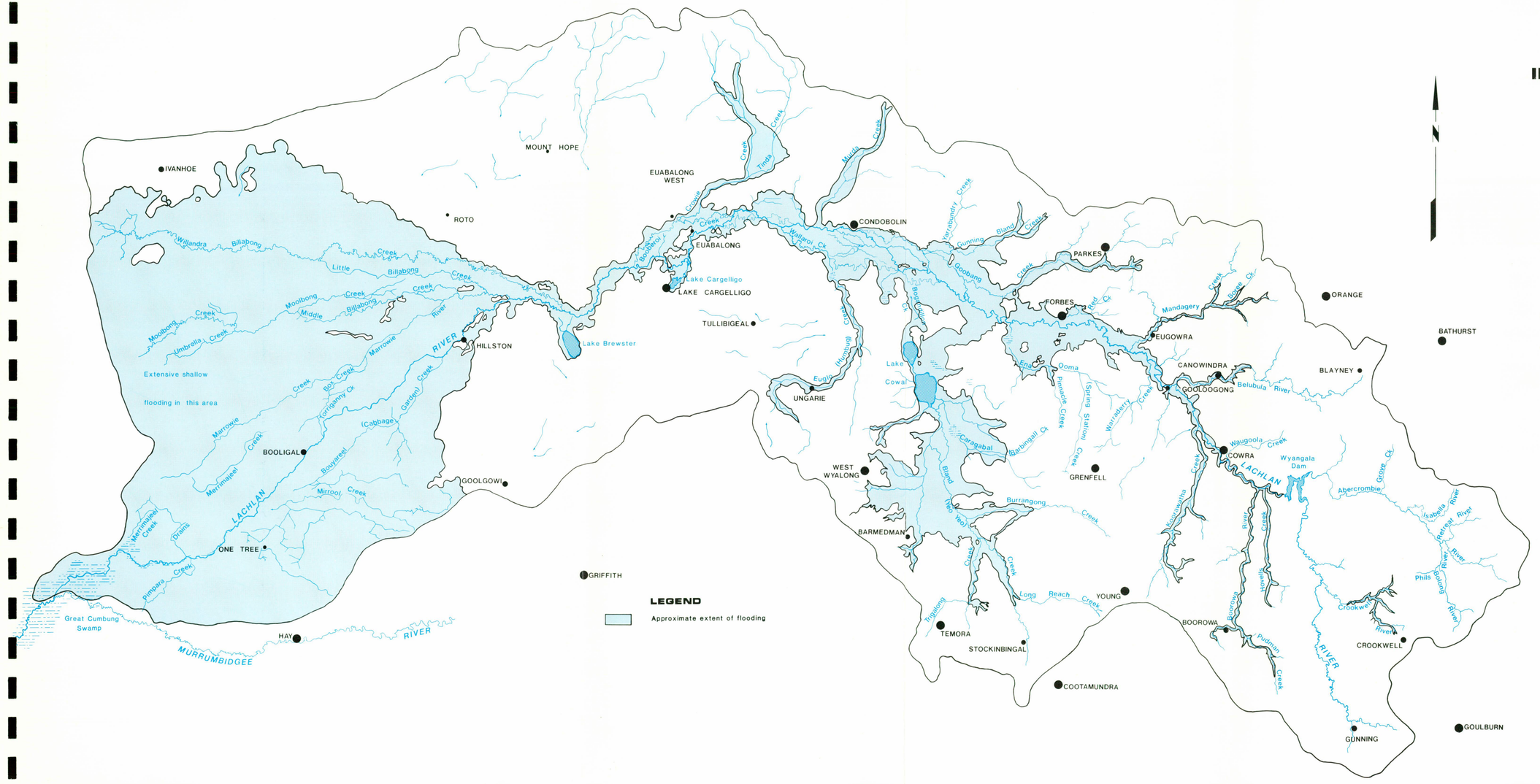
FIGURE 1/2

LOCAL GOVERNMENT AREAS WITHIN THE LACHLAN VALLEY

A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

FIGURE 3/1

EXTENT OF FLOODING IN THE LACHLAN VALLEY

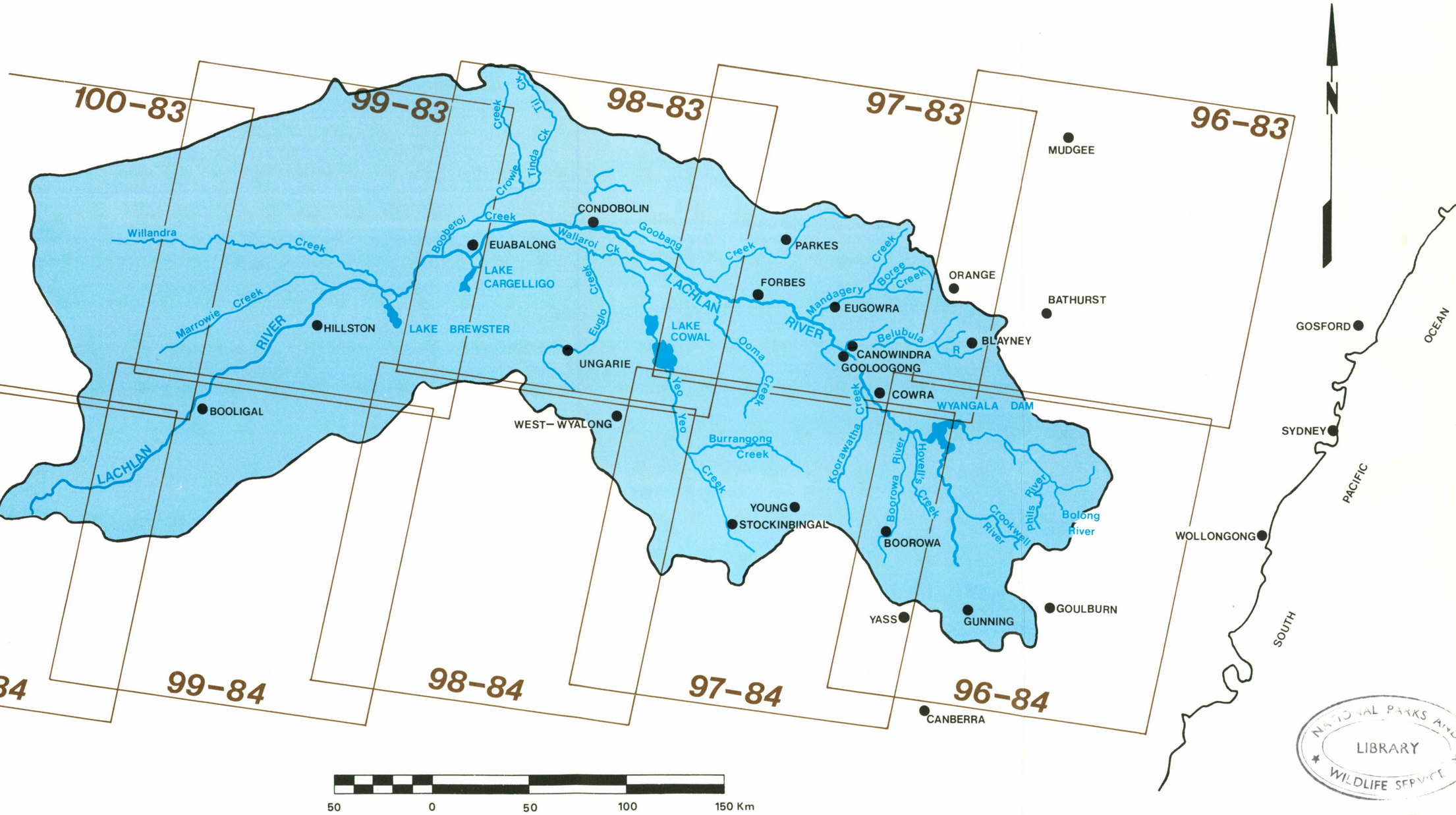


A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

FIGURE 4/1

LANDSAT IMAGERY COVERAGE OF THE LACHLAN VALLEY

NOTE. Landsat image numbers shown refer to path–row number of the world–wide reference system



