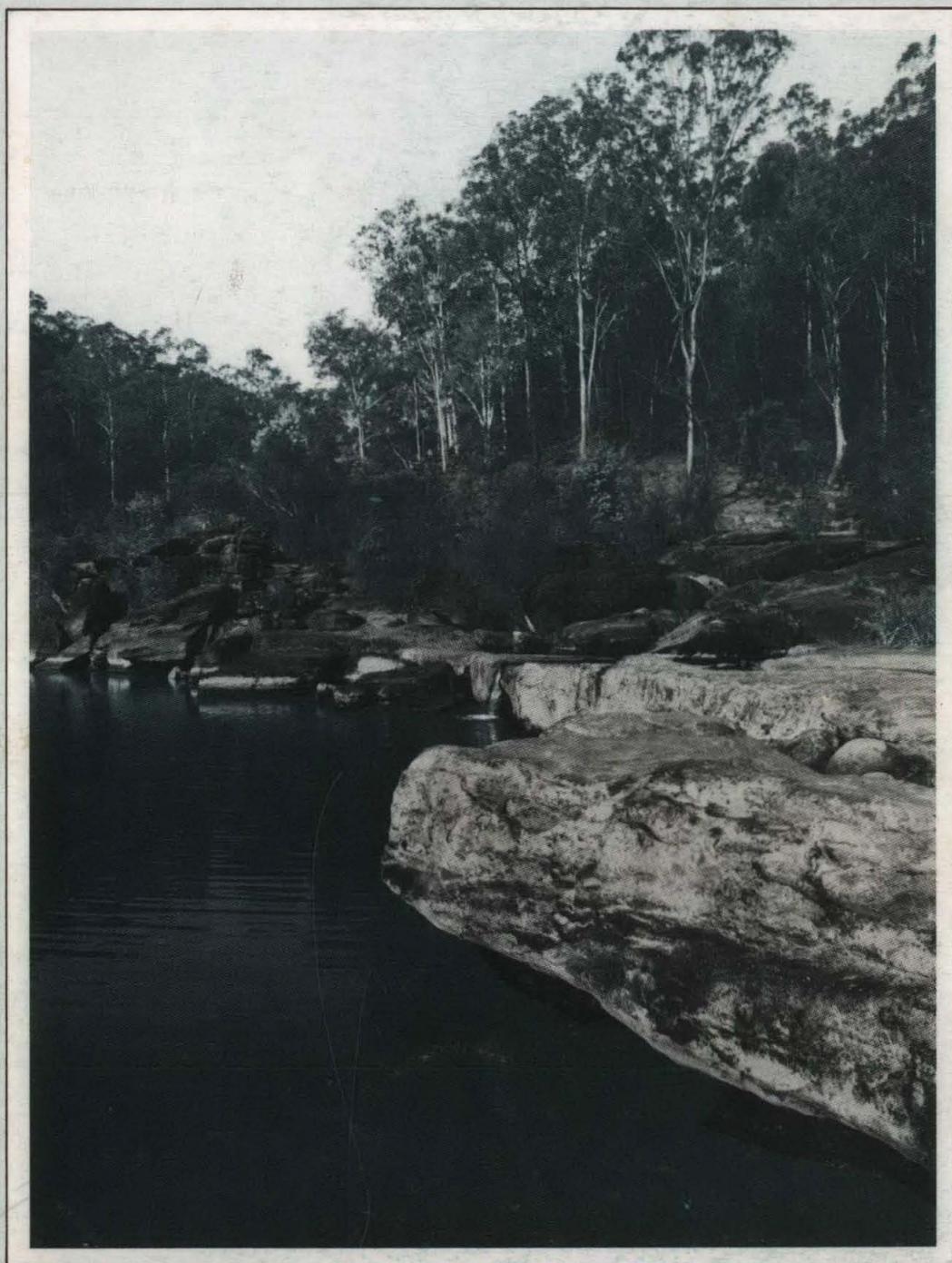


Hawkesbury/Nepean Valley Report



Cover photo: Nortons Basin

RIVER AND ESTUARY
MANAGEMENT SECTION.

Hawkesbury/Nepean Valley Report



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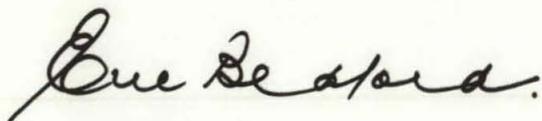
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Foreword

The New South Wales Government recognises the importance of the Hawkesbury/Nepean river system to the people of Sydney. The river provides water for domestic, industrial and agricultural use; sand and gravel for the construction industry; and it is part of an area of outstanding natural beauty, offering a wide range of recreational opportunities. Demands placed on the river by many of these uses have caused substantial changes to its natural character and water quality.

This report examines the natural landscape of the river valley and describes how the many uses relate to and interact with the river system. It is hoped that by providing information on the whole river system the report will form the basis for initiatives to co-ordinate the various uses and resolve conflicting pressures within the valley.

The Hawkesbury/Nepean is important to people living and working within the region. Widespread discussion between people and the authorities operating in the valley will help to solve the problems surrounding present and future uses of the river. Accordingly, I invite you to discuss the report and submit your comments to the Department of Environment and Planning.

A handwritten signature in cursive script, reading "Eric Bedford".

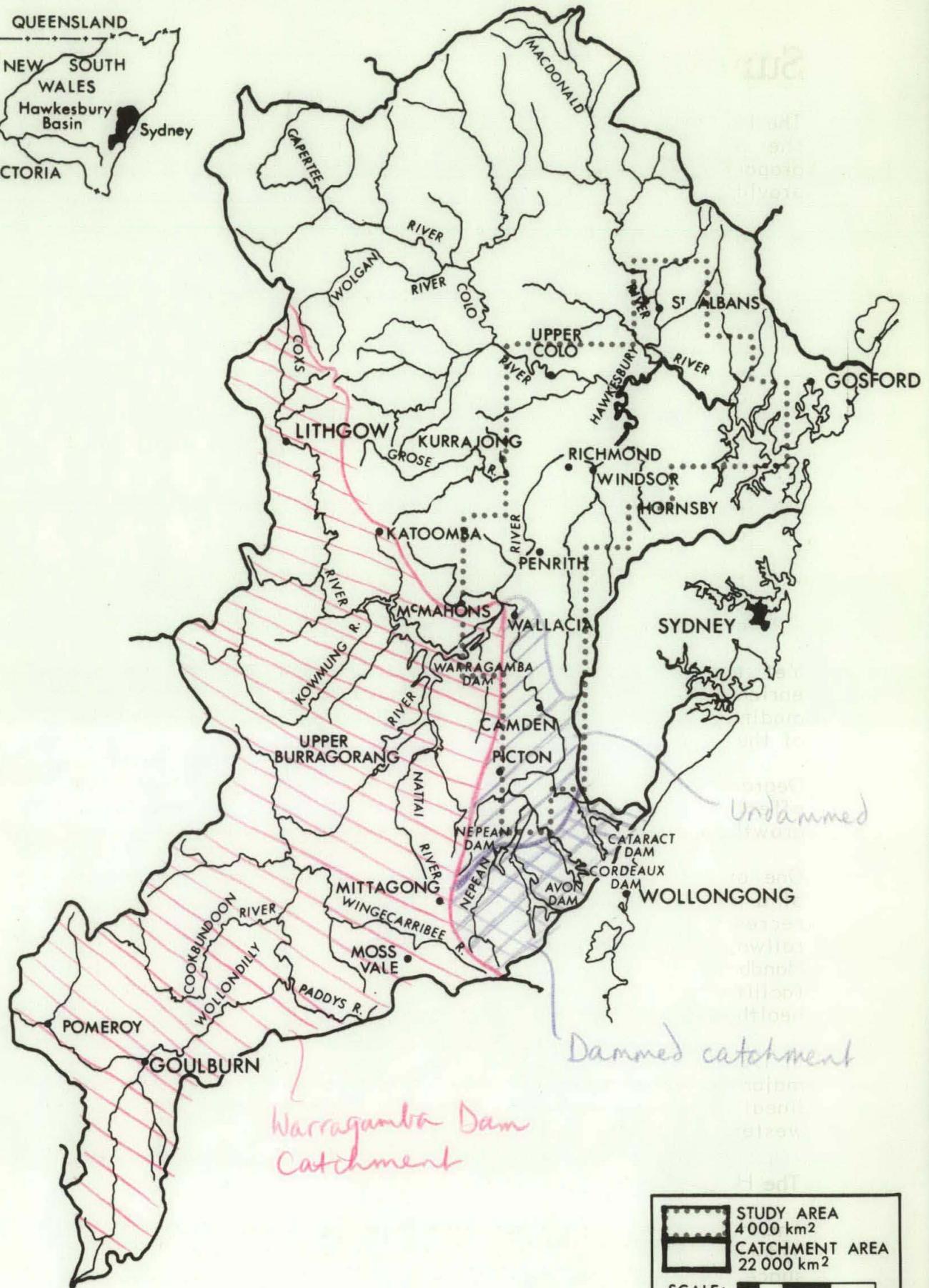
ERIC BEDFORD
Minister for Planning
and Environment



Nortons Basin

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	STUDY AREA 4 000 km ²
	CATCHMENT AREA 22 000 km ²

SCALE: 10 0 10 20km

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**LOCALITY MAP
MAP 1**

Summary

The Hawkesbury/Nepean River system and Valley are essential to the physical, economic and social well-being of a large proportion of people living in Australia's largest city. They provide:

- almost all the water for domestic and industrial use for the Sydney region from a series of major dams;
- the bulk of the water supply for the farmlands in the valley;
- the receiving waterway for treated sewage effluent of approximately 300,000 people;
- the receiving waterway for water runoff from all urban and non-urban development within the catchment;
- the largest source of sand, gravel and soil for the construction industry in Sydney;
- the opportunity for many recreational pursuits; and
- a magnificent backdrop to the Sydney region.

Yet the river is deteriorating in quality due to nutrient enrichment. Also the river continues to be substantially modified by human intervention, while there is little knowledge of the environmental effects of such changes.

Degradation of the river is having an increasingly detrimental effect on users and its ability to continue supporting urban growth in the Sydney region is being eroded.

One of the effects of increasing deterioration will be the loss of a major recreation resource. The river has been a focus for recreational activities for a long time. Tourism began with the railway development to the area in the 1860s. The 1909 Tourist Handbook stated that the Hawkesbury River had "unlimited facilities and attractions for the tourist, whether in search of health, sport or beautiful scenery".

In 1968 the Sydney Region Outline Plan proposed the valley as a major future recreational asset which could be developed as a lineal open space system in light of the rapid growth of Sydney's western and south-western suburbs.

The Hawkesbury/Nepean Valley Study

The Hawkesbury/Nepean Valley Study was initiated as part of the Sydney Region Outline Plan Review process to assess the open space system proposition. A large part of the study examines recreational planning issues and includes a detailed survey and

landscape appraisal of the river. The study also identifies and examines other issues affecting the environment of the valley, namely extraction of sand and gravels, water quality and river management.

Much of the information for the study was collected in a survey of the river from Douglas Park Bridge on the Nepean River to the mouth of the Hawkesbury River at Broken Bay. This report contains a detailed description of the river covering geomorphology, vegetation, the level of human impact on the environment, the value for, and the current use of, the river for recreation and other area specific issues such as extraction, desnagging, and public access.

Recreational Opportunities

The river provides a wide range of recreational opportunities from active to passive, from all forms of boating to picnicking and sightseeing.

The report establishes three objectives for the development of recreational opportunities in the valley which can be summarised as:

- to improve public access by a program of selective acquisition;
- to fully develop the recreational attractions of the Hawkesbury and Nepean Rivers as a regional open space system;
- to develop new recreational areas to ease the pressure on national parks.

Analysis of the river environment from the survey was used to undertake sieve mapping of environmental, land use and tenure constraints. These maps were used to establish recreation suitability. Accessibility and demand were used to establish capability. The resulting recreation capability is mapped and constitutes a structure plan for recreation use in the valley. This report identifies three capability levels, and proposes planning controls for the future development of the valley.

The capability map is also used as the basis for establishing regional open space priorities. The concept of a lineal open space system along the length of the river was considered but the study concludes that priority should be given to improved public access in a few key locations. The following locations are recommended in the report as being suitable for development as regional open space:

- Wallacia - the foreshores below Blaxland Crossing and access to Fairlight Gorge;
- Shaws Island (Castlereagh) - (development of Crown Land currently subject to extraction);

- Yerramundi Point Bar to Clarks Island - including the Grose confluence, sandshoals and the river banks;
- Cattai Valley - beachfronts, wetlands, pasture and bushland; and
- Loughtondale - large beachfront site.

The study also recommends:

- the improvement of access to many locations along the river;
- the upgrading of tourist roads;
- that the role of private recreational developments be continued; and
- that regional open spaces should be managed as State Recreation Areas by the National Parks and Wildlife Service.

Although the valley is a magnificent regional recreational resource, its future as such is not assured. The ability of the river to maintain its recreational role as well as satisfying the demands of continued urban growth in the region (water, sewerage, drainage) is being eroded. This report identifies and analyses the issues relating to extractive industries and river management which have an impact upon the environmental qualities of the river.

* Extraction

The Hawkesbury River is a major source of sand and gravel for construction industries in the Sydney region. These resources are found in the bed and in high level deposits on the floodplain. Supplies in the high level deposits exceed those in the bed and banks by ten to one. Despite this ratio, most extraction in the past has been from the bed of the river. Major high level deposits are located at Penrith (currently being extracted) and Richmond lowlands.

Demand for and supply of sand and gravel are considered in the report and it is estimated that extraction will continue on the Penrith floodplain for 25 years or more.

Although the river provides valuable resources for the Sydney region, the long-term effects of extraction from the river bed on the river regime are not known.

Given the unknown effect of extraction the report recommends that caution should prevail until such time as it is shown that there are significant environmental and economic benefits to be gained from extraction.

The Department is currently preparing a regional environmental study on the region's non-metallic minerals, which analyses in detail many of the issues relating to extractive industries.

This report when published should be used as the basis for future planning and management of extractive resources in the Valley.

Until a firm policy is established for extraction of sand and gravel, the report recommends the following responses:

- Land based extraction should be favoured where possible and reliance on the river as a source should be decreased.
- The social and environmental costs of extraction should be considered in any environmental impact analysis of future development.
- Extraction should be concentrated into fewer larger sites to enable better planning control.

River Management

Water Quality

Water quality is probably the most complex and important issue in the valley and for the Sydney Region as a whole, as most land use and resource management decisions have an impact upon it.

The State Pollution Control Commission (SPCC) has been monitoring the river for many years. Between 1978 and 1981 it has intensified its program as part of a major water pollution control study of the river system. The study is complete and provides an important basis for decisions on the future growth options of Sydney.

SPCC analysis of the river to date shows it to be polluted. Currently three sections of the river (below the Camden and Penrith Treatment Plants and South Creek) are under stress due to eutrophication, that is, excessive nutrient concentrations. Eutrophication results in an increase in aquatic plant growth, such as algae, and a decrease in dissolved oxygen in some sections of the river. Approximately 100 kilometres of the river are already affected. The problem will increase unless effluent quality improves or disposal practices are altered, as effluent from sewerage treatment plants is the main source of nutrients during normal river flows. Runoff from urban and agricultural land is another source of nutrients to the waterway; this source is most important during wet weather or flood periods.

The growth of population in the region will result in additional stresses on the river, especially during periods of low flow when the relatively constant volume of effluent from sewage treatment plants forms a substantial proportion of the total flow of the river.

The full implications of sewage effluent management strategies for the valley need to be further examined from a social, economic and environmental perspective. The capability of the

valley to accept urban development needs to be ascertained and guidelines for urban development should be prepared in the context of the SPCC's study findings.

Flood Mitigation

The Hawkesbury/Nepean Valley contains extensive floodplains. The only flood mitigation measure systematically being applied is a river management program involving desnagging and extraction of sand and gravel from the river bed within ideal alignments established by the Water Resources Commission.