A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

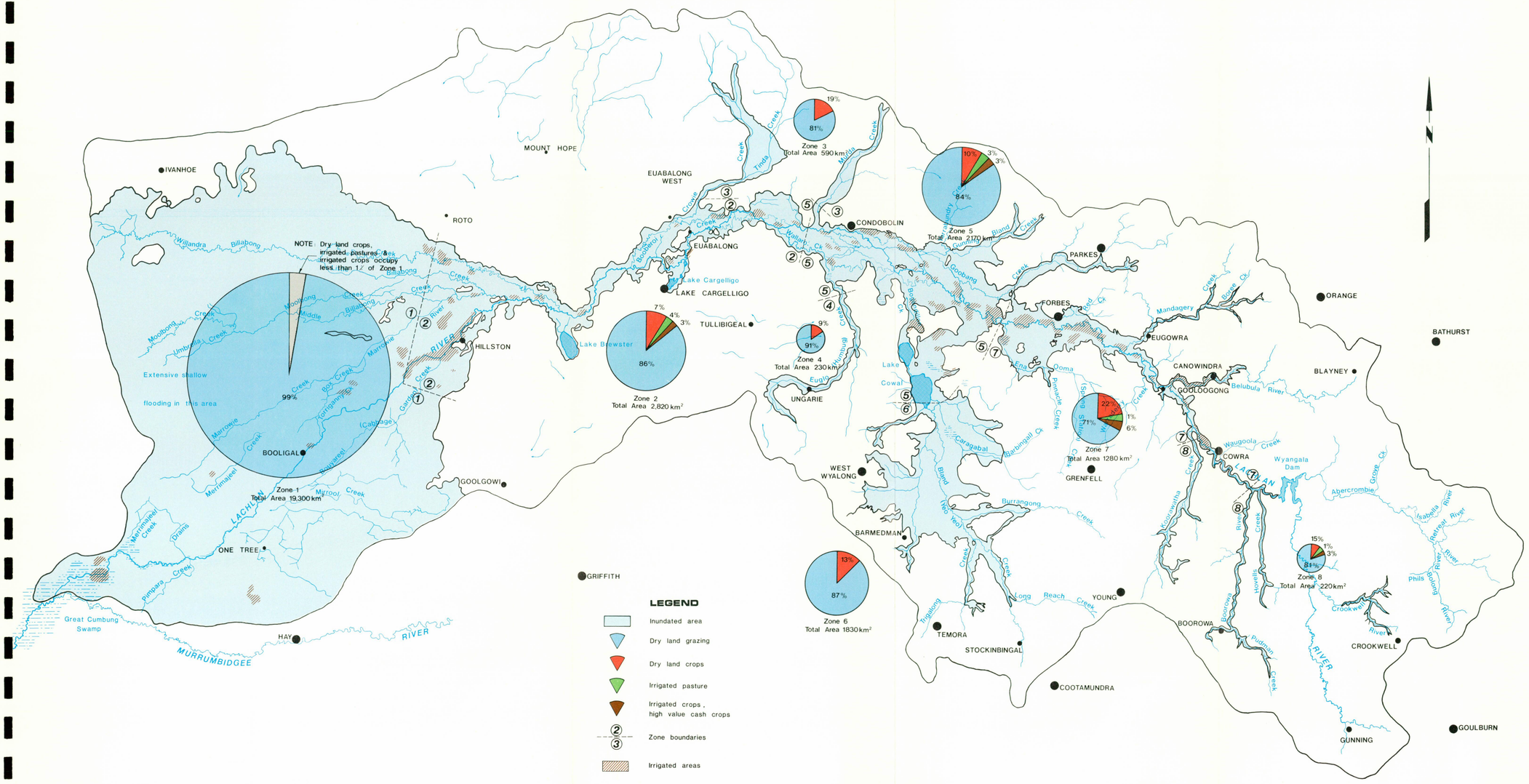


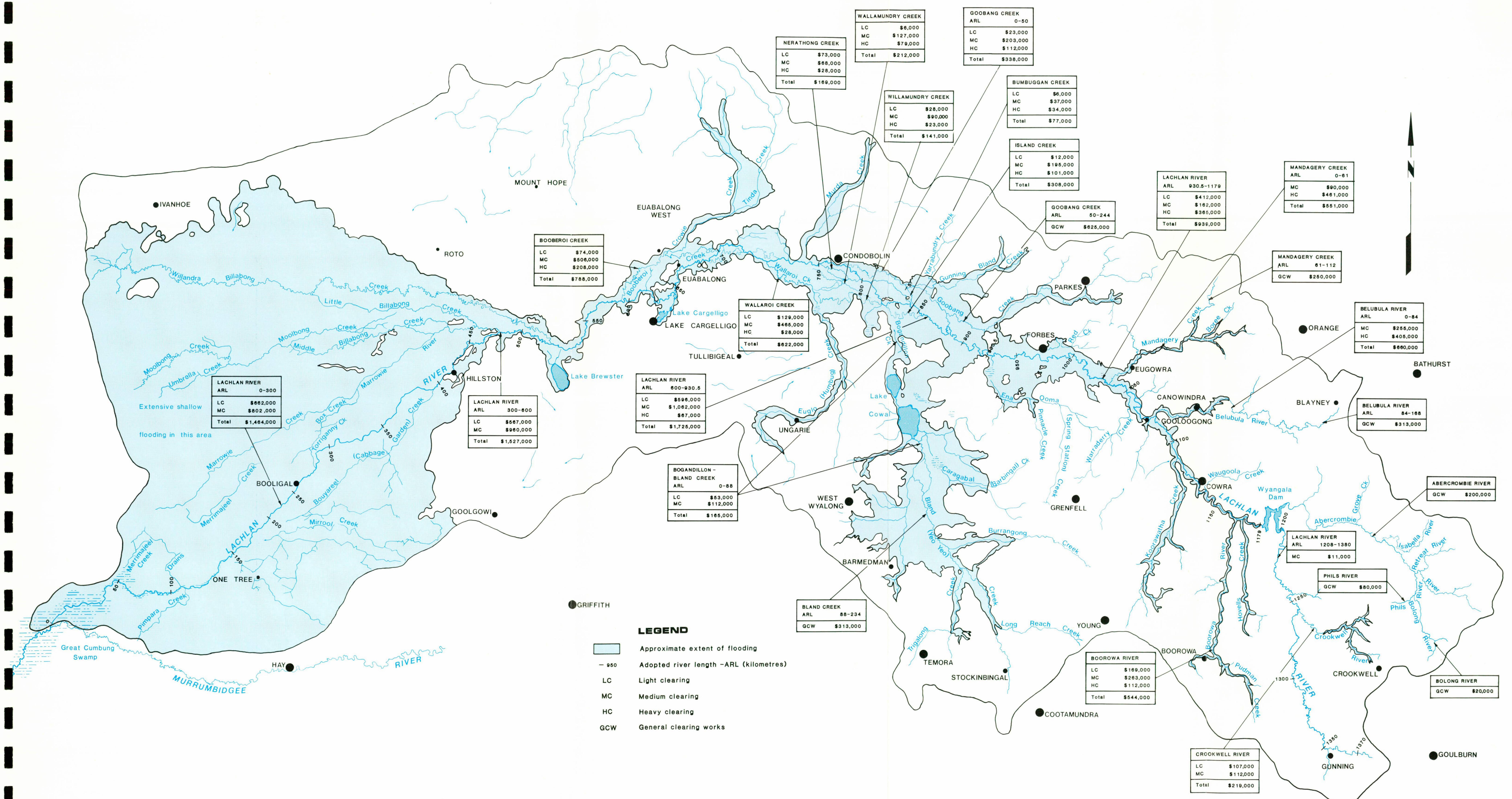
FIGURE 4/2

LANDUSE IN FLOOD AFFECTED AREAS OF THE LACHLAN VALLEY

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 5/1

SUGGESTED STREAM CHANNEL IMPROVEMENT WORKS WITHIN THE LACHLAN VALLEY

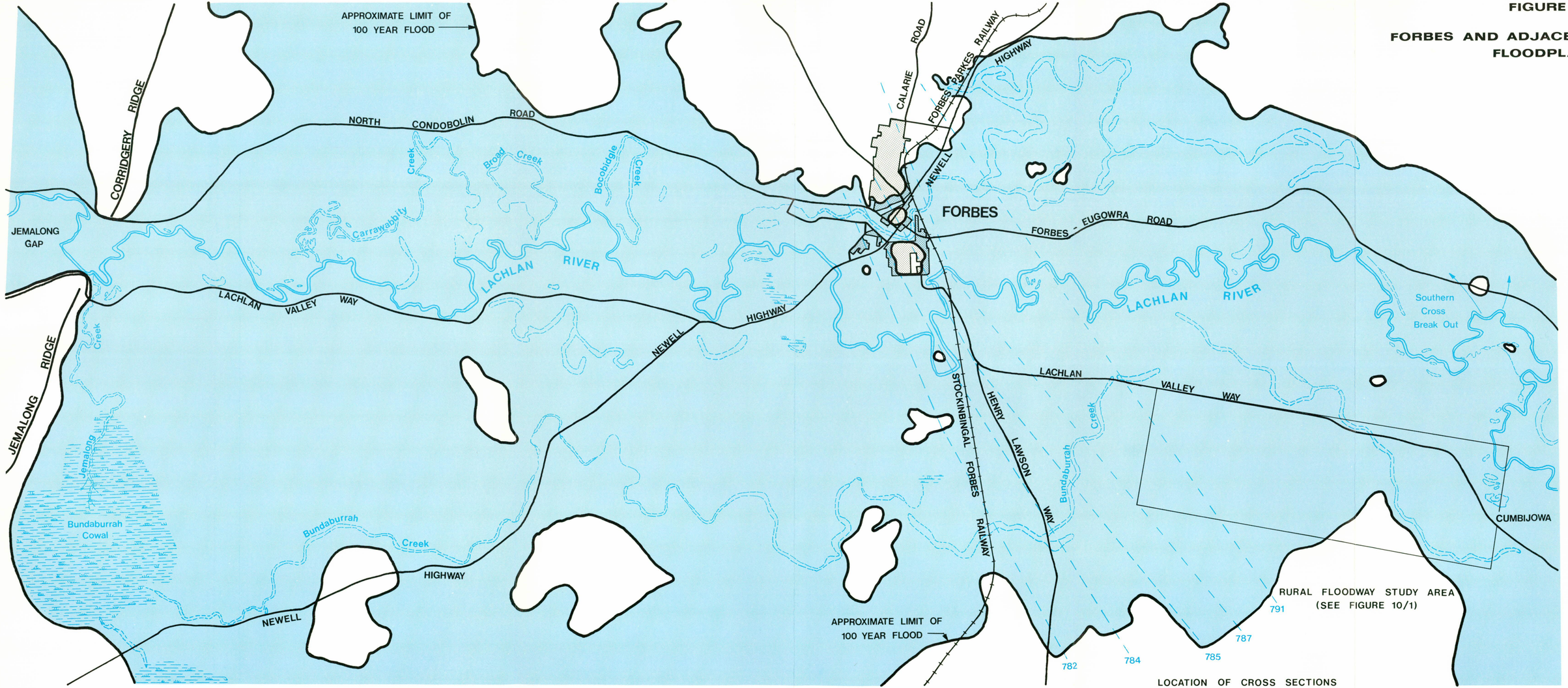


NOTE Work requirements and estimated costs have been supplied by the Water Resources Commission based on detailed surveys carried out over the period 1980-1981 – costs are expressed in mid 1981 values.

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 6/1

FORBES AND ADJACENT FLOODPLAIN



A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 6/2

FLOODING IN FORBES

LIMIT OF 100 YEAR FLOOD

LIMIT OF 20 YEAR FLOOD

LIMIT OF 50 YEAR FLOOD

HIGHWAY

NEWELL

BATTYE STREET FLOODWAY

BATES BRIDGE

NEWELL HIGHWAY BRIDGE

JOHNNY WOODS CROSSING

CAMP HILL

IRON BRIDGE GAUGE

LACHLAN RIVER

This area also flooded

This area also flooded from Marsh

N

LEGEND

AREA INUNDATED BY A TWENTY YEAR FLOOD

ADDITIONAL AREA INUNDATED BY A FIFTY YEAR FLOOD

ADDITIONAL AREA INUNDATED BY A HUNDRED YEAR FLOOD

NOTE: The base for this figure is the "FLOOD INUNDATION MAP LACHLAN RIVER AT FORBES" prepared by the Water Resources Commission of New South Wales

300 0 300 600 900

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 6/6

LEVEE SCHEME —FORBES

BOGAN GATE RD. TO BOGAN GATE

Mc DONALD ST.

RD.

FARNELL ST.

CALARIE

UNION ST.

SAM ST.

NEWELL HIGHWAY TO PARKES

S.H. 17

PRINCE ST.

FARRAND ST.

TO BEDGEREBONG

FLOODGATE

LAKE

FORBES

RACE COURSE

LACHLAN ST.

SHERRIFF ST.

FLOODGATE

HERBERT ST.

RAILWAY

FORBES - EUGOWRA RD.

TO ORANGE

OXFORD ST.

WILLIAM ST.

BERKLEY ST.

CHURCH ST.

FLINT ST.

YOUNG ST.

WAMBAT ST.

REYMOND ST.

LACHLAN RIVER