The rationale and data supporting these operations have not been published and their effectiveness both in mitigation of minor floods and bank stabilisation has not been conclusively demonstrated.

This report's main conclusions on flood mitigation are that:

- The cost-effectiveness of using structural methods of mitigation for minor floods is questionable quite apart from their environmental effects.
- A well vegetated and stable catchment helps to minimise damage by flood waters.
- Consideration should be given to the manual prereleased operation of the Warragamba Dam combined with forecasting to minimise peaks and rise and fall rates during major floods.

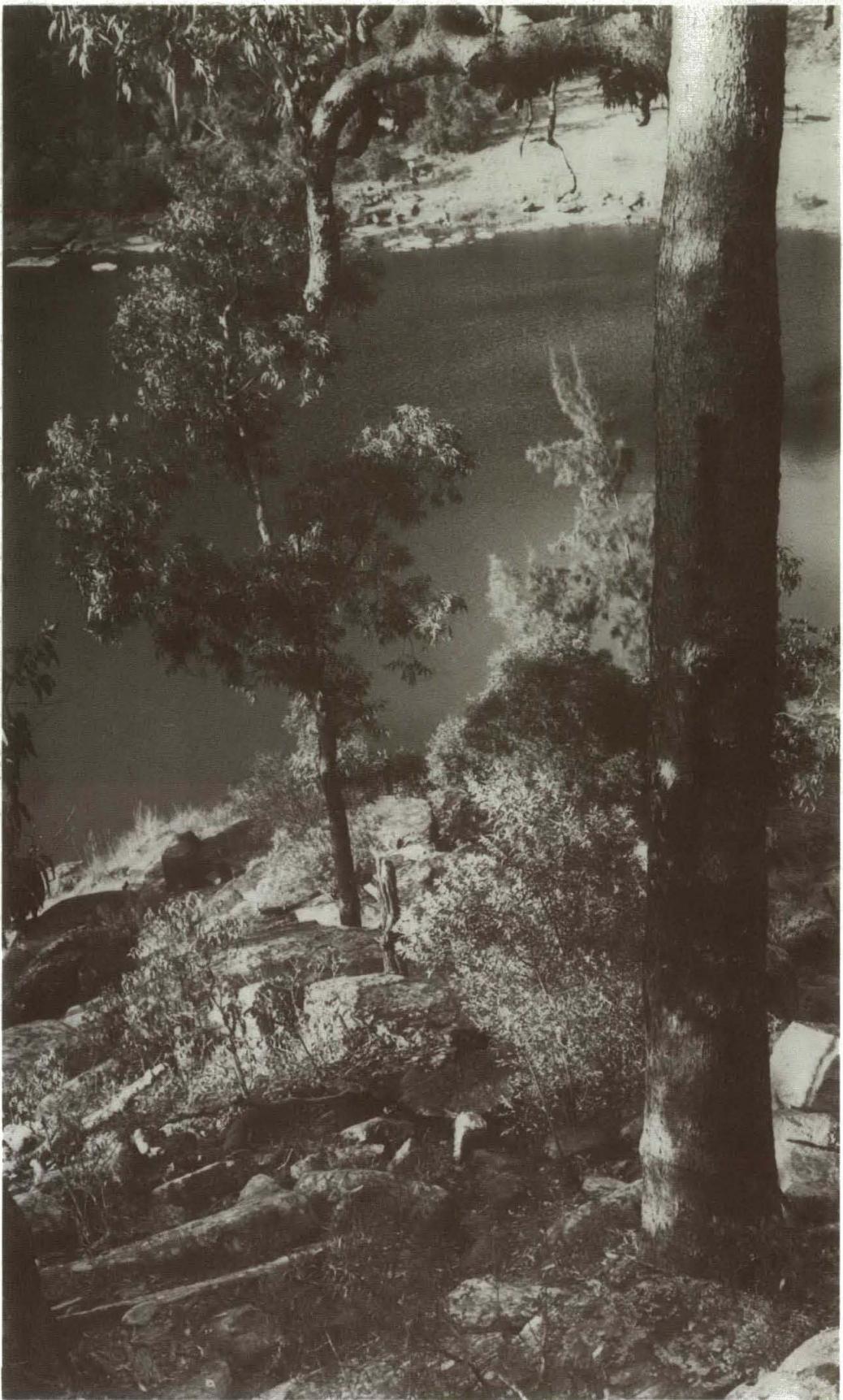
General Conclusion

Sydney is fortunate to be one of the few large cities in the world with abundant relatively undisturbed natural landscapes of uncommon beauty on its periphery.

Because there is a lack of knowledge of the natural order and of the effects of human intervention caution should prevail and conservative management policies are desirable. Further intervention should be carefully assessed and non-structural solutions should be explored.

An understanding of the river as an integrated system and consequent co-ordinated management have been hampered by the disparate responsibilities and actions of single-purpose authorities. A co-ordinated interdisciplinary and inter-departmental effort is necessary to reach solutions to the complex questions of hydrology, water quality and the maintenance of natural systems.

The Government and local councils should continue their efforts to maximise the recreational potential of the river.



Nortons Basin

* Introduction

The Hawkesbury/Nepean Valley study was initiated in 1976 as part of the Sydney Region Outline Plan Review process. It was considered desirable to examine the Sydney Region Outline Plan proposition that the valley was a major future recreational asset in the region which could be developed as a lineal open space system in the light of the rapid growth of Sydney's western and south-western suburbs and their demand for water-based recreation. This is consistent with other more recent State Government initiatives such as the Western Sydney Area Assistance Scheme and the Western Sydney Planning and Development Committee.

The study initially examined recreational planning issues. It went on to examine other issues in the valley such as the management of its extractive resources, the conservation of the valley's natural and man-made resources, and the threat to water quality from urbanisation pressures.

The study consists of four parts. The first part, a landscape appraisal, examines the valley as a sequence of geophysical units, looks at area-specific issues and draws conclusions for each unit. The other parts overview the issues of recreation and regional open space, extractive resources and river management.

A number of reports, together with the Department's river survey, formed a data base for this report on the Hawkesbury/Nepean Valley. These reports were:

- (1) Hawkesbury River Valley Environmental Study - Background Report N.S.W. - Department of Environment (1973).
- (2) Extractive Industries in the Hawkesbury Region - N.S.W. State Pollution Control Commission (1977b).
- (3) Effects of Water-borne Traffic on the Hawkesbury River - N.S.W. Inter-Departmental Committee, (1977).
- (4) The Hawkesbury/Nepean River - Effects of Water-based Recreation Activities - De Leuw Cather, (1977).

A bibliography is included at the rear of this report together with a compilation of the data generated by the study.

Study Area

Broadly the study area is defined on the Locality Map (No.1) which is based on the Central Mapping Authority 1:25,000 series maps covering the river corridor.

While the river should be considered in relation to the whole catchment, it was necessary because of limits on study resources to concentrate on the immediate river corridor where urban pressures are most severe.

Method

A task force, including a landscape architect, a botanist, a forest ecologist, an engineer/hydrologist and an architect/planner, was formed in July 1978.

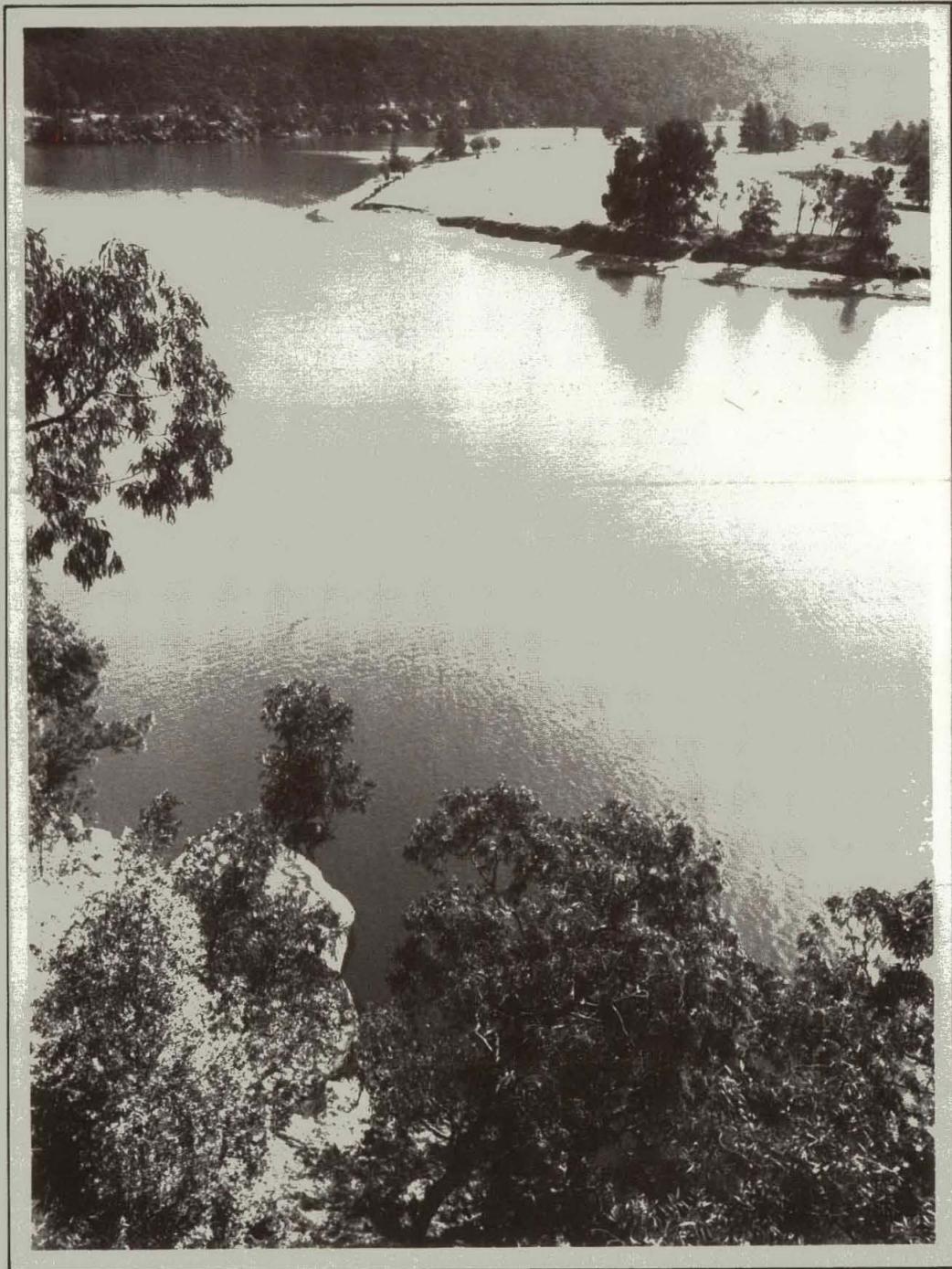
The task force carried out a survey of the river from Douglas Park (Wollondilly) to Bar Point (Gosford), recorded the vegetation and typical transects, and photographically recorded the effects of the major flood in March 1978. This data formed the basis for the Landscape Analysis section of this report.

A natural systems approach to the recreational land use aspects of the study (using McHarg sieve mapping techniques) was used to determine land suitability, land constraints and subsequent capability in response to demand/accessibility and resource attributes criteria. The results were used to produce the Recreation Capability Maps (No. 3a and 3b) which are included in Part 2 of this report.

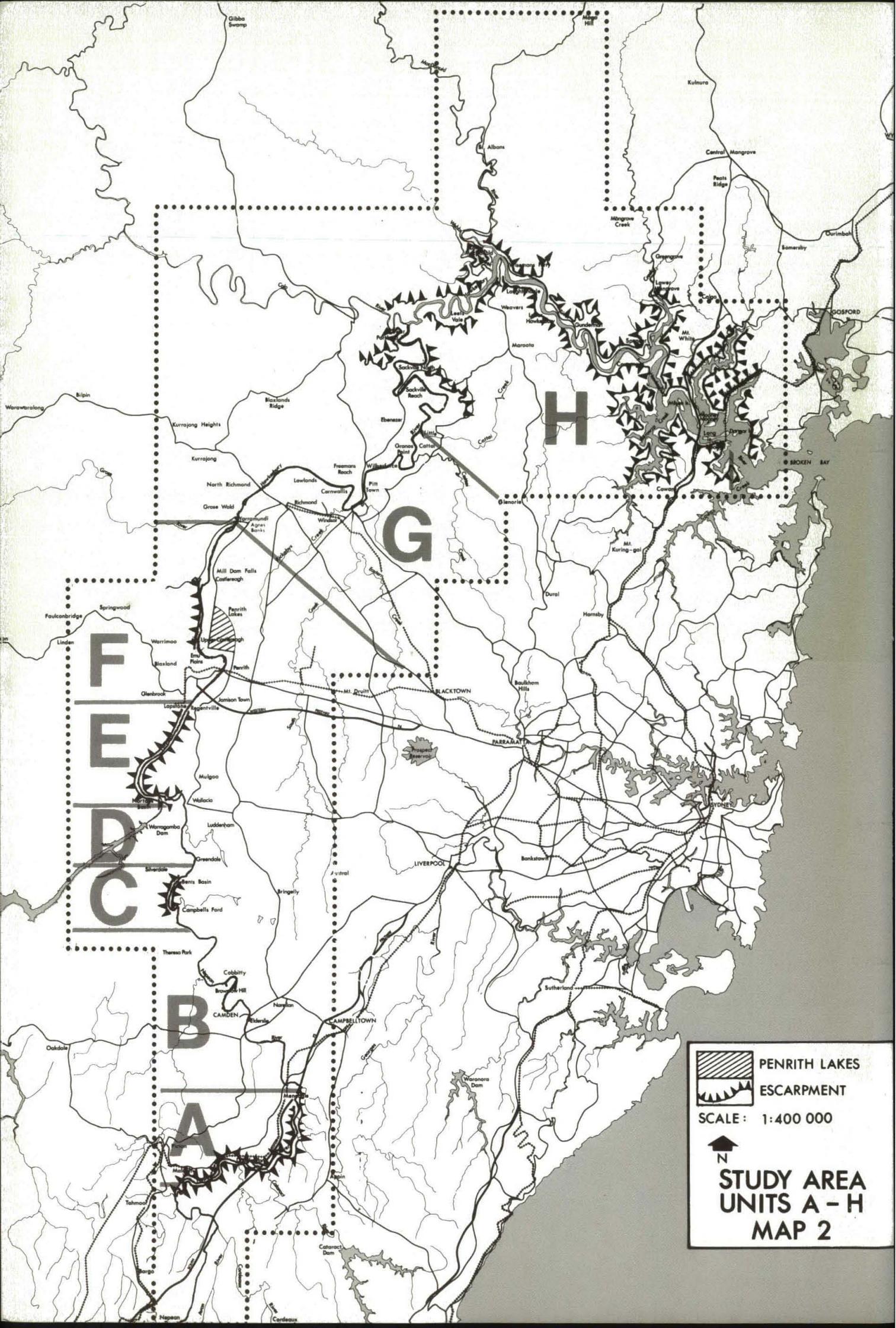
Resource limits prevented the extension of these techniques to other aspects of the study but existing land use and tenure patterns were mapped.

Development control casework during the course of the study was used as a testing ground for policy formulation.

Part 1 Landscape Analysis



Leets Vale



 PENRITH LAKES
 ESCARPMENT
 SCALE: 1:400 000

**STUDY AREA
 UNITS A - H
 MAP 2**

LANDSCAPE ANALYSIS

Geomorphology

The natural landscapes of the valley subdivide readily into eight discrete geomorphic units which reflect the dramatic land forms of the area the river traverses (named Units A to H in this study and shown on Map No. 2). It is surmised that in the Tertiary period the Hawkesbury/Nepean flowed on a broad and senile floodplain south and west as part of an inland river system that joined the Macquarie River. With the gradual settling of the coastal block, the former Great Divide was submerged, throwing into comparative elevation the adjoining block which became the present day Great Divide. The Hawkesbury/Nepean system reversed and began flowing north and east to the coast*. (Personal communication V. Smith, geologist, Department Mineral Resources).