S.H. 17

MARSDEN

TO

TO STOCKINBINGAL

LEGEND

Proposed levee

Area inundated by 100 year flood

1 0 1km

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 6/7

NEWELL HIGHWAY
DEVIATION – FORBES

N

BOGAN GATE RD.
TO BOGAN GATE

Mc DONALD ST.

CALARIE RD.

FARNELL ST.

UNION ST.

SAM ST.

NEWELL HIGHWAY
TO PARKES

S.H. 17

POSSIBLE ACCESS
RAMP

RAILWAY OVERPASS

VIADUCT

PRINCE ST.

FARRAND ST.

TO BEDGEREBONG

LAKE

FORBES

LACHLAN ST.

SHERRIFF ST.

HERBERT ST.

RACE
COURSE

RAILWAY FORBES - EUGOWRA RD.
TO ORANGE

OXFORD ST.

WILLIAM ST.

CHURCH ST.

FLINT ST.

BERKLEY ST.

YOUNG ST.

WAMBAT ST.

OXFORD STREET
ACCESS RAISED

REYMOND ST.

LACHLAN RIVER

S.H. 17

MARSDEN

TO

TO STOCKINBINGAL

LEGEND

Suggested roadworks

Area inundated by 100 year flood

1 0 1km

A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

FIGURE 6/9

RECOMMENDED PLANNING ZONES — FORBES

LEGEND

- Existing village zone boundary
- Suggested village zone boundary
- (A) Suggested special sub-zones
- Area inundated by 100 year flood

1 0 1km

N

BOGAN GATE RD. TO BOGAN GATE

Mc DONALD ST.

RD.

HIGHWAY TO PARKES

FARNELL ST.

CALARIE

SAM ST.

NEWELL

UNION ST.

S.H. 17

PRINCE ST.

FARRAND ST.

(B)

TO BEDGEREBONG

LAKE

HERBERT ST.

FORBES

LACHLAN ST.

SHERRIFF

RACE COURSE

RAILWAY

FORBES - EUGOWRA RD.

TO ORANGE

(A)

(C)

OXFORD ST.

WILLIAM

CHURCH

BERKLEY

FLINT ST.

YOUNG ST.

WAMBAT ST.

REYMOND ST.

LACHLAN RIVER

S.H. 17

ST.

TO MARSDEN

TO STOCKINBINGAL

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 7/2

APPROXIMATE FLOOD EXTENT —EUGOWRA

LEGEND

- Existing development
- Proposed village zone boundary
- Changes to proposed village zone requested by objectors
- Approximate extent of April 1950 flood from Mandagery Creek
- Approximate extent of February 1973 flood
- Approximate extent of active secondary floodway

Reserve for Public Recreation

Racecourse & Showground

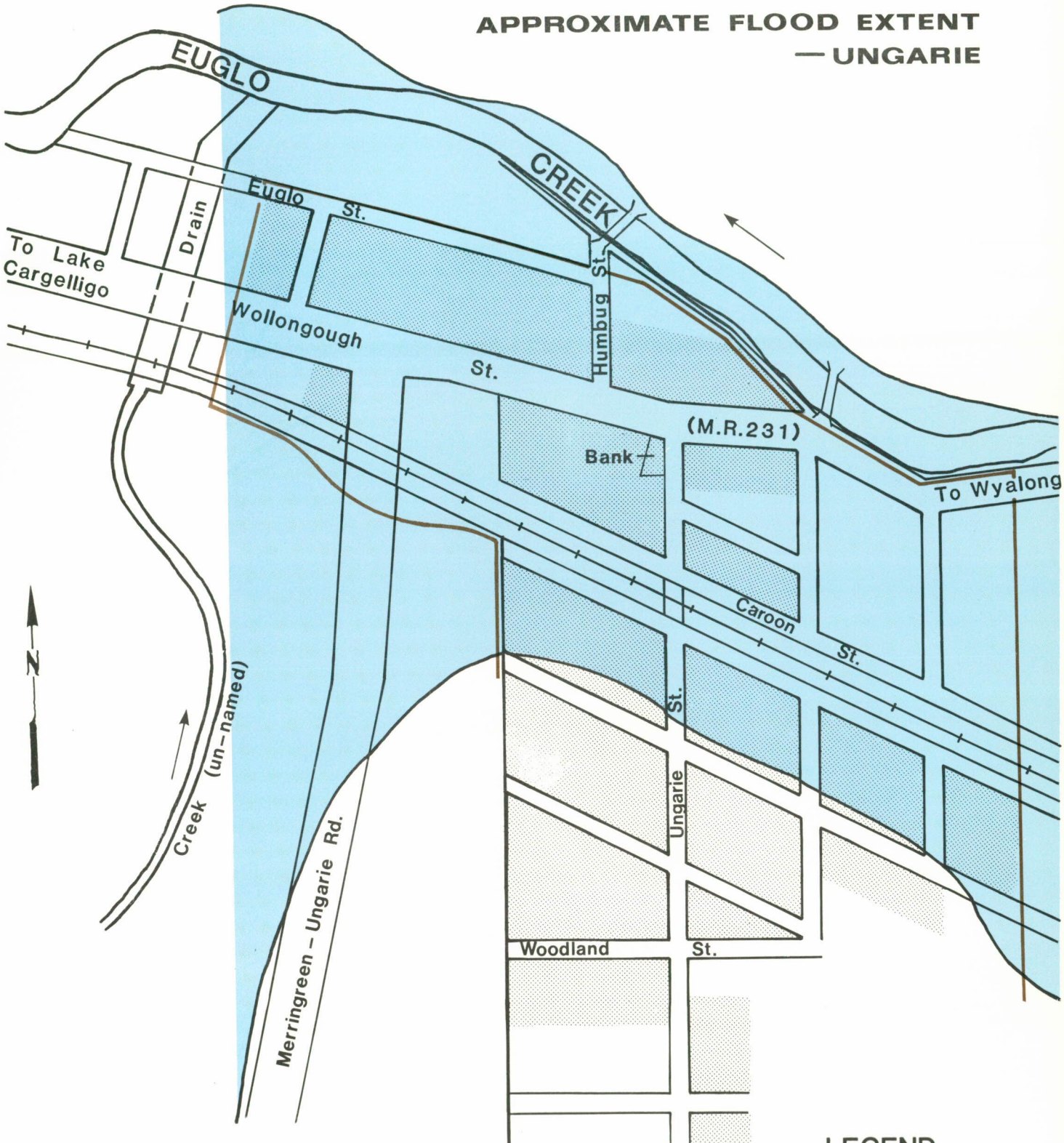
RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Implementation of town planning measures including acquisition of property	High
Finding of programme of raising floor levels of existing Buildings	High
Upgrading of Murga gauge	Meduim

100 0 100 200 300 400 m

A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

FIGURE 8/1

APPROXIMATE FLOOD EXTENT — UNGARIE



RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Implementation of town planning measures including setting of minimum floor levels	High

LEGEND

- Existing development
- Possible levee
- Approximate flood extent (1962)

100 0 100 200 300 m

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 8/2

APPROXIMATE FLOOD EXTENT — STOCKINBINGAL

RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Amendments to existing planning scheme including setting of minimum floor levels	High
Additional minor banking to be provided to Dudauman Creek	Medium

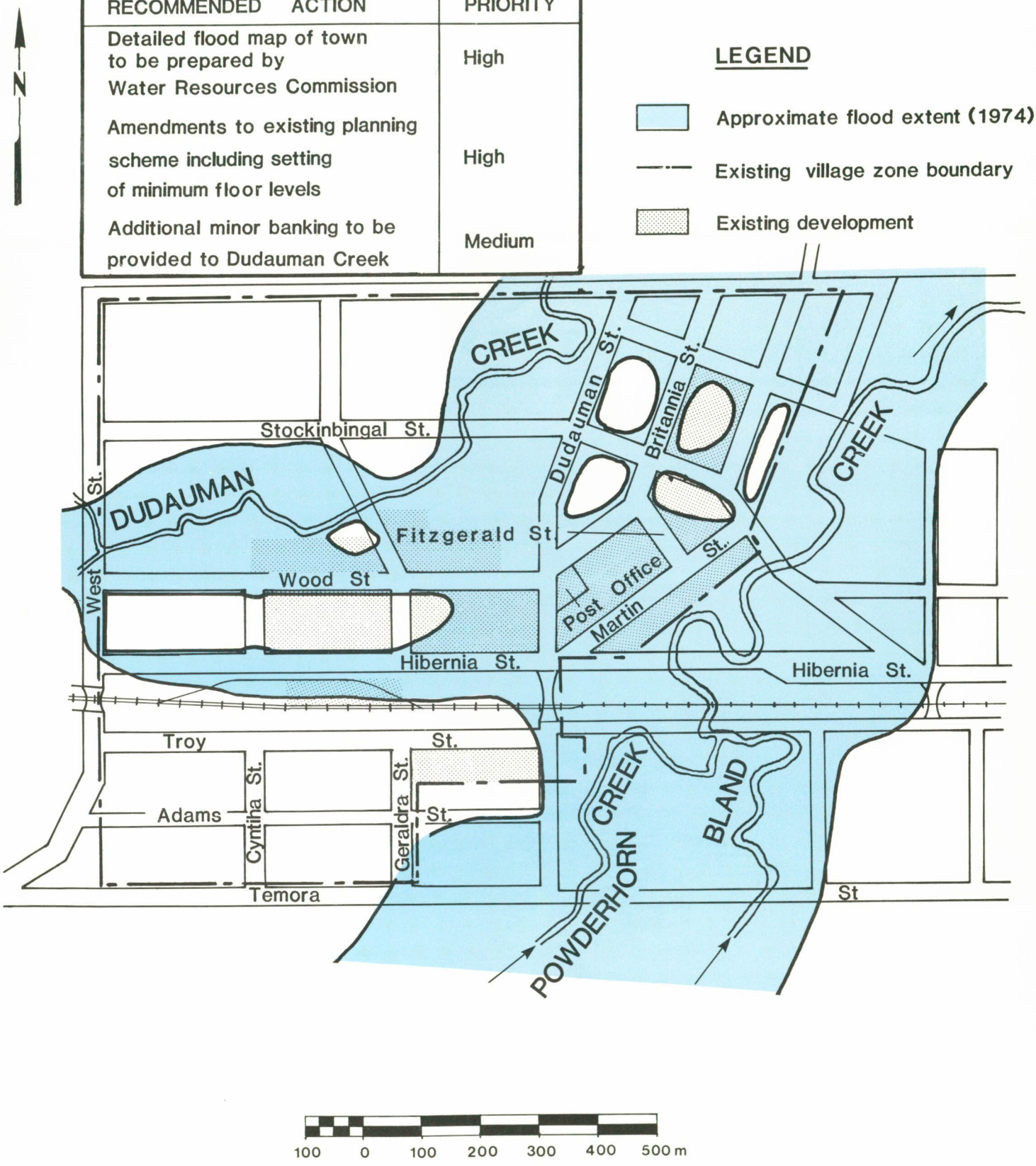
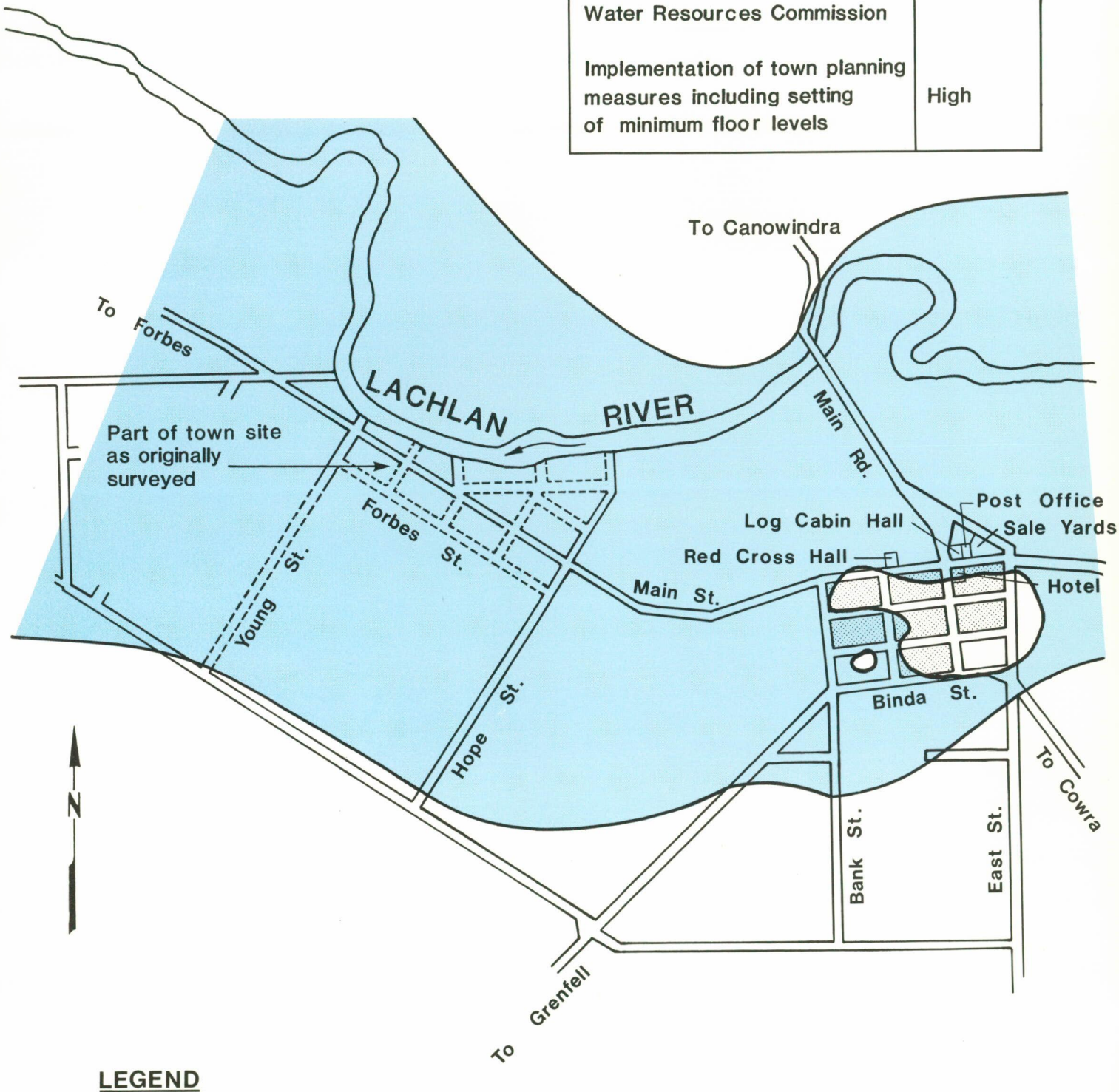