Parts of the river course remaining on the coastal block retained its meandering form on a floodplain. These are Units B, D, F, and G. The remaining portions of the Hawkesbury/Nepean located on the inland block responded to the settlement of the coastal block by cutting down through the residual shales of the former floodplain into the harder material of the Hawkesbury sandstone, creating the gorge landscapes. These events have resulted in the dramatic changes and disjunctions in the scenery of the valley that make it an unusual and highly valued landscape. Unit C, which includes Bents Basin, exhibits such scenic diversity.

The junctions and transitions between the units are of particular scenic and geological interest because of the contrasting elements and the response of the river to the change of geology.

The Unit Analysis sets out the key issues for each unit and draws area-specific conclusions relating to the unit's environmental value, its conservation attributes, and its potential for recreation. Broader conclusions on each of the issues are drawn in Parts 2, 3 and 4.

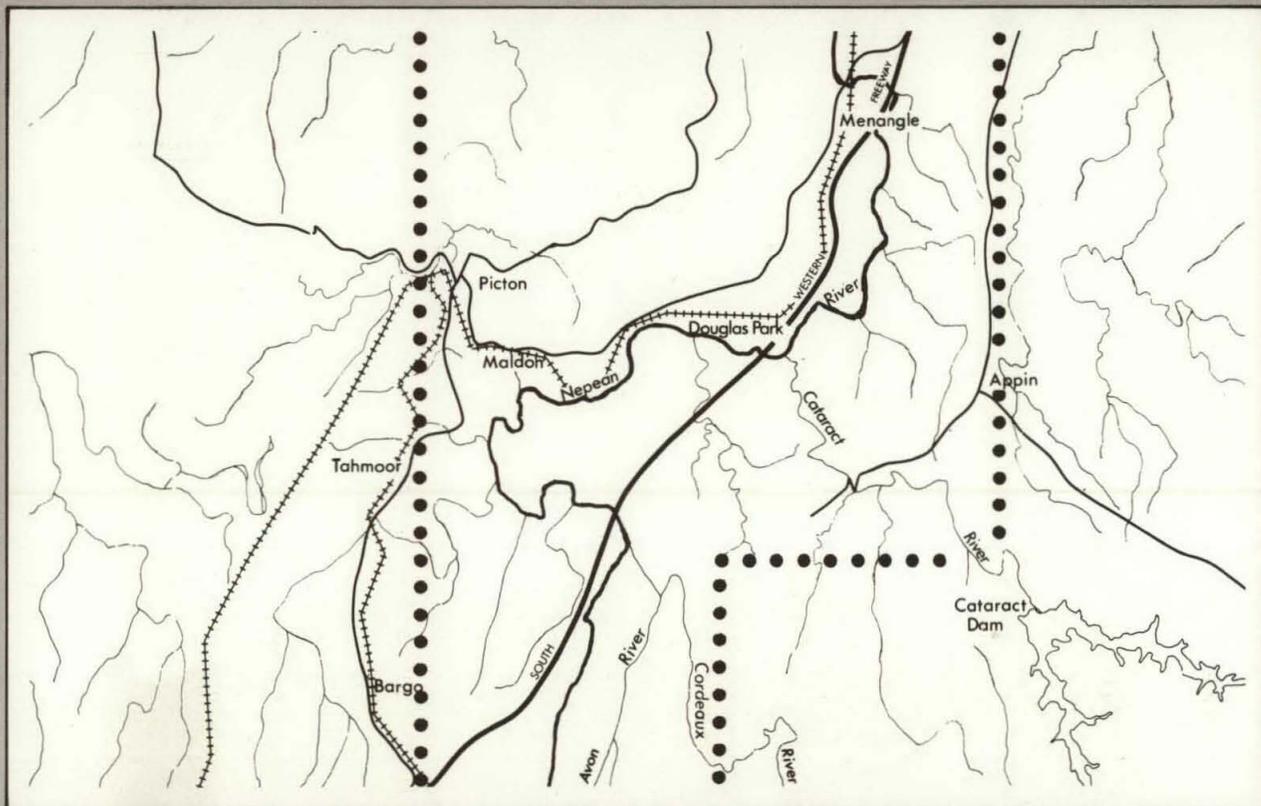
The eight units, commencing upstream in the southernmost portion of the study area are:

- Unit A - Douglas Park Bridge to Menangle
- Unit B - Menangle to Campbells Ford
- Unit C - Campbells Ford to Bents Basin
- Unit D - Bents Basin to Wallacia Weir
- Unit E - Wallacia Weir to Regentville - Fairlight Gorge
- Unit F - Regentville to Yarramundi
- Unit G - Yarramundi to Cattai
- Unit H - Cattai to Broken Bay

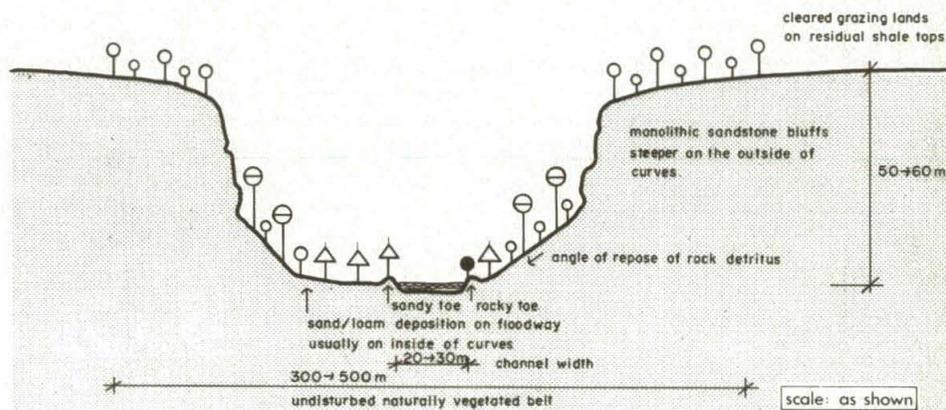
* Note: This is necessarily a hypothetical view of the events that took place and not all authorities would agree with this interpretation.

Unit A

Douglas Park Bridge to Menangle (F5 Freeway Bridge)



UNIT A : Douglas Park Bridge to Menangle (F.5 Freeway Bridge)



The Nepean is incised into a sandstone gorge* which from the river has the appearance of a pristine sandstone vegetated environment. This is deceptive as the plateau above has been cleared for agricultural use including grazing, rural industries such as chicken farms, a major piggery, and rural residential development on smaller subdivisions.

The Nepean emerges from the gorge onto the alluvial plain at the second F.5. Freeway crossing. The last sandstone outcropping occurs adjacent to Menangle Bridge.

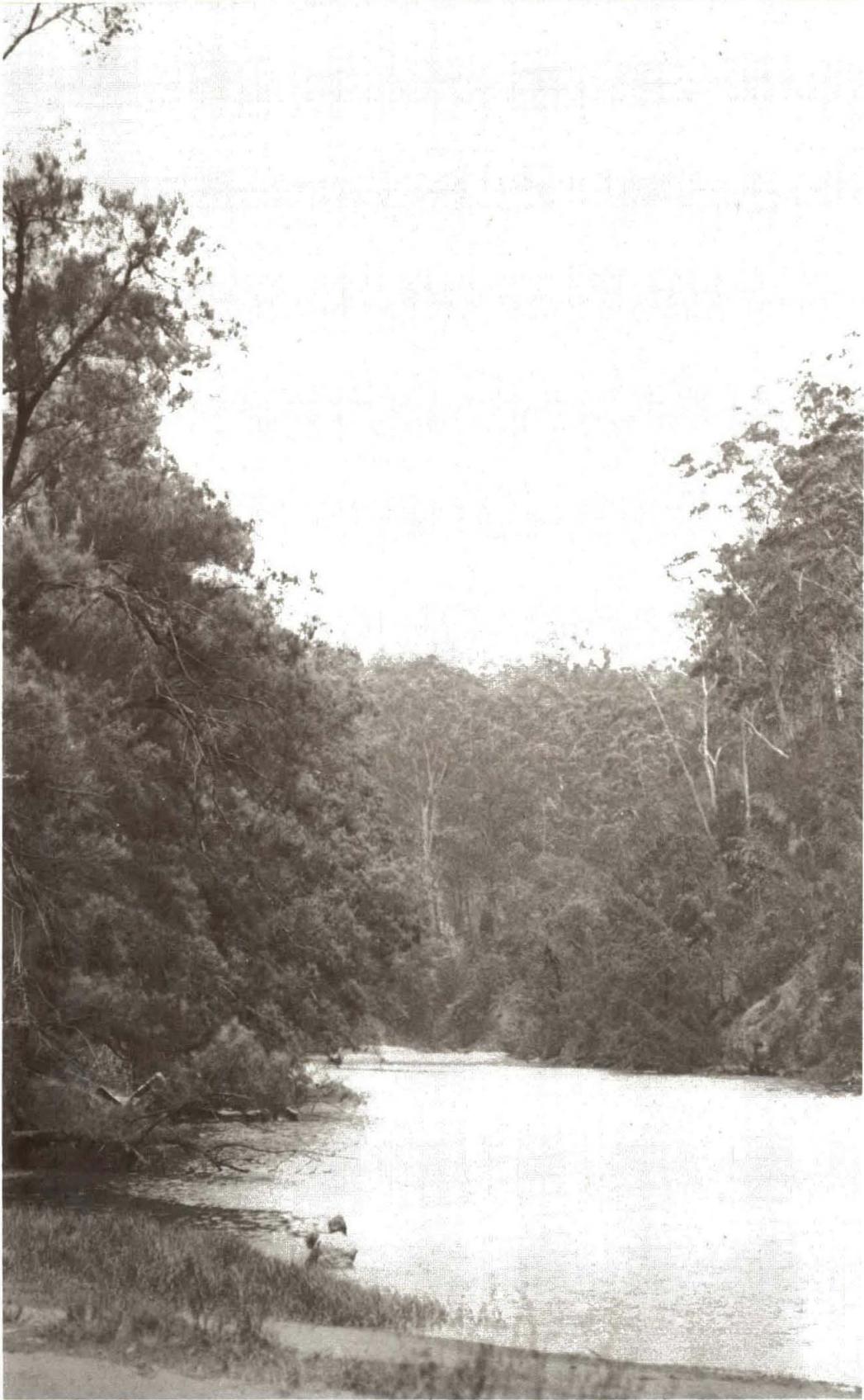
Vegetation in this unit is typical of Hawkesbury sandstone terrain with some exotic shrubs and understorey. Tristania laurina flourishes where the toe of the bank is rocky and Casuarina cunninghamiana on sand/alluvium banks. Water clarity is much better than in all the succeeding units. No fauna surveys were attempted but the narrow width of the vegetated strip along the gorge suggests that the habitat for larger mammals would be limited.

It is likely that agricultural runoff, especially of nutrients, has had an effect on the ecosystem. The urbanisation of Appin must place this unit under increasing pressure which is likely to further modify the natural landscape. These factors must reduce the unit's value for nature conservation but it is an important local natural resource and wildlife refuge.

Conservation

This unit is in a more pristine state than downstream units as there has been less opportunity for water-borne dispersal of seeds, thus reducing invasion of exotic plants. Exotics are less in evidence in the understorey and groundcover than downstream in

* This gorge is referred to in this report as the Nepean Gorge. The gorge on the Nepean between Wallacia and Regentville is called the Fairlight Gorge for clarity, although it is also known as the Nepean Gorge.



Nepean Gorge at Douglas Park Bridge

spite of agricultural land uses adjoining the Gorge. Some native species which occur in this unit do not occur downstream.

The narrow width of the vegetated belt makes the biological defence of the unit difficult, limits its value as a habitat, and agricultural runoff is likely to have disturbed the species distribution and diversity. This suggests that it is an important local resource but of secondary value for nature conservation compared to the other sandstone units. It could perhaps serve as a 'corridor' between natural areas allowing genetic interchange between plant and animal populations.

The unit is likely to contain undisturbed Aboriginal sites but no data are available. Part of the Camden Park Estate adjoins the unit but it does not share a significant relationship to the incised form of the river. The conservation of the estate and its landscape as a cultural and recreational resource is an objective in the planning of the Macarthur growth area. The village of Menangle and the Church of St. James are pivotal elements in the valley landscape.

Recreation

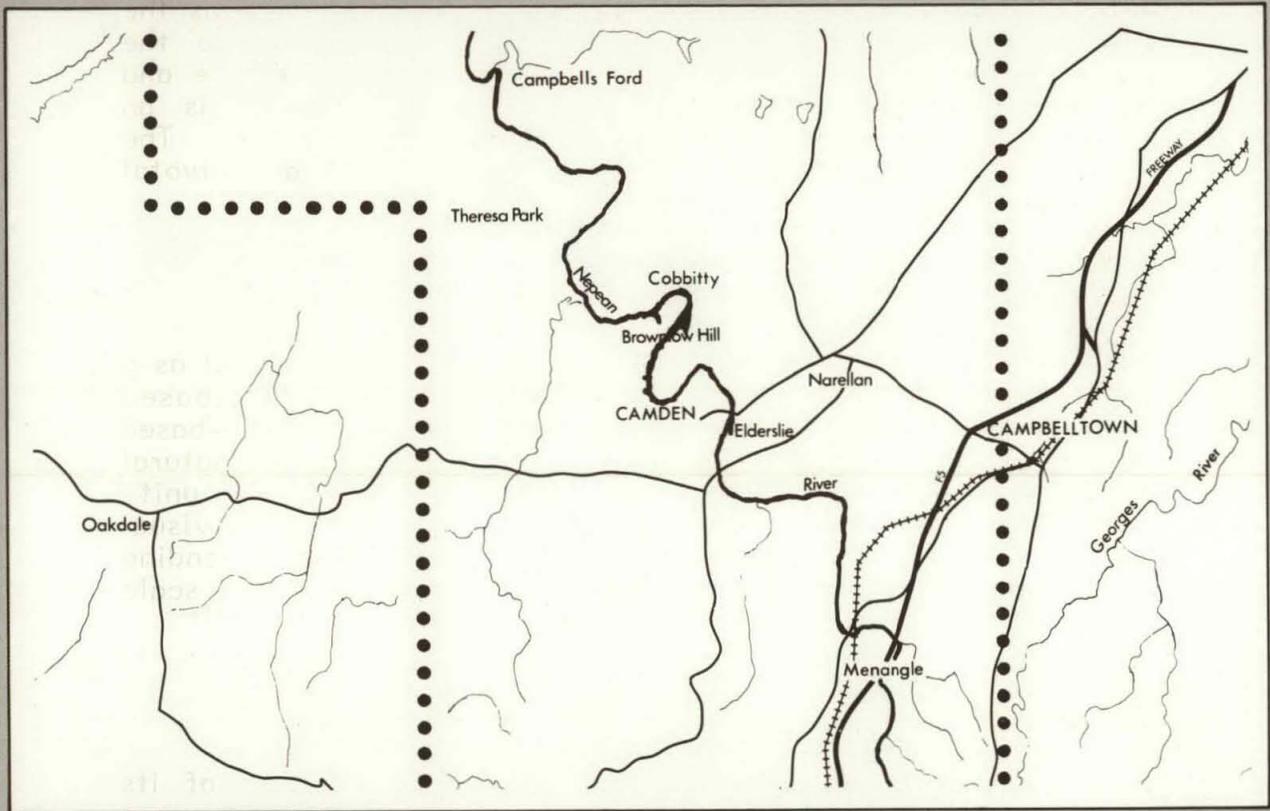
The unit's main value probably lies in its use and potential as a scenic and passive recreation resource for water-based recreation, canoeing, small boating and camping. Land-based recreation is likely to be more destructive to its natural attributes. There is no evidence of flood damage in this unit, although a lot of debris has been deposited. The unit's visual interest derives from changing vegetation communities, depending on aspect, geological features and birdlife, and it is of a scale that can be appreciated from slow moving transport.