FIGURE 8/3

APPROXIMATE FLOOD EXTENT — GOOLOOGONG

RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Implementation of town planning measures including setting of minimum floor levels	High



LEGEND

- Existing development
- Approximate flood extent (1952)

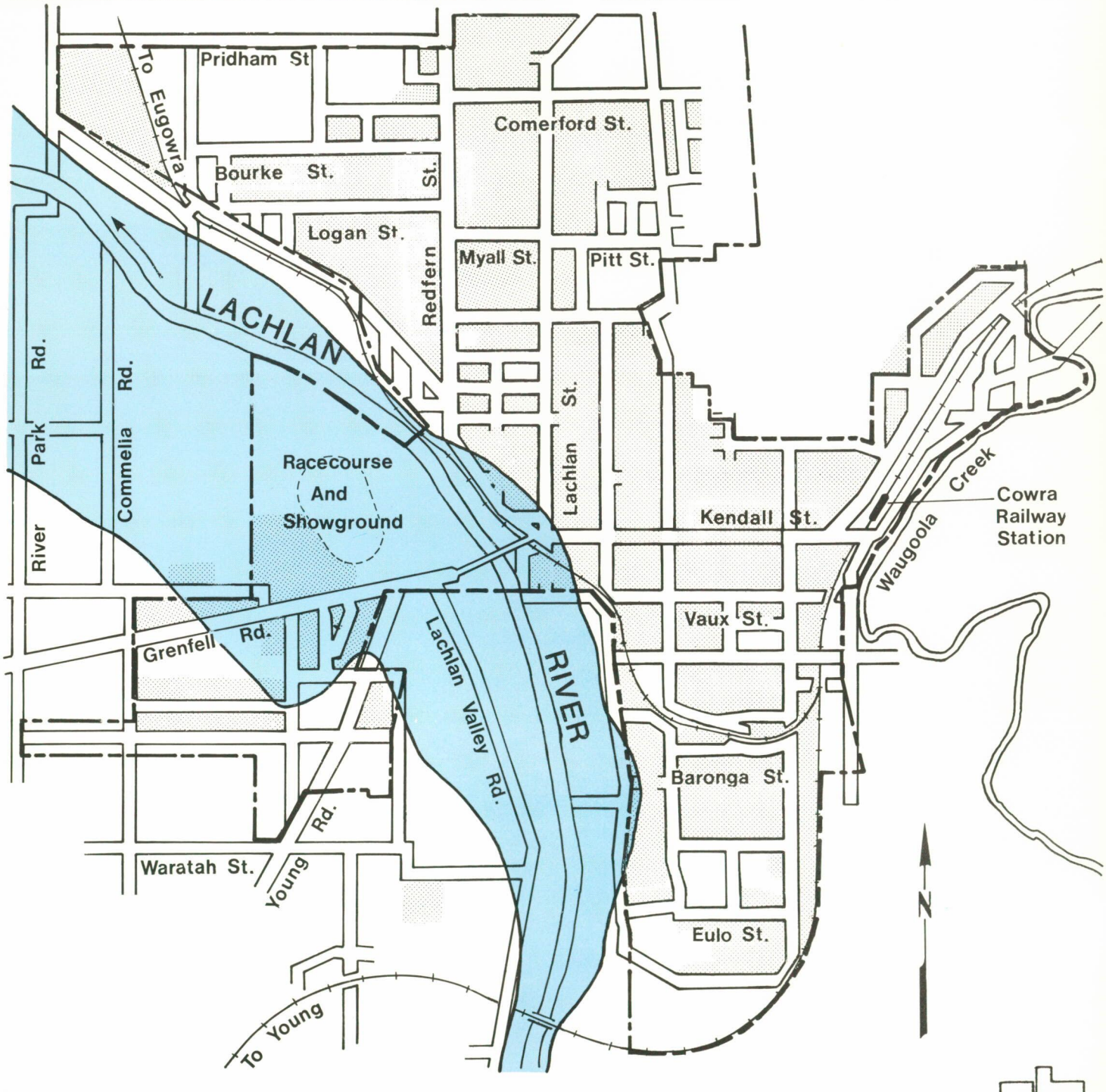
200 0 200 400 600 800 1000 m

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 8/4

APPROXIMATE FLOOD EXTENT — COWRA

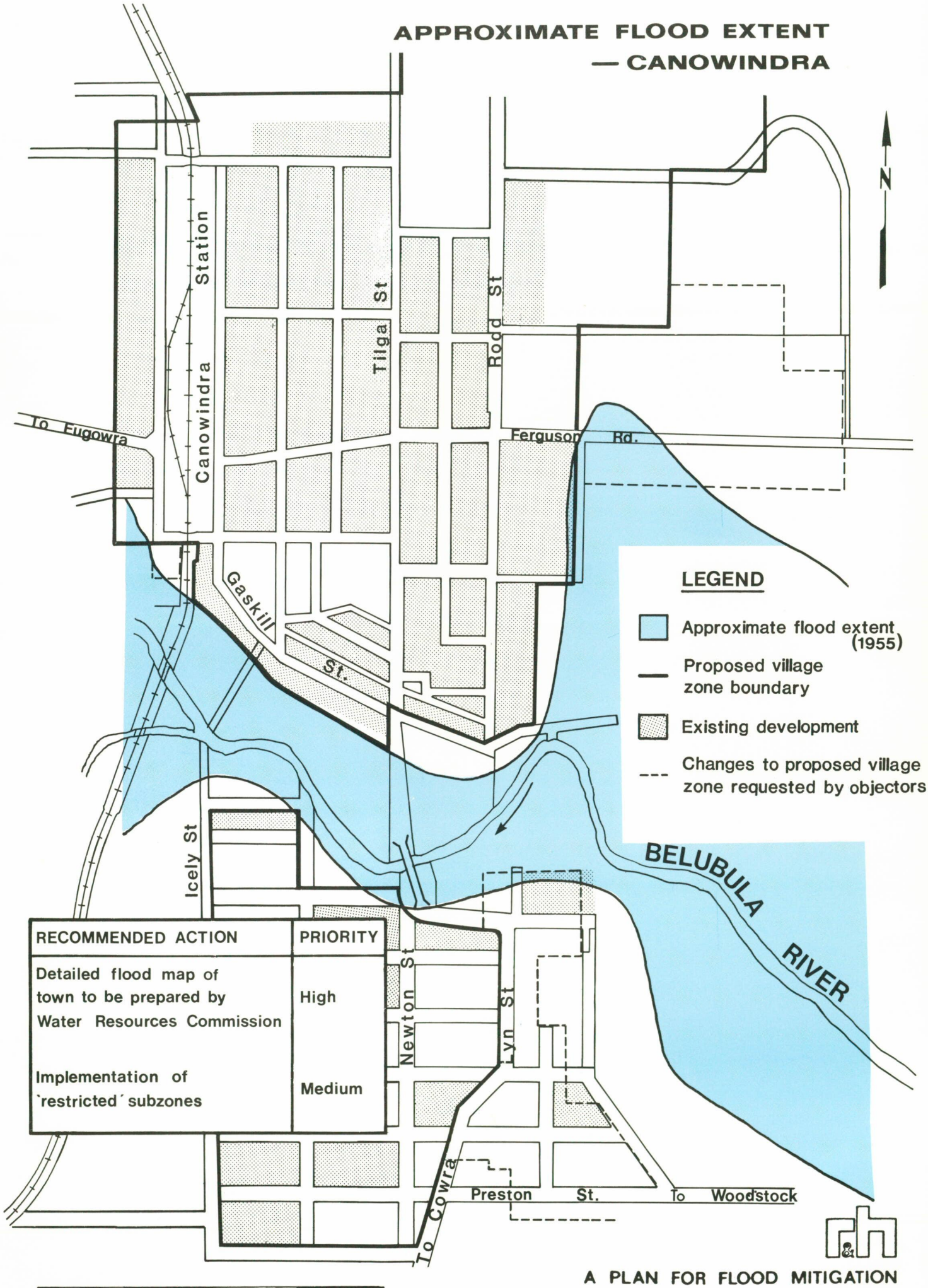
RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Implementation of 'restricted' subzone to control further development in West Cowra	High



A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 9/1

APPROXIMATE FLOOD EXTENT — CANOWINDRA



RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Implementation of 'restricted' subzones	Medium

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 9/2

APPROXIMATE FLOOD EXTENT — GUNNING

RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Rezone areas along Gunning Creek as 'Rural (floodway)'	Medium

LEGEND

- Approximate flood extent (1974)
- Existing village zone boundary
- Existing development

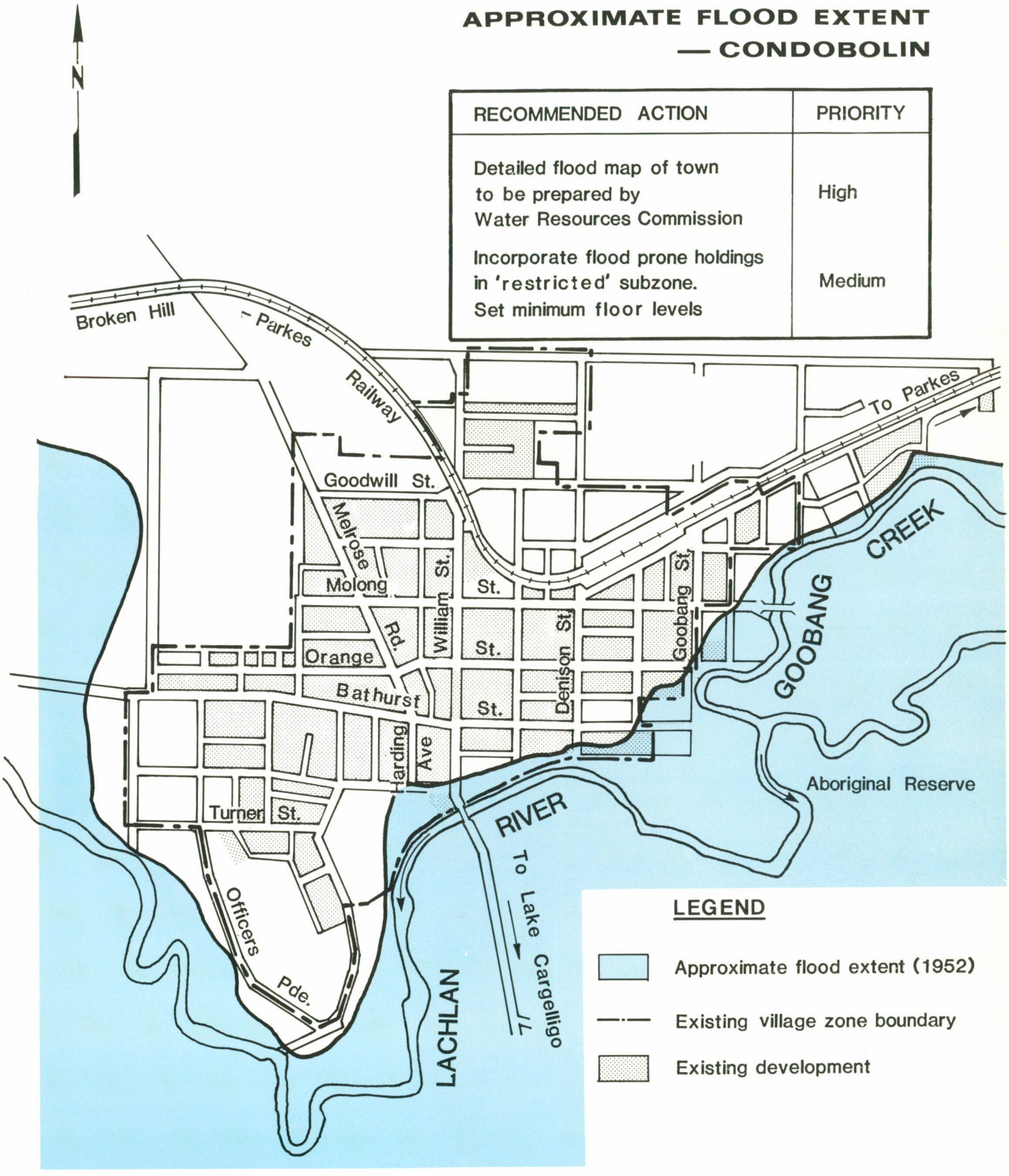
100 0 100 200 300 400

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 9/3

APPROXIMATE FLOOD EXTENT — CONDOBOLIN

RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Incorporate flood prone holdings in 'restricted' subzone. Set minimum floor levels	Medium