Conclusions

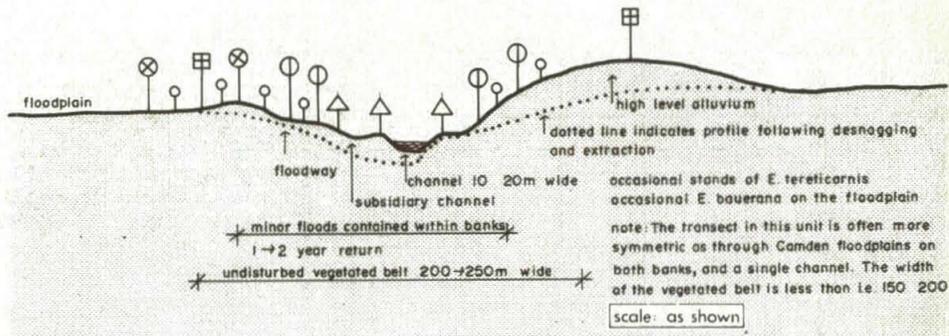
1. The unit is valuable in its present form because of its scenic and recreational attributes. Careful management measures and limits to access will need to be imposed if Appin is urbanised.
2. The major recreational use is canoeing and small boating in the waterway itself, with public access at Menangle and Douglas Park.
3. The unit is suitable for water-based recreation. Access to the river for such uses could be improved.
4. Land-based recreation and access need to be carefully controlled.
5. Environmental protection controls covering the width of the vegetated strip, which averages 300 metres, would be desirable.
6. Public acquisition is not warranted at present.

Unit B

Menangle (F5 Freeway Bridge) to Campbells Ford (Bringelly Creek)



UNIT B: Menangle (F5 Freeway bridge) to Campbells Ford (Bringelly Creek)



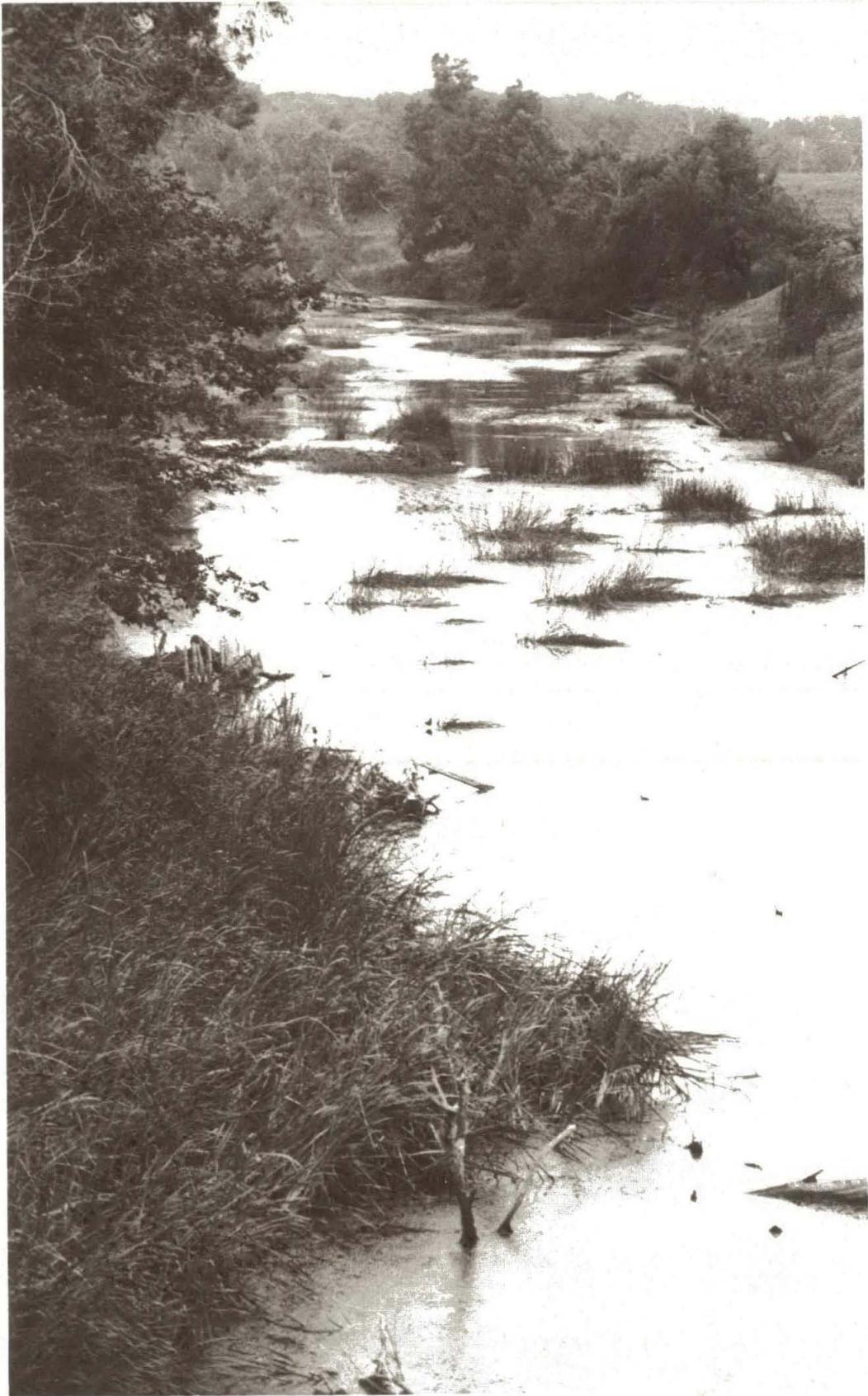
The Nepean between Menangle and Campbells Ford passes through an undulating pastoral landscape with a backdrop to the east of residual shale hills including the Central Hill Lands and with views of the Lapstone monocline on the horizon to the west. The river is in a depositional phase with a low gradient, low velocity and is frequently impounded by irrigation weirs. Fields are defined by lines of trees along the watercourses, boundaries and roads, with an occasional specimen shade tree.

Canopy cover on the Nepean is generally indigenous, with exotics such as a privet forming the understorey. Casuarinas are the most common toe vegetation with some willows occurring. Elms, mature *Angophora subvelutina* and *A. floribunda* occur on some waterfrontages such as that on Camden Park. The natural bank profile is a series of terraces, resulting in a zonation of soil profiles, as deposited silts are graded during floods. This is reflected in the vegetation communities. The terrace form impedes drainage thus aiding vegetation and habitat diversity.

The river environment in this unit has been degraded in recent years by the effects of desnagging, sandmining from the bed, and topsoil/loam extraction from the banks. The current restoration practice is to regrade banks to a 1:3 batter back from the toe following extraction. This results in Casuarinas being retained on the toe with the loss of the main canopy, usually Eucalypts and Angophora.

Loss of vegetation also makes urban development at Camden and industrial activities such as the Glenlee Coal Washery more intrusive. The public waterfront through Camden, with its soft alluvial banks, has been denuded and eroded by human use, suggesting that well designed and more urban orientated landscaping measures are desirable to cope with more intensive use and also to facilitate water-based recreation. A more urban waterfront with a 'hard' promenade or boardwalk and leisure facilities, such as a boating concession would enhance the rather uniform character of the Nepean in this unit.

Below Camden the river environment adjoining the aerodrome deteriorates. Mature bank vegetation has been destroyed because of



Nepean River at Camden

extractive activities. While some selective desnagging of the bed may be beneficial to recreation use, the narrow channel and intimate landscape of the so called 'snagged' sections hold more interest.

Below the Camden Aerodrome the pastoral landscape and river environment is less disturbed and continuance of rural use, together with voluntary revegetation programs, should protect these qualities. Landholders should be encouraged to revegetate their frontages and to keep stock off their banks to enable revegetation to occur.

Approaching Campbells Ford, the monocline once again becomes an important landscape element. The Ford is a very scenic area adjoining the re-entry of the Nepean into a sandstone gorge phase with extensive sandshoals ideal for water-based recreation. There is no public access to the area at present.

Conservation

The unit has important conservation value as an agricultural and pastoral landscape, including important 19th century homestead groups, and as a scenic backdrop to the South-West Sector. The main building groups within the viewshed of the Nepean are the Camden Park Estate, Glenlee at Menangle Park and Brownlow Hill. The town of Camden and the village of Cobbity, sited on old alluvium ridges within their agricultural setting on the floodplain, are comparable in landscape quality to the Macquarie towns (Unit G).

Recreation

The river in this phase is characterised by steep muddy banks, a narrow and shallow stream, and considerable water quality problems related to the slow flow conditions, runoff from agricultural and urban areas, and sewage effluent from Camden Treatment Works. These conditions suggest a limited recreation role for the waterway itself. The river is suitable for canoeing and small boating, and the deeper water above gravel bars and weirs is suitable for swimming. Public access should be improved to the weirs and adjoining the bridges with purpose-built structures, platforms, pontoons and ramps to improve water access and alleviate erosion to the soft alluvial banks.

It is desirable to improve public access at Cobbity Bridge. A small local picnic and camping ground would be appropriate. Public access is desirable from Cut Hill Road across Bringelly Creek to Campbells Ford and to the attractive waterfront and sand bars at the top end of the Bents Basin Gorge.

Tourism and the development of a system of tourist roads in the valley would benefit from a link route from Cut Hill Road to Wolstenholme Avenue.

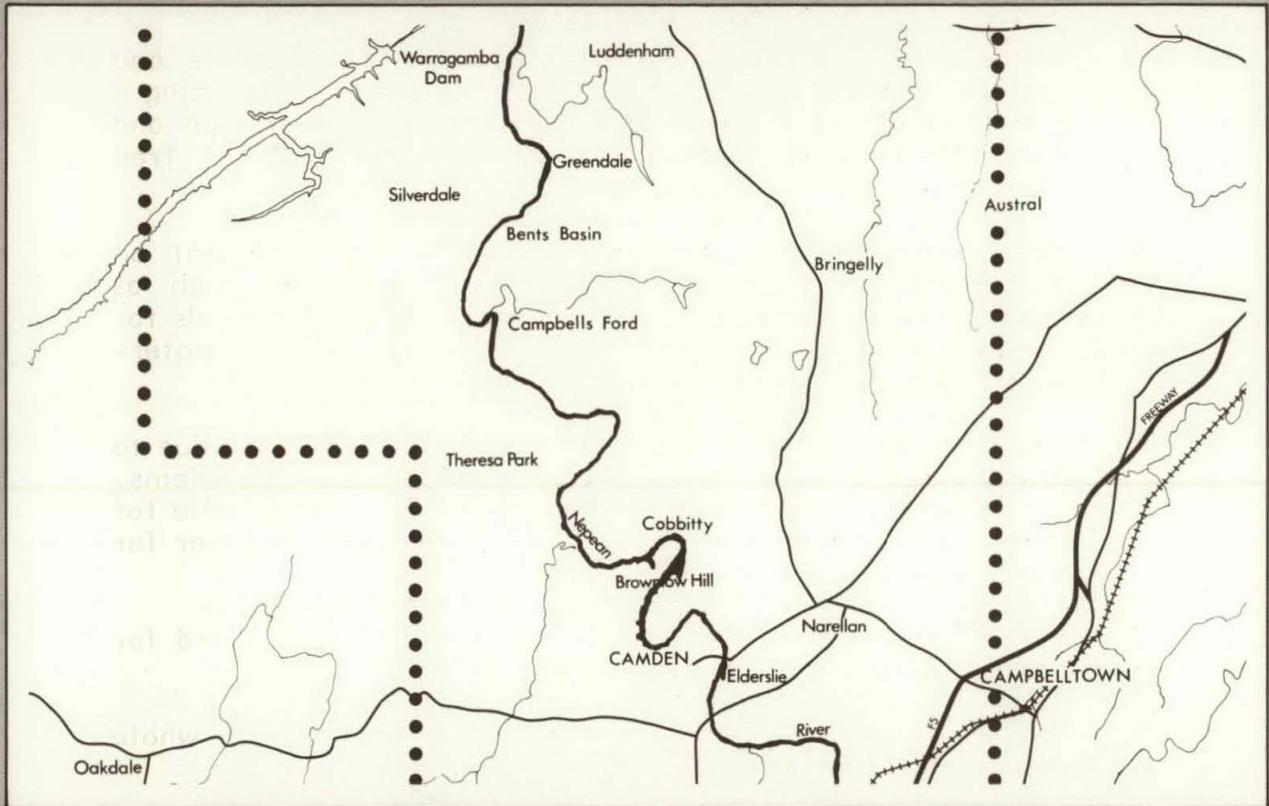


Macarthur Bridge and farmland near Camden

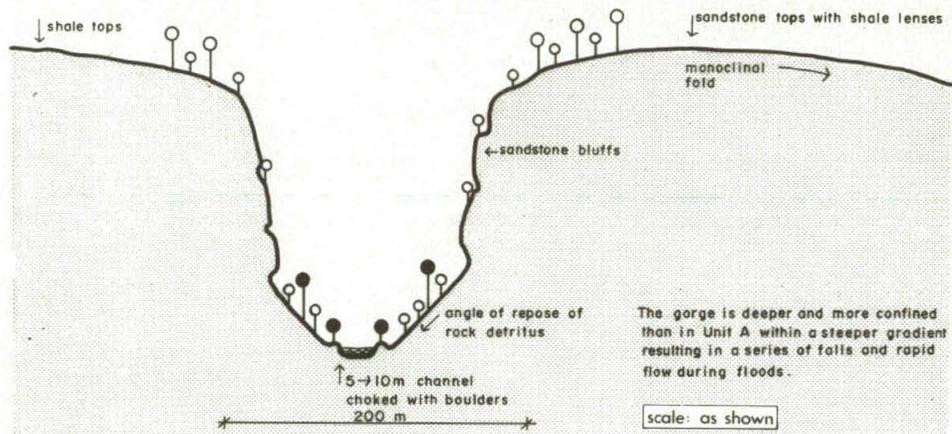
Conclusions

1. This unit has an attractive, although uniform, pastoral landscape requiring restoration where urban and industrial areas and extractive industry detract from its qualities.
2. Where the banks are disturbed topsoil could be stored and the banks regraded to reinstate the terraced form of the natural bank in order to re-establish the indigenous flora/fauna habitats and to create sheltered sites for camping and recreation use.
3. Urban design solutions are desirable for the Camden waterfront.
4. Methods to encourage private landholders to conserve and restore bank vegetation need to be investigated, including a grant system as proposed by the Forestry Commission and other Government initiatives such as the supply of free plant material.
5. Maintenance of the landscape character is dependent on continuation of pastoral land uses. Initiatives such as zoning controls, resolution of conflict with the demands for extractive resources, and guarantees of riparian water-supply may need investigation.
6. The unit has limited value for water-based recreation due to low flows, shallow water, and water quality problems, particularly below Camden. The floodplains are suitable for active and passive recreation as an open space corridor for the South-West Sector.
7. Public access to Cobbity Bridge and Campbells Ford for passive recreation use is desirable.
8. The unit requires scenic protection controls over the whole area to the adjacent ridge lines.
9. Environmental protection measures over a strip totalling 150 metres wide, including a strip 30 metres wide on the top of each bank, would be desirable to protect the river environment, the objective being maintenance and restoration of the natural condition of the river within stable banks.

Unit C Campbells Ford (Bringelly Creek) to Bents Basin



UNIT C: Campbells Ford (Bringelly Creek) to Bents Basin



From Campbells Ford to Bents Basin the Nepean is incised into a sandstone gorge 3 kilometres long on the edge of the Blue Mountains Plateau. The unit is now entirely within the Bents Basin State Recreation Area. A Trust has recently been appointed to manage the area.

Conservation

The Bents River Basin Unit has a prime conservation value because of its *Eucalyptus benthamii* and *Hibbertia hermannifolia* which have been amply documented by Mr D. Benson (national Herbarium). Due to its longstanding isolation the knoll to the east of the Nepean is likely to contain some fauna and flora different from those on the Blue Mountains plateaux and it contains a broad sample of sandstone flora. The knoll is an important local refuge for swamp wallabies, and supports a considerable variety of reptiles.

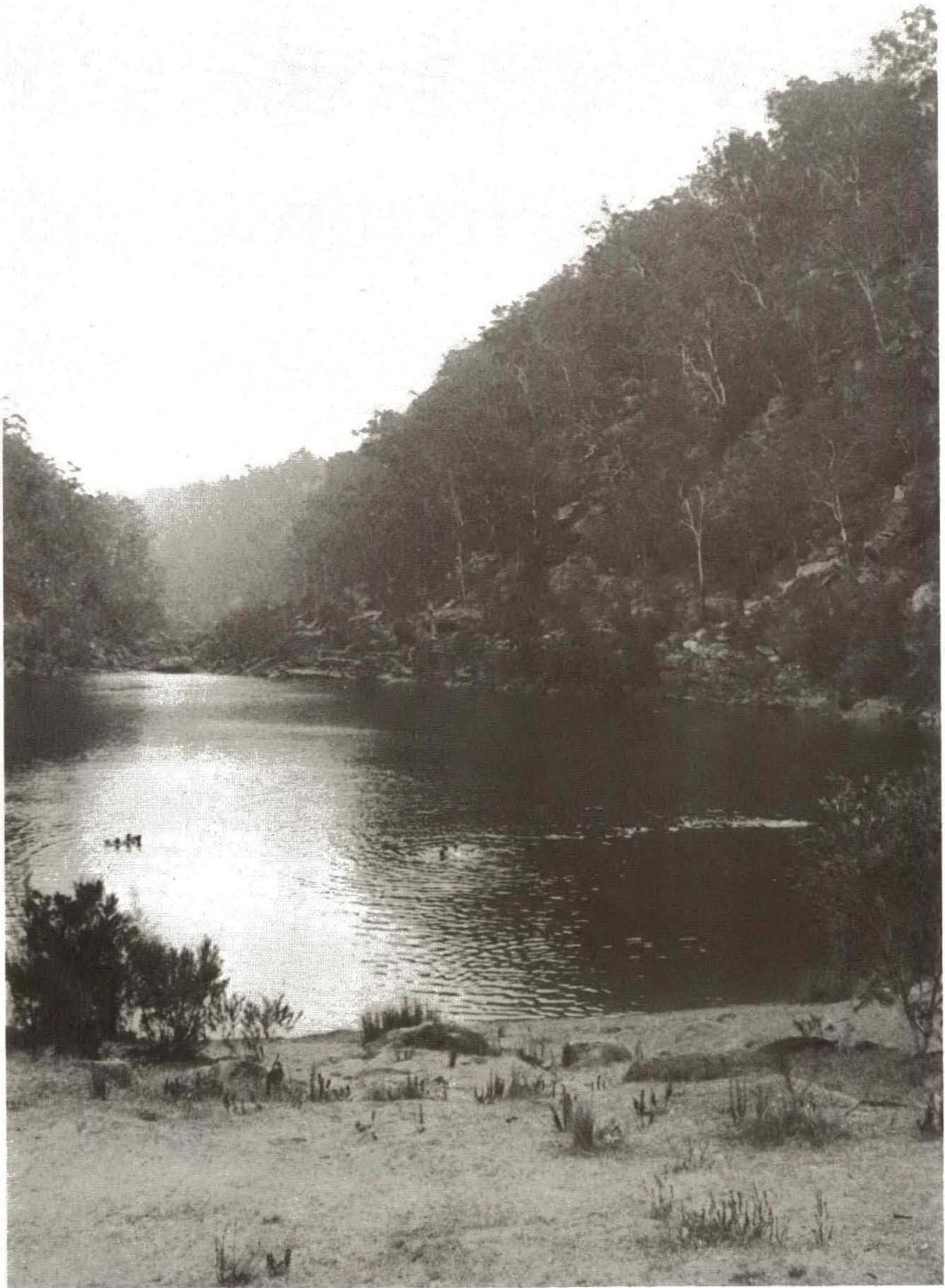
The Basin itself is an unusual geomorphic feature resulting from the spill of water from the rock choke at the end of the gorge setting up a whirlpool at flood time and forming a basin.

As this unit has the attributes of the sandstone phases of the river in miniature it has considerable value for nature study. Bearing in mind its small scale compared to the other sandstone units, its relative conservation importance is of first rank.

Other work on the area includes the **Resource Inventory and Preliminary Development Strategy** (N.S.W. Department of Lands, 1980) and the **Landscape Study for Bents Basin** (University of N.S.W., 1978).

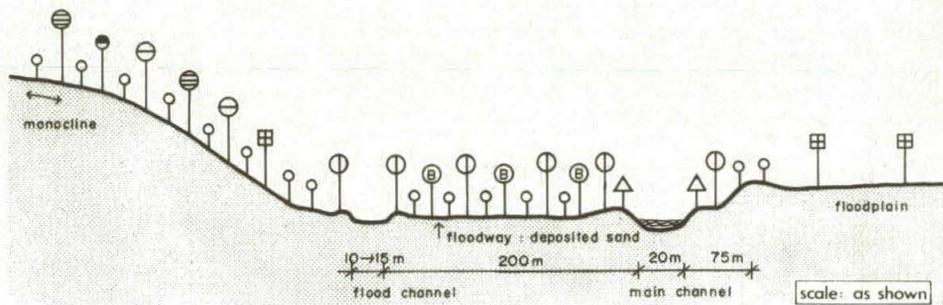
Recreation

The landscape study referred to above, provides guidelines for the management of the area. It suggests that the area's capacity for recreation is limited without compromising the major conservation value of the area, and that 250 car spaces and 1,000 persons/day be considered a maximum capacity. It recommends that



Bents Basin

the bulk of development for the new State Recreation Area should be on the cleared farmlands to the north-east of the Basin with access from the Sydney side only. The existing car park and public access via Bents Basin Road on the western side of the Nepean would be removed.

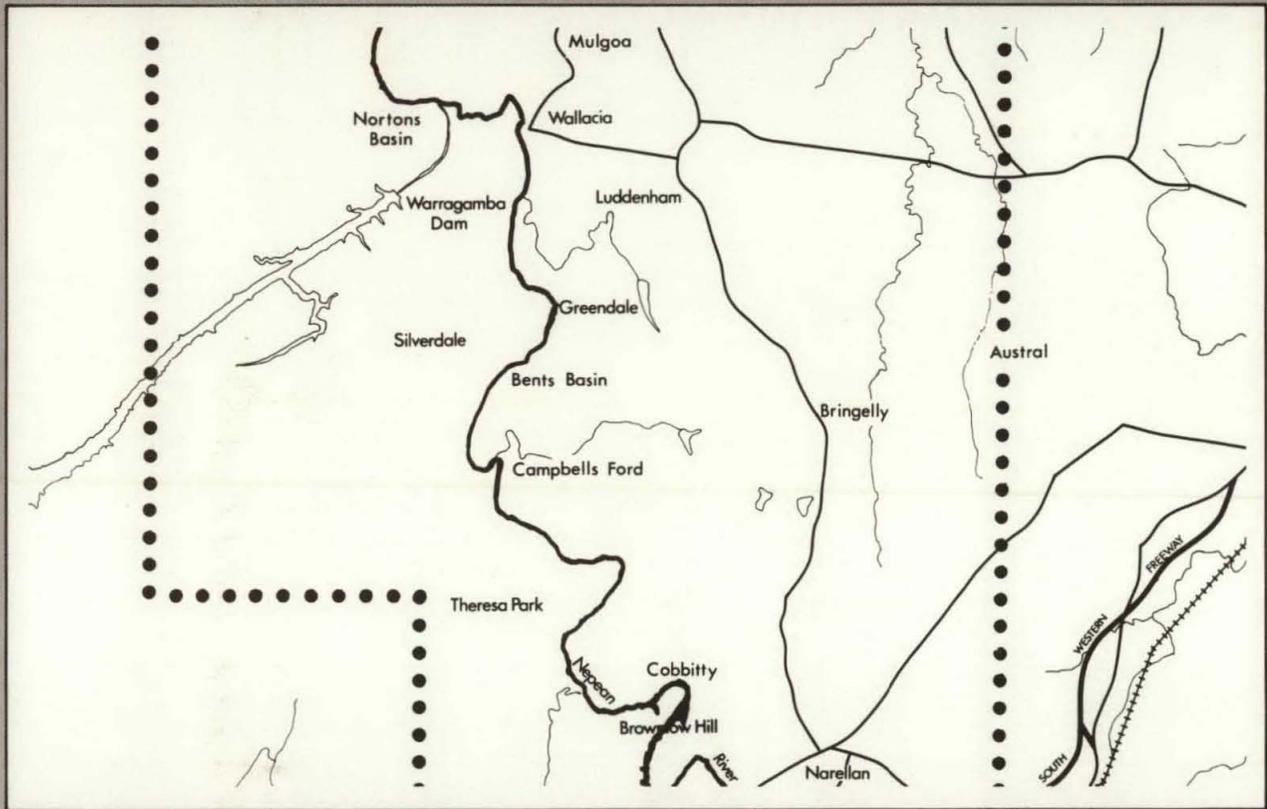


Conclusions

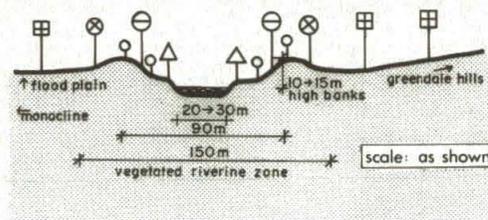
1. The unit is of prime conservation value because of its rare flora, habitat value, geological interest and Aboriginal sites.
2. The area also has important but limited capacities for recreation, particularly at the Basin.
3. The management guidelines established by the landscape study (University of N.S.W. 1978) could be adopted as an interim measure to permit low-impact and water-based recreation while protecting the conservation attributes, until a Plan of Management is adopted for the State recreation area.

Unit D

Bents Basin to Wallacia Weir



UNIT D: Bents Basin to Wallacia Weir



The Nepean flows from Bents Basin for some 10 kilometres to Wallacia Weir in a small-scale pastoral landscape with an undulating shale ridge, Greendale Hills, to the east and the Lapstone monocline as a very striking natural feature to the west. This picturesque small-scale landscape, with cultivation on the rich alluvial flats, includes notable early buildings such as St. Marks Church, Greendale Road. Any development is obtrusive in such a landscape.

Commercial agriculture is under pressure because of demand for rural residential lots and hobby farms and because extraction of sand and loam is more profitable. There is a proliferation of small extractive sites, mostly on the Wollondilly side, which are used for taking sand, loam and topsoil from the floodplain and for mining the banks.

The village of Wallacia is affected by scattered ribbon development along the major roads. The landscape would benefit from consolidation of the village as an urban feature in the landscape. With future public foreshores and improved access to the Fairlight Gorge downstream, the village can anticipate growth as a service town for recreational uses and tourism.

Recreation

As there is no public access between Bents Basin and Wallacia and as the Nepean is a narrow stream with steep alluvial banks, recreation use is limited to small boating and canoeing.

Conclusions

1. The unit has a very fine small-scale landscape with a backdrop of the monocline whose quality depends on continuation of agricultural use. Initiatives such as zoning controls, resolution of conflict with the demands of extractive resources, and guarantees of riparian water supply may need investigation.
2. Further extraction needs to be carefully controlled and methods should be investigated to conserve and revegetate the banks.
3. Further development, including leisure and resort facilities should be concentrated in the village of Wallacia. The river is ideal for canoeing.

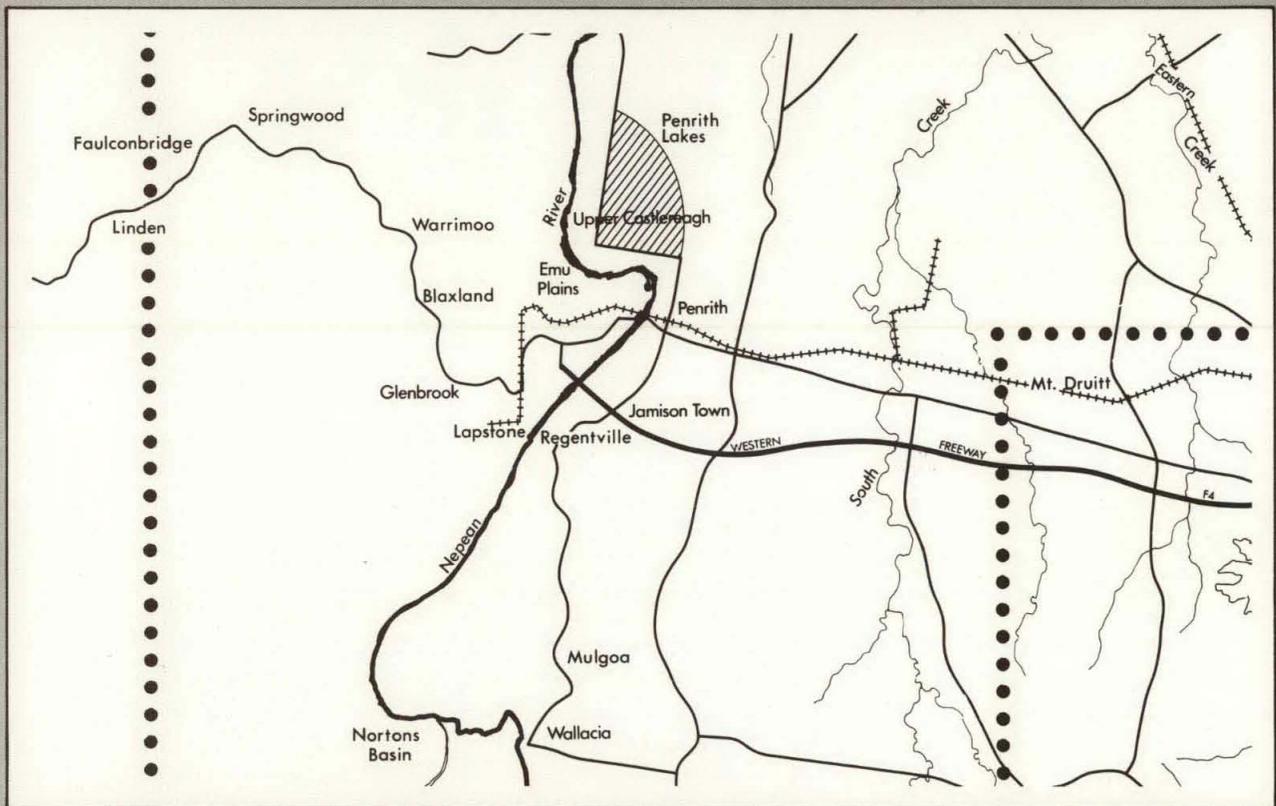


Nepean River near Greendale

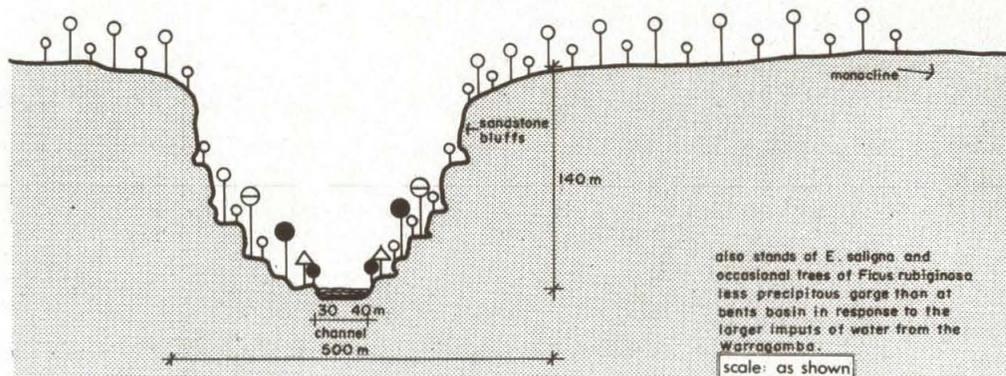
4. The unit requires scenic protection controls from the top of the monocline to the ridge lines of Greendale Hills (Greendale Road).
5. Environmental protection measures over a strip 150 metres wide, including the top of each bank, would be desirable to protect the river environment, the objective being maintenance and restoration of the natural condition of the river within stable banks.