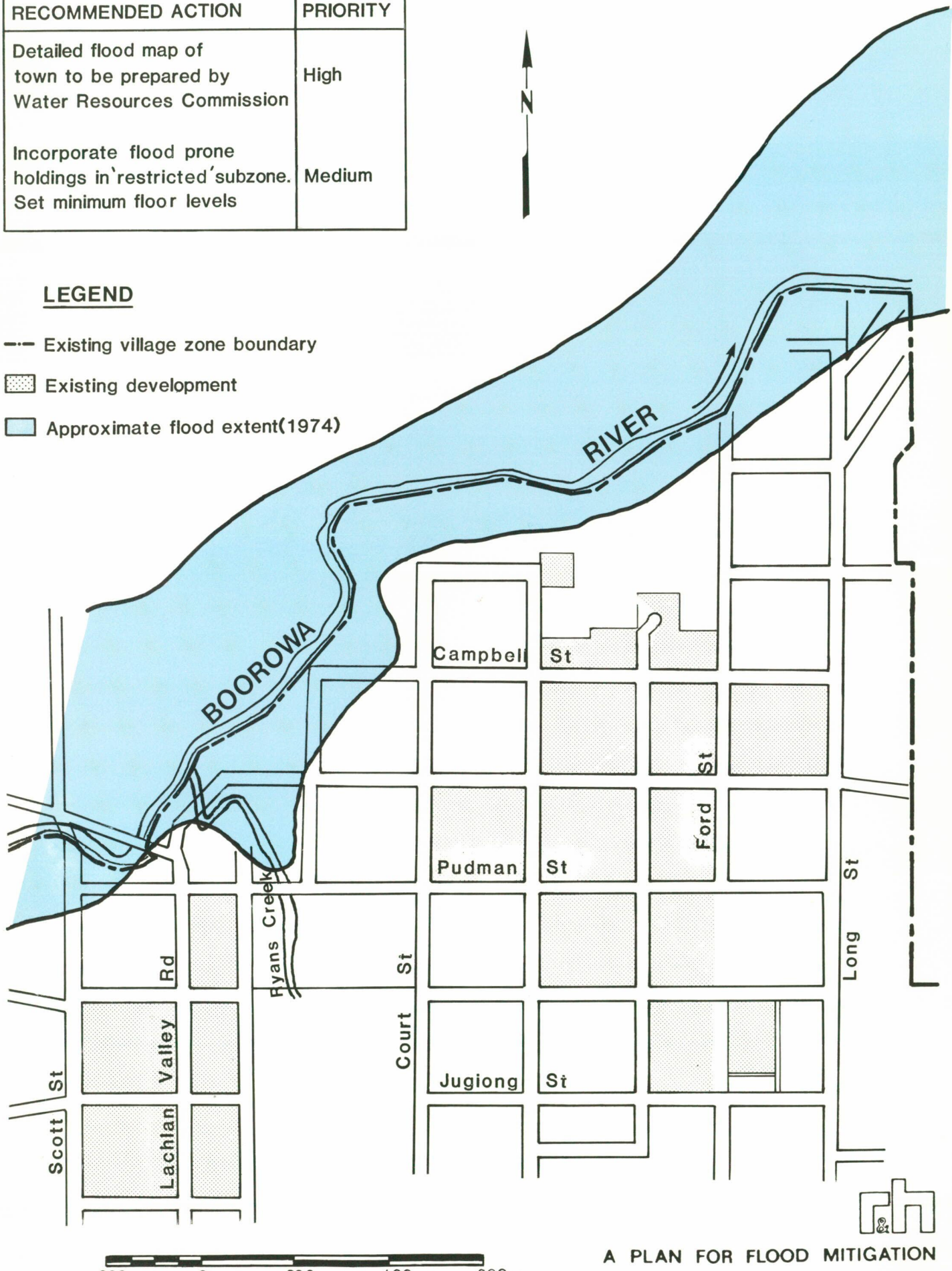


A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

FIGURE 9/4

APPROXIMATE FLOOD EXTENT —BOOROWA

RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Incorporate flood prone holdings in 'restricted' subzone. Set minimum floor levels	Medium

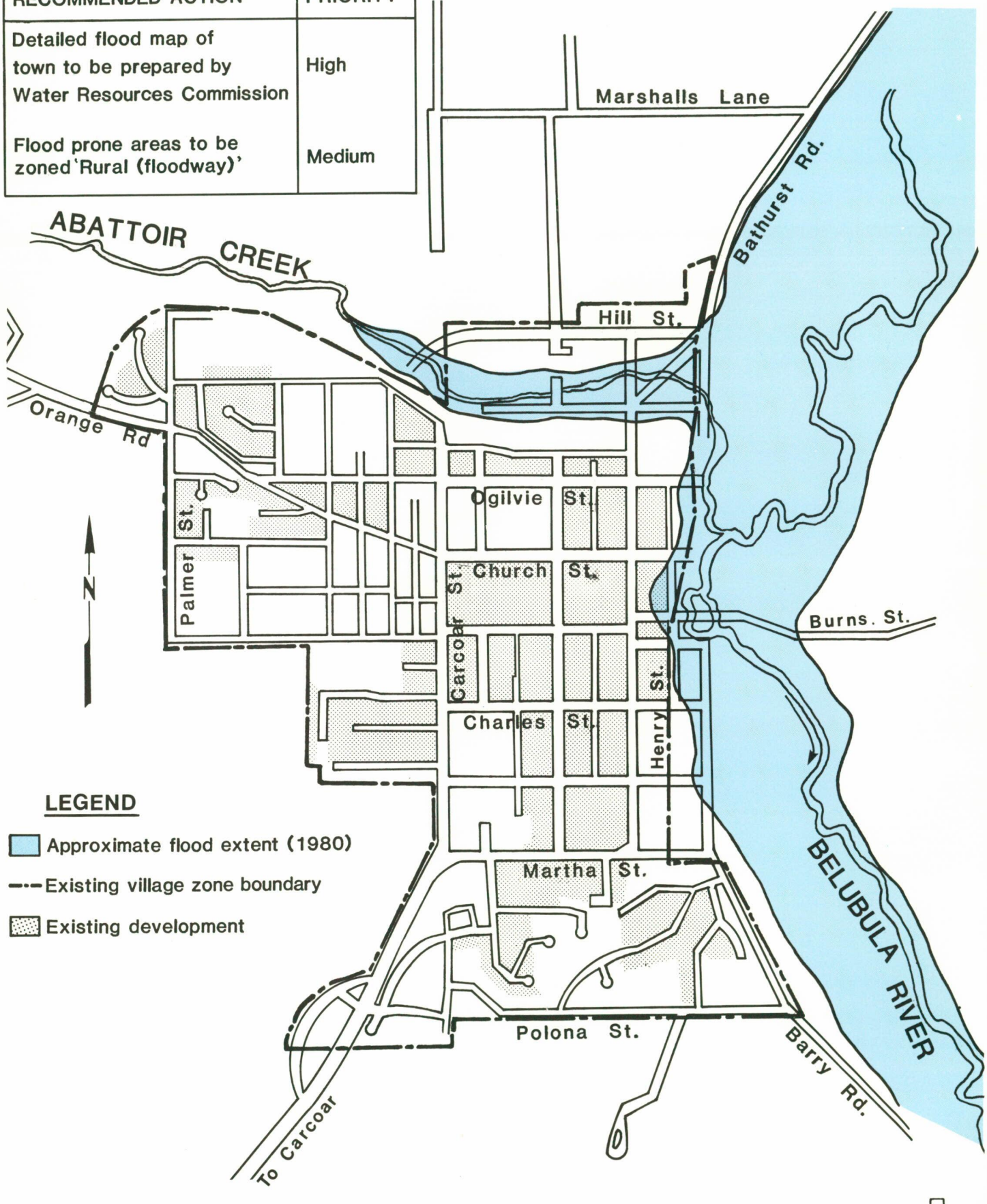


A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 9/5

APPROXIMATE FLOOD EXTENT — BLAYNEY

RECOMMENDED ACTION	PRIORITY
Detailed flood map of town to be prepared by Water Resources Commission	High
Flood prone areas to be zoned 'Rural (floodway)'	Medium