Unit E

Wallacia Weir to Regentville-Fairlight Gorge



UNIT E: Wallacia Weir to Regentville - Fairlight Gorge



From Wallacia Weir to Regentville the Nepean is incised into a gorge in the Blue Mountains Plateau for some 16 kilometres. This is a scenically majestic landscape of considerable geological interest in a largely undisturbed sandstone unit. Both sides of the Fairlight Gorge are now in the Blue Mountains National Park. However extension of the national park above Nortons Basin to the Warragamba pipeline siphon, including the Wollondilly side and the lower Warragamba, is desirable to protect the whole of the gorge.

Conservation

The highest value must be given to the Fairlight Gorge for its superlative scenic qualities. It also provides a boundary for the Blue Mountains National Park to the east. The conservation value of the park could be bolstered by including the whole of the unit in the park and managing the eastern and southern foreshores as a buffer zone for intermediate recreation use. This would enable more restrictive management of the park proper.

The vegetation of this unit is typical of the sandstone strata and no special attributes have been identified.

The Basins and Warragamba Confluence area are of prime geological interest, due to the Warragamba gravels at the confluence, and the presence of volcanic breccia necks. Nortons Basin was formed as a result of a neck being eroded out.

There is only limited data on Aboriginal sites but it can be assumed on the basis of other surveys in the sandstone units that they proliferate. As the Fairlight Gorge is navigable up to the confluence by boat, sites in this unit are more likely to be disturbed than in Unit C. The only European site is the ruins of a homestead, outbuildings and garden on the confluence.

Recreation

Improved public access to the superb scenic qualities of the gorge is desirable and with careful management within the Blue Mountains National Park the conservation values can be protected.



Fairlight Gorge

Conclusions

1. The whole of the unit along the Nepean should be considered for inclusion in the Blue Mountains National Park. The eastern and southern sides of the Fairlight Gorge could then serve as a buffer zone with provision for low-impact recreation use and access. This would permit more restrictive management of the park to the west of the gorge, reinstating some of its more natural qualities.
2. Water-based recreation and access should be encouraged.
3. Land-based recreation and access should be carefully controlled.

Wallacia/Mulgoa Creek Landscape (Adjacent to the river within this Unit).

The landscape along Mulgoa Creek between Wallacia and Regentville is similar in character to Unit D with the monocline to the west and residual shale hills to the east.

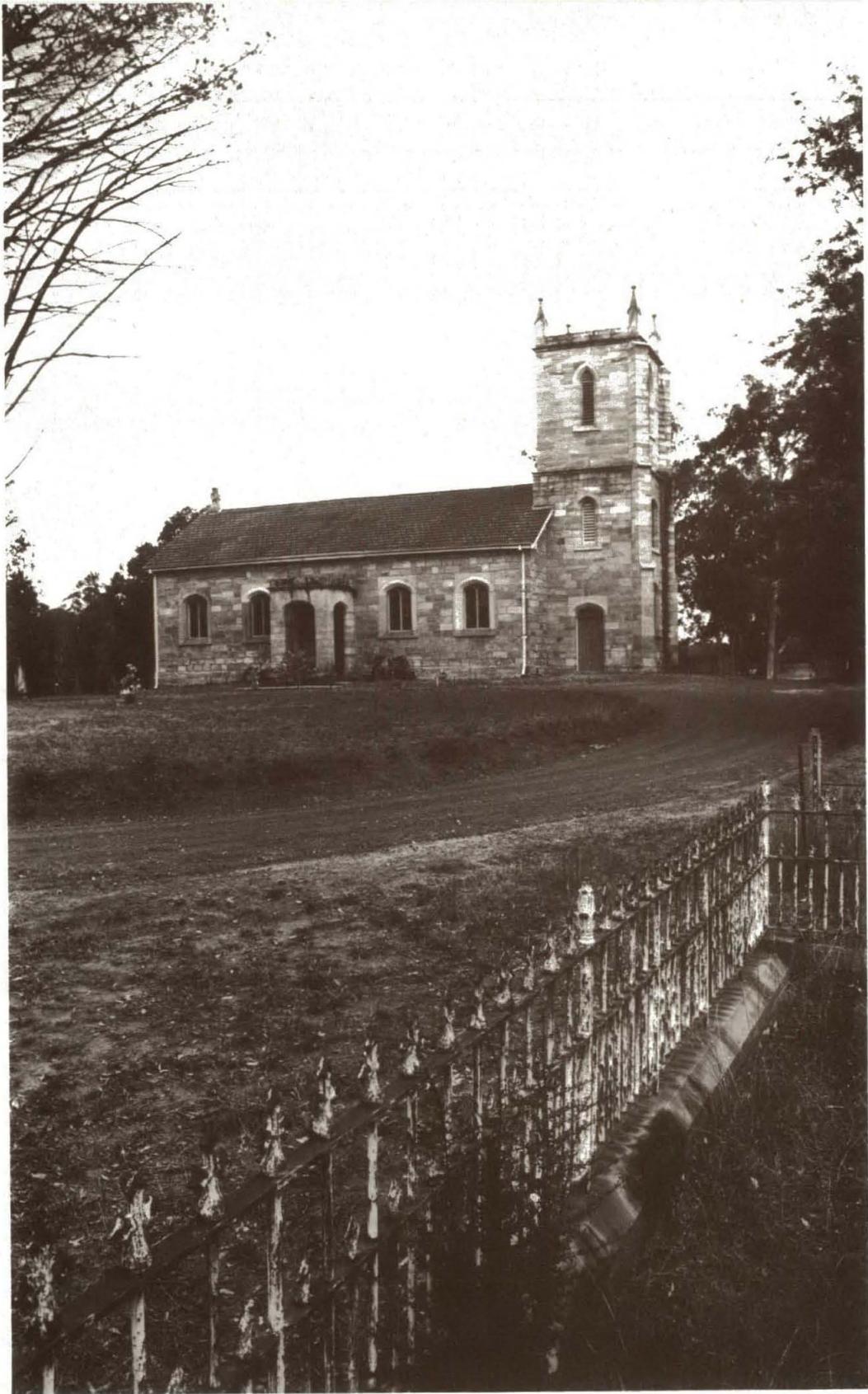
The valley contains important heritage elements at Mulgoa, including the historic precinct of Fernhill, St. Thomas's Church, Edward Cox's Cottage of 1811, Glenmore (1825 - Cox) north of Mulgoa and the high Victorian Glen-Leigh at Regentville in a relatively undisturbed rural landscape.

The area is also of considerable geological interest, as Mulgoa Creek is thought to have been an ancestral course of the Nepean. Glenbrook Creek is thought to have joined the mainstream via The Windgap, now a dry canyon 60 metres above the present bed. (Personal communication V. Smith, Geologist, Department Mineral Resources).

A Mulgoa Nature Reserve is proposed for portion 39, Mulgoa, which includes important remnant vegetation on the Wianamatta shales and unusual shale cliffs to the east of the creek.

Conclusions

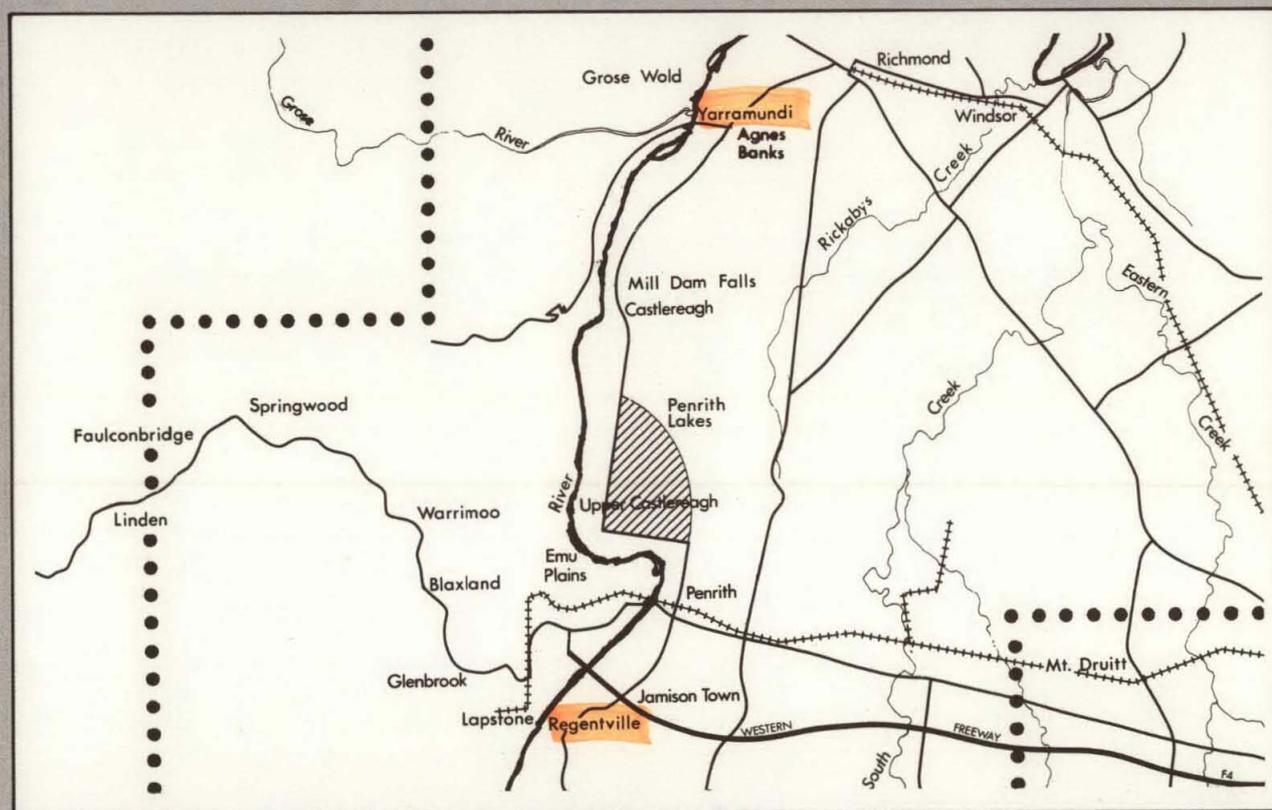
1. Given its proximity to Penrith and impending urbanisation in South Penrith, the Mulgoa Valley will become an increasingly important regional resource for its scenic, cultural, and recreational attributes.
2. Scenic protection controls over the whole of the Fairlight plateau to the west, to the ridge lines of the hills to the east, from Wallacia to the F.4. Freeway (Regentville) would be desirable to protect the Mulgoa Creek landscape. The impact of intensive rural uses such as feedlots, stables and nurseries on the landscape needs careful consideration and controls should limit the bulk, location and materials of all buildings.



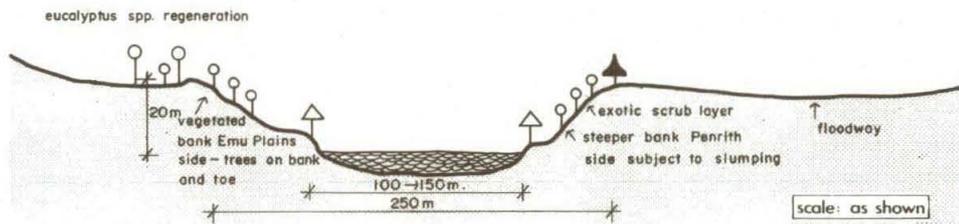
St Thomas's Church, Mulgoa

3. Development should as far as possible be concentrated in the existing settlements but excluded from the historic precinct at Mulgoa to conserve its landscape setting.
4. The proposed Mulgoa Nature Reserve could be protected with environmental protection controls as an interim measure pending finalisation of the proposal.

Unit F Regentville to Yarramundi



UNIT F: Regentville to Yarramundi



The Nepean emerges from the sandstone at Regentville and flows north in a trench at the toe of the monocline until Yarramundi. The river emerges as a broad straight channel with steep and high alluvial banks. The large-scale landscape with the river itself, the monocline as a backdrop to the west and the City of Penrith on the plain to the east has very formal and dramatic qualities.

The Penrith waterfront does not have urban qualities nor formal landscaping commensurate with the scale and potential of its setting. A riverfront promenade with both hard and soft areas, improved access for swimmers and boating, riverside uses, resort facilities, hotels and medium density housing would all be appropriate. The waterfront not only has considerable potential for water-based public events but also for boating and ferry services into the Fairlight Gorge.

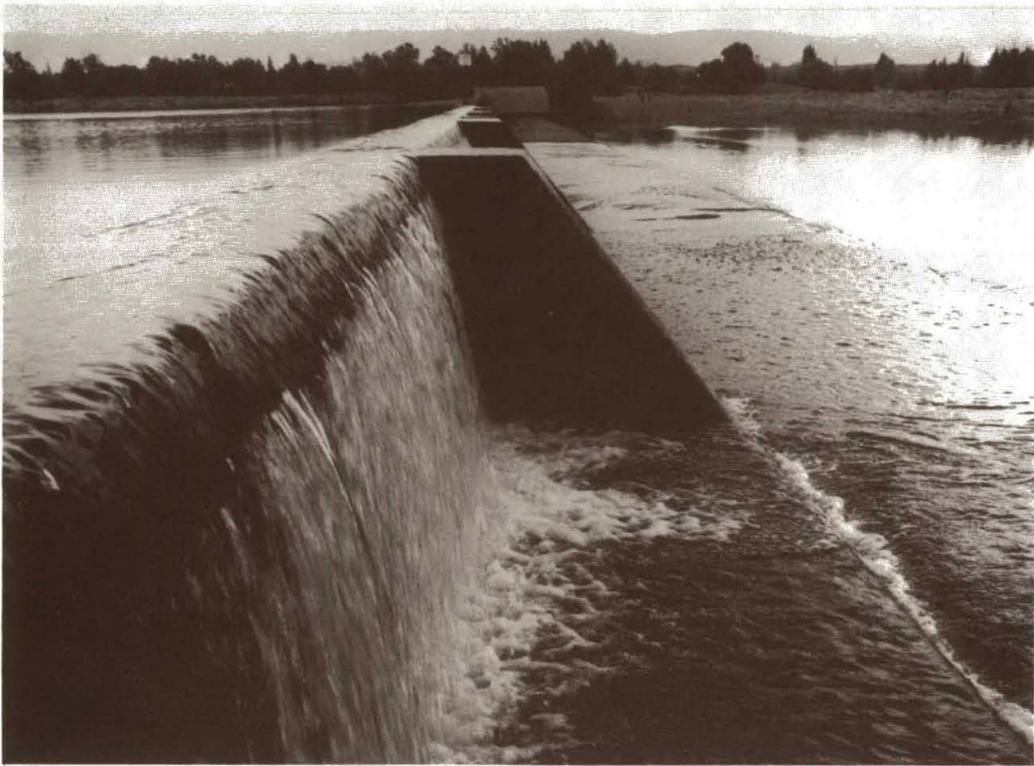
In response to severe bank slumping in the 1978 flood, Penrith Council embarked upon a major program of stabilisation involving dumping broken rock along the toe of the bank. This made water access less attractive and comfortable than formerly. A more urban quayside environment with ramps, steps, beachfronts and jetties would be preferable.

Below Penrith Weir the Nepean drops steeply through a series of heavy gravel bars and islands that act as natural weirs, contributing white and green waters to the diverse scenic qualities of this unit. The river passes the area proposed for sand extraction and rehabilitation as a potential recreation area, to be known as Penrith Lakes.

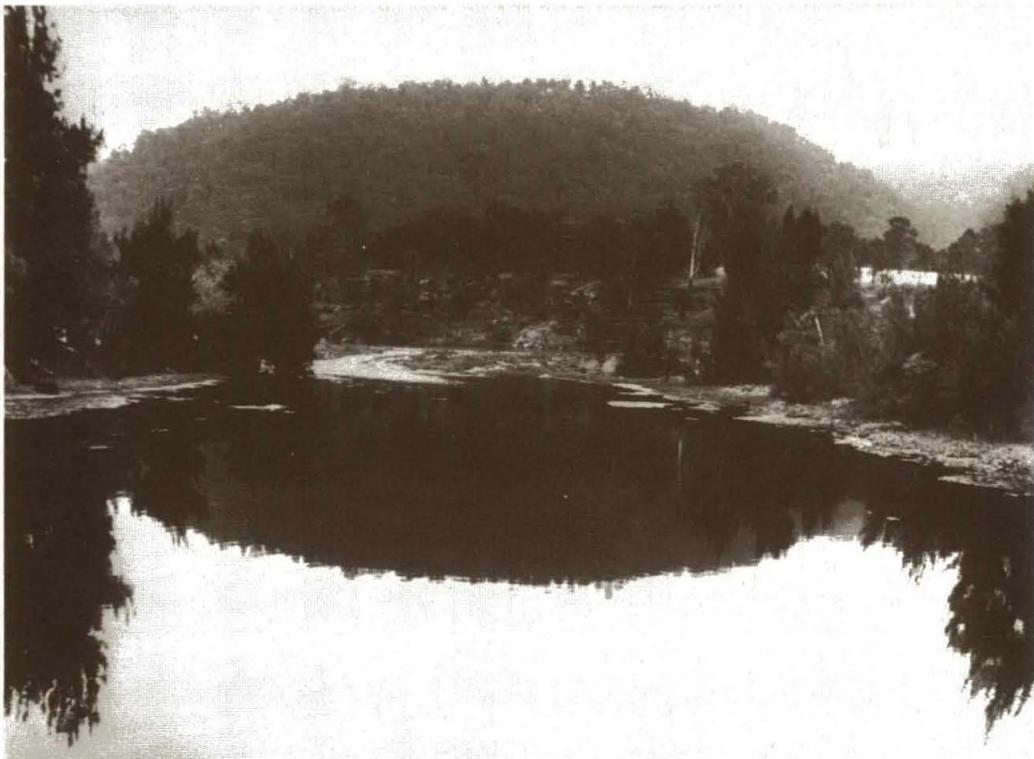
The naturally vegetated monocline dominates the western bank. The eastern bank comprises cleared agricultural lands with sparse vegetation. This contrast could be heightened by full restoration of the natural vegetation on the western bank. A vehicular track used to service a high tension powerline would be ideal for a public walking trail.

Although the gravel bars/sand islands have been extracted, some replenishment occurs and Casuarina/Acacia communities regenerate quickly, creating an ideal environment for passive water-based recreation.

Extraction and restoration of McCanns site was completed and it was notified as a Public Recreation Reserve in 1979. The permissive occupancy over the Mill Dam Falls area for extraction

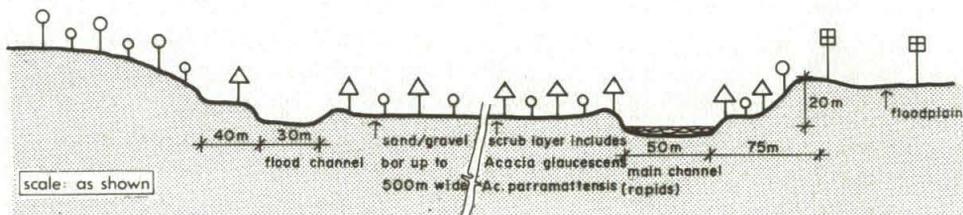
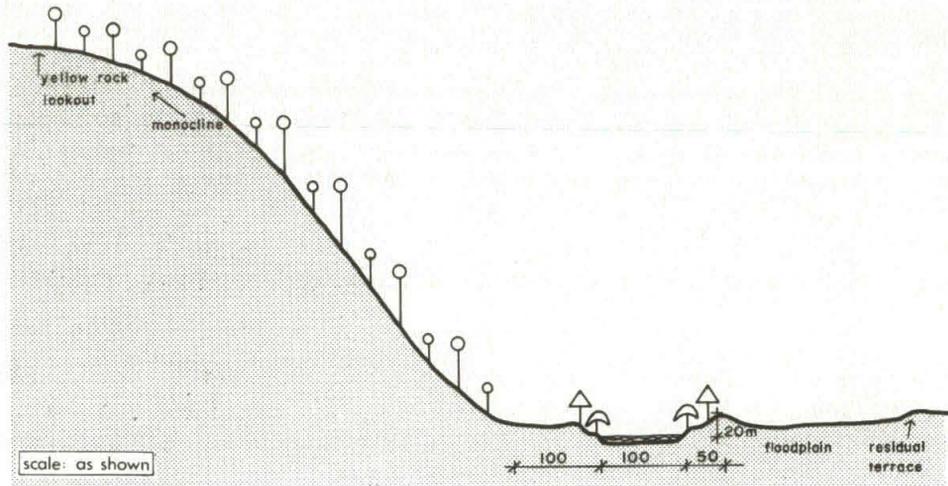


Penrith Weir



Mill Dam Falls

is likely to be terminated on the completion of restoration with the area then being available for public recreation. Extraction at Yarramundi Bar is likely to be completed in 1984.



The river through the islands changes from being broad, shallow and slow to a narrow and fast flowing stream. Through the Yarramundi Point Bar the channel is very narrow and contained by a continuous line of overhanging willows, a superb visual sequence by canoe. Channel realignment proposals for these islands would destroy these scenic and recreational attributes.

Conservation

The main conservation objective in this unit is the protection of its major scenic asset, the Lapstone monocline, by consolidation into public ownership.

The other conservation attributes of the unit are:

- (i) **Freshwater wetlands.** The floodplain below Penrith contains ephemeral wetlands which, apart from their natural values, (particularly as bird habitats), contribute to the scenery. As many have been filled or drained for agricultural or urban purposes most of those remaining require environmental protection measures.

The alluvial units (F,G) contain a number of ox-bow lakes, old river terraces, which are remnants of former river courses. These areas have been substantially modified by agricultural use and those in the Upper Castlereagh floodplain are likely to be obliterated by sand and gravel mining in the Penrith Lakes Area.

The most extensive wetland above the tidal limit, Yarramundi Lagoon, is of considerable scenic importance. Its nature conservation value requires a more comprehensive assessment.

- (ii) **High level deposits (Tertiary floodplain).** The Tertiary gravels and clays of the Castlereagh State Forest and Londonderry are extensively affected by extractive leases. Part of the Castlereagh State Forest is a proposed nature reserve. This is currently subject to objections from the Forestry Commission. It would be desirable that a reservation at Londonderry be linked to the Agnes Banks proposal, preserving the ecotone between the clay and sand deposits.
- (iii) **Aeolian sands at Agnes Banks.** This area is of special interest because of the unusual occurrence of coastal vegetation associations some 60 kilometres inland. (Banksia serrata/serratifolia). The deposits are presumed to have been laid down by the ancestral Grose River and blown up into dune formation at a later time. The deposits have since been stabilised by vegetation. However, as the deposits are valuable silica sands of glass-making quality the area is under threat. Only three of the six identified communities on the sands are protected in the current nature reserve proposal. Some attempt should therefore be made to extend protection over remnant Banksia serrata communities on freehold land not included in the modified proposal.

Recreation

The river in this unit has been extensively modified by extraction. Rehabilitation and conversion to recreation use are desirable.

The Nepean below Regentville is a broader waterbody with a steeper gradient than above Wallacia. The extensive sand and gravel shoals below Penrith and diverse scenic qualities suggest the possibility of intensive recreation use with adequate management. This phase of the river has the most potential for immediate gains in public access and the best attributes for water-based recreation. The creation of a major regional open space at Yarramundi is the most immediate opportunity for improved provision for recreational use.

The Penrith Lakes Scheme adjacent to the river in this unit is seen as providing a major resource for water-based recreation for Western Sydney.

As the scheme's recreational facilities will become available progressively, there will be a shortage of outlets for water-based recreation in the shorter term if other options are not pursued.

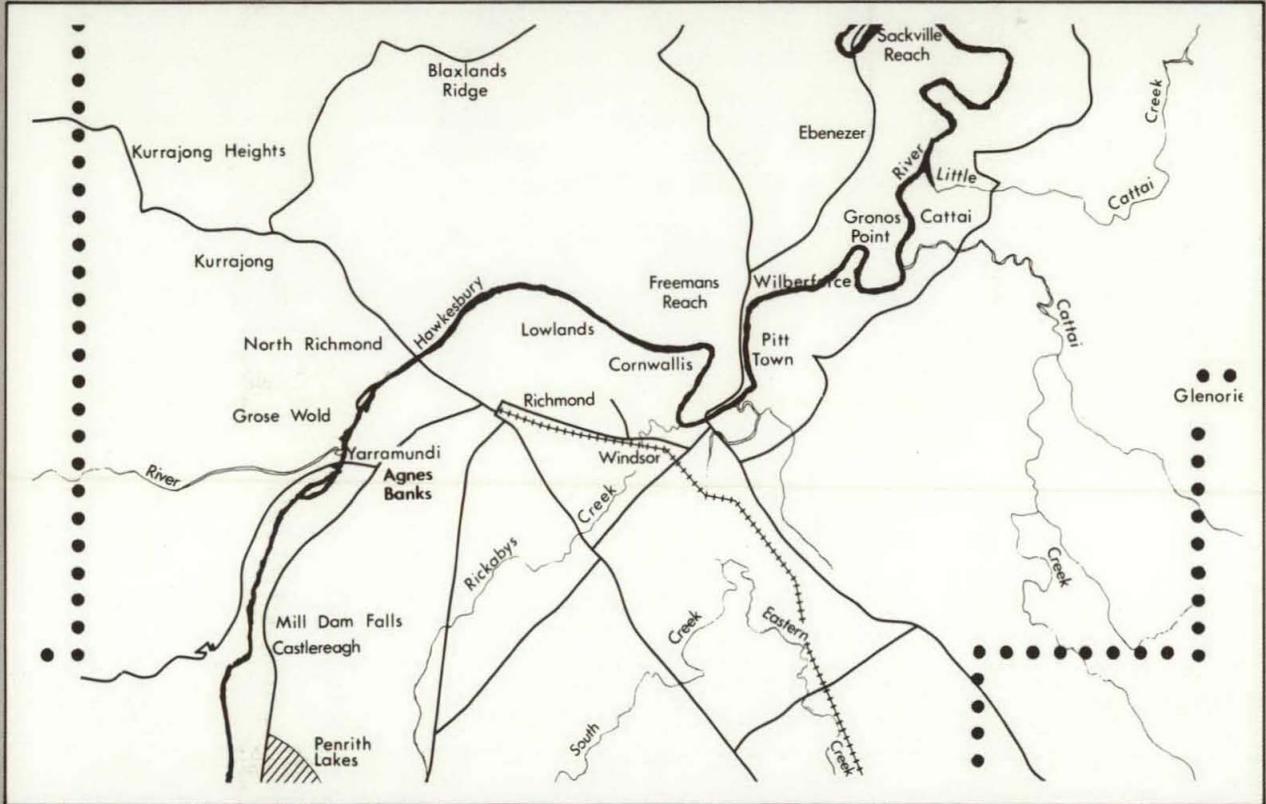
The Department of Environment and Planning is currently preparing a Regional Environmental Study to assess the feasibility of the scheme.

Conclusions

1. The considerable potential of the City of Penrith's waterfront could best be realised by development of a riverfront promenade, with both hard and soft areas giving improved access for swimmers and boating to adjoining resort facilities, hotels, and medium density housing.
2. This unit would gain immeasurably from the cessation of extraction and the removal of evidence of past operations at Mill Dam Falls and the Yarramundi Bar and from the development of these areas for open space.
3. The western bank (the monocline) has the potential to be restored to its natural condition while enabling limited access for bushwalking, camping, etc.
4. Public ownership of the monocline and the western foreshores from Emu Plains to Yarramundi should be consolidated whenever the opportunity presents itself.
5. The eastern shore, including the sand/gravel islands, is suitable for intensive water-based recreation with more formally designed landscape treatment.
6. It is desirable that scenic protection controls be applied to the top of the monocline in the west and the Cranebrook to Castlereagh ridge line in the east and then along the Castlereagh Road to Agnes Banks.
7. Environmental protection controls over a 200 metres wide strip, expanding up to 500 metres through the islands, allowing for a 30 metre buffer from the top of the bank on both sides would be desirable to protect the immediate river environment.

Unit G

Yarramundi to Cattai

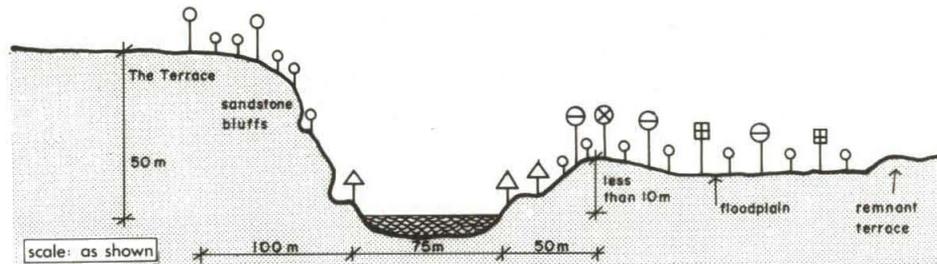


UNIT G: Yarramundi to Cattai

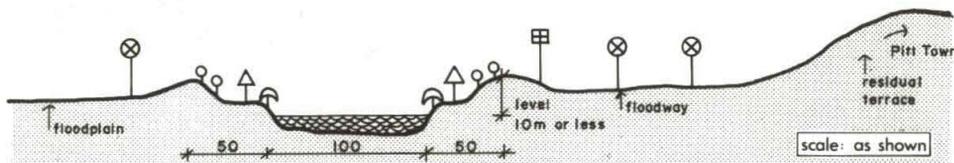
From Yarramundi the river establishes a very low gradient as it becomes tidal and dissipates its energy by meandering in a wide depositional plain, laying down the extensive sand and gravel deposits of the Richmond Lowlands. The steeply undulating hills of the Grose Wold rise from the western bank between the Grose confluence and Richmond Bridge with important features such as the St. John of God Hospital on Richmond Hill and Belmont Hill effectively screening the residential areas of North Richmond. The eastern bank is a high levee backed by the serried ranks of citrus orchards.

Below Richmond Bridge the sandstone reappears in a low terrace about 20 metres high on the western bank with an horticultural landscape opposite on the floodplain. Residential development along The Terrace, is screened by native vegetation. Below The Terrace the river is contained in a high leved channel which cuts out distant views except to occasional vertical features such as St. Matthew's Tower at Windsor.

The extensive floodplain contains many water bodies, ox-bow lakes, and terraces which are remnants of earlier channels and provide relief in the open horticultural landscape. The textures, colours and patterns of market gardens and citrus orchards are also important visual elements.



The large-scale open landscape is accented by the Macquarie Towns, especially Richmond and Windsor, located on the higher level deposits of a former flood plain, with a backdrop to the west of the retreating Blue Mountains escarpment and to the north-east, the Hornsby Plateau.



In contrast to the other settlements in the valley, which are set back from the river on the broad plinth of their floodplains, Windsor presents a dramatic, urban face to the waterfront. Nevertheless its waterfront is vegetated with overgrown willows and a scrubby and untidy understorey of exotics. A more public and formal interface would be desirable with appropriate waterfront activities and development for recreation and tourist use.



Hawkesbury River at Windsor



Hawkesbury River near Windsor

In recognition of this unit as one of Australia's most Europeanised landscapes, landscaping measures should be both selective and formal in character. The use of deciduous and exotic plant material would often be appropriate.