A PLAN FOR FLOOD MITIGATION
IN THE LACHLAN VALLEY

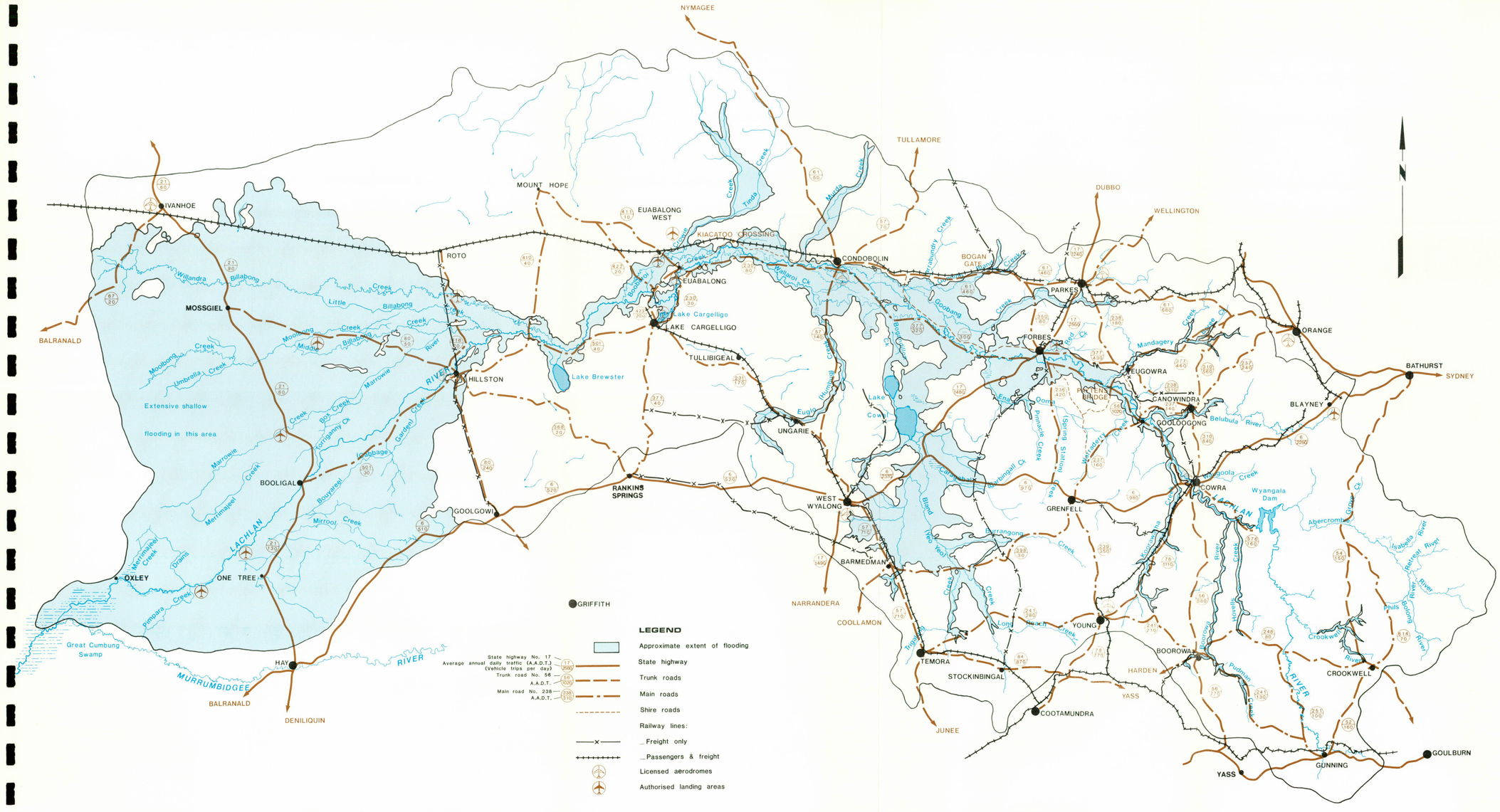


FIGURE 11/1

TRANSPORT LINKS WITHIN THE LACHLAN VALLEY

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 11/2

DISRUPTION TO ROAD TRAFFIC CAUSED BY FLOODING IN THE LACHLAN VALLEY

COBAR

DUBBO, BRISBANE

Access to Euabalong from south is prevented by the river during major flooding.

CONDOBOLIN

PARKES

EUABALONG

BOGAN GATE

BOREE

ORANGE

Sth CONDOBOLIN Rd (UNSEALED)

NTH CONDOBOLIN Rd (SEALED)

IVANHOE MOSSGIEL

Hillston – Roto Road north of the river was cut in 1974 by the Lachlan River.

LAKE CARGELLIGO

FORBES

EUGOWRA

Booligal – Mossgiel Road (Cobb Highway) is cut north of Mossgiel by the Willandra Creek

HILLSTON

CANOWINDRA

MARSDEN

H. LAWSON WAY

NEW GRENFELL Rd

GOOLOOGONG

BLAYNEY

IVANHOE

Depth of flooding in this region during major flooding is between 300mm – 450mm. Several dirt roads in the region are impassable after flooding and local thunderstorms.

WEST WYALONG

BOOLIGAL

COWRA

Hay – Booligal road is inundated at a number of creek crossings during moderate flooding.

GRENFELL

BOOROWA

MELBOURNE

BARMEDMAN

HAY

TEMORA

YOUNG

LEGEND

AADT – AVERAGE ANNUAL DAILY TRAFFIC (VEHICLES/ DAY TRIPS)

500
0
2000
4000
6000

TIME ROAD IS CUT IN DAYS

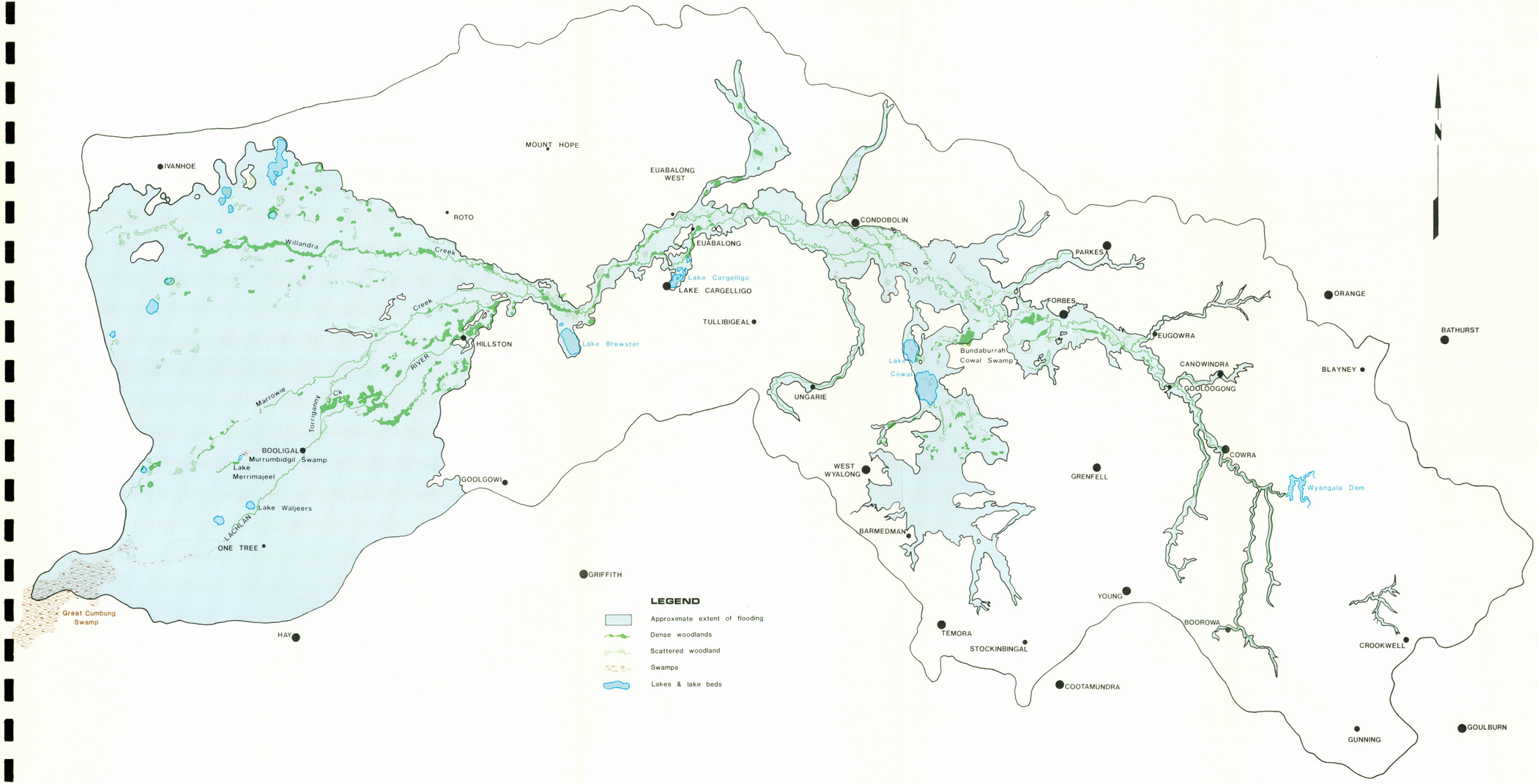
AVERAGE RECURRENCE INTERVAL OF FLOOD IN YEARS

SECTIONS OF THE ROAD UNSEALED

A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY

FIGURE 13/1

RIVERINE VEGETATION COMMUNITIES AND WETLANDS WITHIN THE LACHLAN VALLEY



A PLAN FOR FLOOD MITIGATION IN THE LACHLAN VALLEY