Scenic protection measures should cover the viewsheds between the towns, including McGraths Hill, which is the important entry point into this very special environment. McGraths Hill could become the reception point for visitors to the Macquarie Towns and the Upper Hawkesbury.

Conservation

The main objective in this unit is the conservation of the identity of the Macquarie Towns in their nineteenth century horticultural landscape setting. Flood liability has constrained the growth of the towns and subdivision of their rural surroundings. Further urban expansion in the area will tend to erode this quality unless measures are implemented to consolidate growth within the towns and to maintain agricultural use of the rural surroundings.

There is an urgent need for research into the evolution of the cultural landscape, including the role of the river, as a preliminary to conservation planning.

The depositional plain between the Macquarie Towns contains extensive wetland areas, including Bushells, Bakers and Pitt Town Lagoons, which contribute to this major heritage landscape and have demonstrated nature conservation value as drought refuges.

Longneck Lagoon at Cattai is a wildlife refuge with an adjoining Field Studies Centre set up by the Gould League. As the catchment to the Lagoon is inadequately protected proposals are mooted to extend the refuge to take in the adjoining shale and sandstone ridges. A change of status to a nature reserve is under consideration. Discussions are in progress between the Department of Lands and the National Parks and Wildlife Service. Its accessibility, small size and use as an educational centre will place it under increasing pressure and supplementary and more protected refuges are desirable.

Recreation

The Hawkesbury between Richmond and Windsor, which is in a broad depositional plain with high alluvial banks, is less attractive for recreation except where sand-shoals and beaches occur. A local open space would be desirable at Gorricks Lane to improve public access to the extensive sandbeach on Freemans Reach. A similar public beachfront on Argyle Reach just above Windsor is immensely popular. A similar local facility is proposed at Cordners Corner on the Windsor side.

Below Windsor the Hawkesbury becomes fully navigable for general boating and it is feasible to consider the return of ferry services from Brooklyn. The use of the river below Windsor for

power-boating and water-skiing has created conflicts with other recreationalists and has limited the potential of the reaches downstream to Sackville. Here frequent sand-shoals, beaches and prime scenic areas are ideal for intensive water-based recreation. The Inter-Departmental Committee Report (1977) on the Hawkesbury has recommended the phasing out of water-skiing above Sackville in order to release these reaches for passive recreation.

The private sector has played the dominant role in recreation development below Windsor and should continue to do so. However, some public initiatives in this area are desirable in order to balance provision.

The Inter-Departmental Committee Report (1977) suggests that improved facilities and public foreshores are desirable at the Pitt Town launching ramp local open space area.

The main public facility in the Cattai Valley is Mitchell Park, a Crown Reserve on Cattai Creek.

Caddie Park is on the Cattai Creek/Hawkesbury confluence. Formerly a private recreation ground and caravan park, it has been identified by this study for its value for regional open space and has been acquired by the State Government. It is managed by the National Parks and Wildlife Service as a State recreation area. This was seen to be the best choice for public investment in the area with a longer-term view to achieving an open space corridor up the Cattai Valley to Cattai Ridge Road. This would create a regional open space some 10 kilometres long, ideal for State recreation area status and for intensive recreational use of the valley floor. It would have similar capacities to the proposed Yarramundi recreation area (5,000 persons/day) but it has extensive natural resources suitable for trails, nature study, and youth and school camping groups. There have been several attempts to create a Cattai Valley regional park and the acquisition of Caddie Park on the confluence will bring this much closer.

Immediately to the north of the Cattai is the Little Cattai Valley which is one of the most important wetland areas in the Hawkesbury/Nepean Valley. An extension of the proposed Maroota National Park through the Little Cattai Valley to include the Broadwater Swamp would be desirable in the longer term. A Cattai Valley regional park could serve as a buffer zone to the national park.

Conclusions

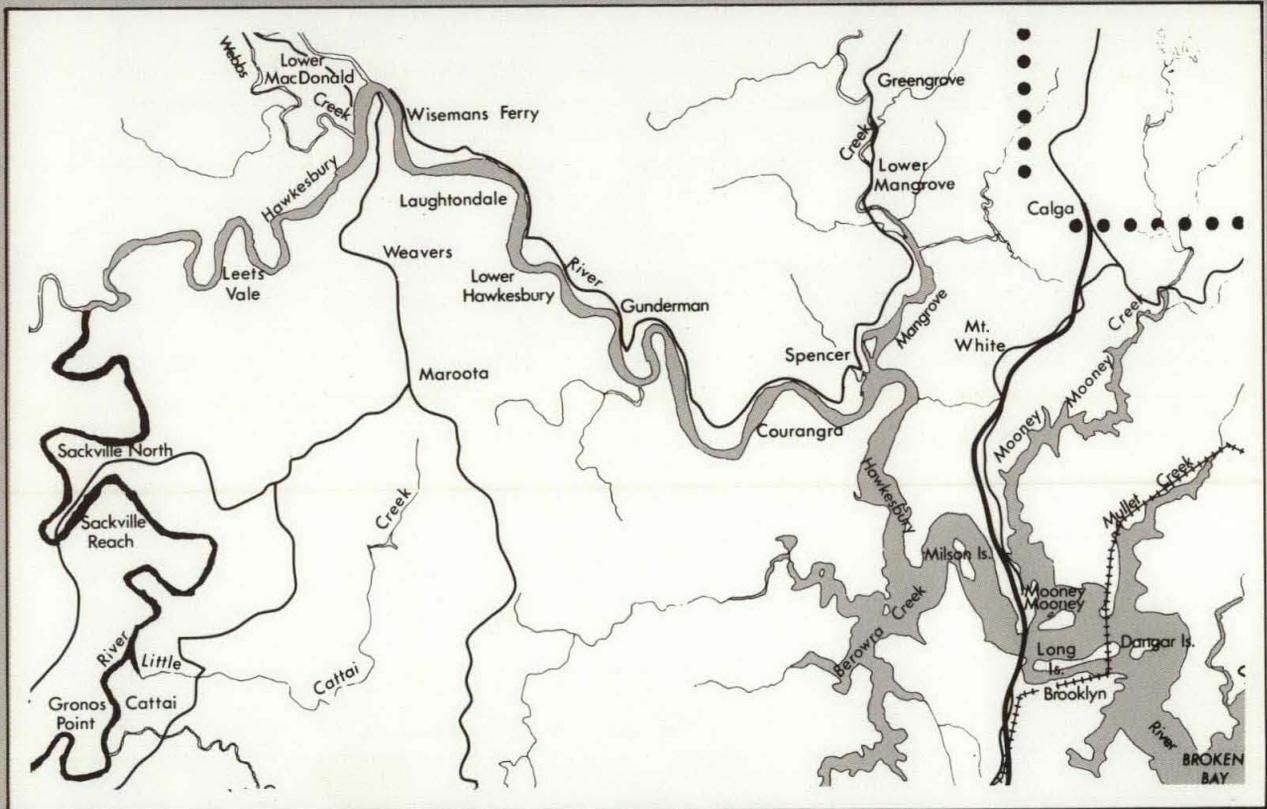
1. This unit is the most important in the valley from the point of view of man-made heritage, and landscaping should respect the strong formal discipline of a landscape established during the early nineteenth century.
2. In many respects the unit is comparable to Unit B with similar planning responses required. Development pressures

for urbanisation, extraction, and recreation are likely to be more intense and the water-quality issue of critical importance.

3. The identity of the Macquarie Towns in their rural setting should be maintained.
4. Any new development would be very intrusive and the most appropriate form would be infilling, which would maintain the existing townscapes.
5. Public recreational development in the Cattai Valley is the best option for early investment and public benefit in the Hawkesbury/Nepean Valley.
6. Environmental protection measures over a strip 250 metres wide would be desirable to protect the river environment.
7. The viewsheds between the towns, including McGraths Hill should be protected by scenic protection measures.
8. The water bodies in this unit, including Yarramundi, Bakers, Bushells and Pitt Town Lagoons, play a significant role in the area's visual quality, quite apart from their value as wetlands. Environmental protection controls would be desirable to protect these environments.

Unit H

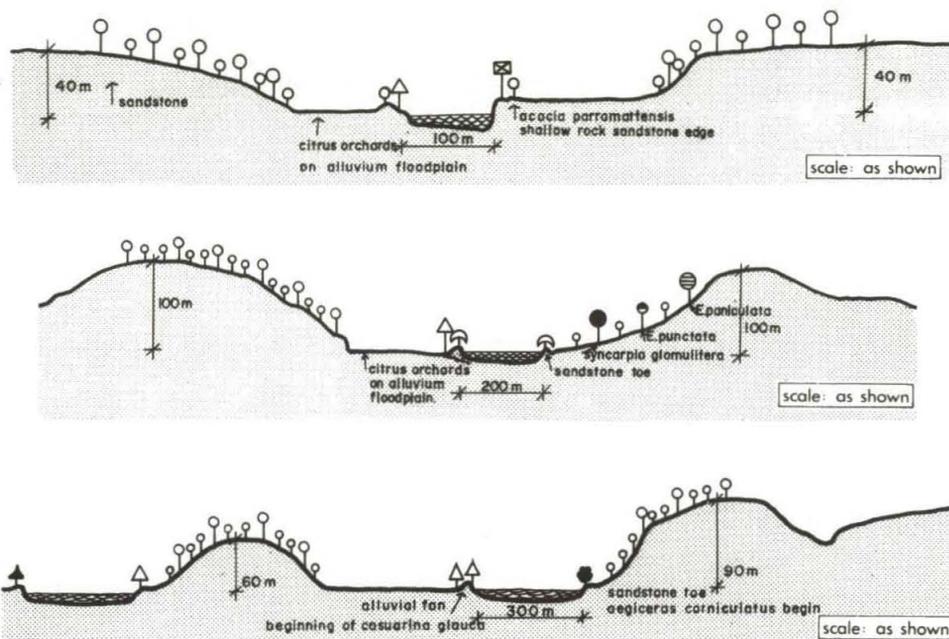
Cattai to Broken Bay



UNIT H: Cattai to Broken Bay

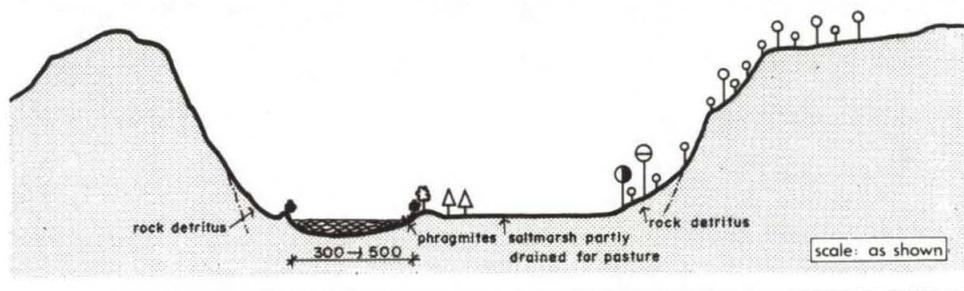
The river enters its final phase at Cattai. It is incised into the Hawkesbury/Hornsby Plateau as a drowned river valley with entrenched meanders into the increasingly elevated sandstone cliffs, which rise 250 metres above the water as the river nears Broken Bay. Most of the sandstone strata is in Crown ownership or national parks and is relatively undisturbed. The escarpments are largely unspoiled by evidence of human intervention. The cultivated and developed silt troughs and alluvial fans which form the remnant flood plain on the valley floor give a contrasting scale to the huge landforms. This is the key to the landscape quality of the Lower Hawkesbury.

The valley progressively increases in both width and height downstream. The human presence diminishes as the river flows between sandstone bluffs rising sheerly from the water's edge. Built-form gives both detailed visual interest and scale to the grandiose but rather uniform landforms which are best appreciated in a fast moving craft. This pattern should be encouraged by development of the existing settlements at Lower Portland, Wisemans Ferry, Spencer and Brooklyn as urban/resort features, while the impacts of development on the escarpments and plateaux should be minimised and, where possible, discouraged.

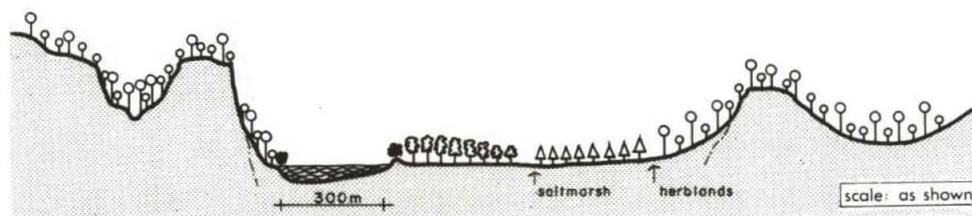


Above Wisemans Ferry the remaining undisturbed floodplain areas, which are usually wetlands, citrus orchards, or poplar plantations, are a welcome visual relief from the frequent commercial waterfronts of caravan parks and resorts. These caravan parks have considerable spare capacity and, as the capacity of the river for water-skiing during peak use has been reached, new developments would be hard to justify, especially on the Baulkham Hills side where they would detract from the visual amenity. Consolidation of these uses needs to be encouraged.

Ephemeral elements such as boating contribute much to the visual scene of the Lower Hawkesbury. Development of leisure boating and maritime uses is seriously inhibited by lack of moorings and public landing rights. Landings, wharfs, jetties, marinas and small-scale maritime industry would contribute to the recreational environment, to employment opportunity, and to the visual scene. These should be encouraged in the village and resort zones.



The other major landscape elements in the unit are the extensive marine wetlands and mangrove communities which occur below Wisemans Ferry. The strong horizontal bands of the mangroves and their yellow/green foliage contrast markedly with grey/greens of the sandstone vegetation and the vertical massing of the rock faces. Where mangroves have been cleared to facilitate views and boat access these long horizontals have been broken, causing considerable visual disturbance. As the clearance of mangroves is also biologically unsound no further disturbance of these areas should be permitted. Water access through marine wetlands and the inter-tidal zone, where it can be justified, would be better achieved by means of jetty structures and pontoons rather than by fill and ramps.



Conservation

This report suggests that there is a need for research into the evolution of the cultural landscape of the Macquarie Towns. This work should also examine the role of river transport in the settlement of the Lower Hawkesbury, and the development of the ship building industry and the granary mill sites on the tributaries. This work would assist in conservation planning and in the promotion of tourism in Units G and H.

It is more difficult to describe and rank the conservation attributes of the Lower Hawkesbury as the unit is extensive and has a landscape progressing from a small-scale valley at Cattai where incision begins, to the large-scale drowned river valley closer to Broken Bay.



One Tree Reach



Laughtondale

Scenically this unit is more diverse and dramatic (in scale) than the Fairlight Gorge. Although it is a modified natural landscape, its man-made features add rather than detract. In terms of popular acceptance of the valley's scenery this unit is the best known and most valued.

In the upper end of the unit from Cattai to Lower Portland rural elements predominate, including important buildings and sites of the Colonial period. This area was a proposed Scenic Preserve in the National Trust's publication, *Sydney 2000*, (1975). From Lower Portland downstream the natural and sandstone elements begin to dominate the rural landscape of the remnant floodplain.

This unit contains some of the least disturbed natural areas in the region, predominantly in the Dharug National Park, Muogamarra Nature Reserve and the Marra Marra National Park, as well as the highly valued but more disturbed Ku-ring-gai Chase and Brisbane Waters National Parks. The waterway is a major natural dividing line and this is reflected in flora and fauna changes between Dharug and Marra Marra. The deeply dissected topography also demarcates Aboriginal tribal territories and there are striking differences between Marra Marra and Dharug archaeological sites.

Marra Marra contains volcanic breccia necks of value for aggregate and shale lenses for brick-making. A case may be made in the future for limited excision from the park to allow aggregate extraction. As there is a shortage of cream burning shale/clays in the Sydney Region the shale lenses in the Hawkesbury sandstone are highly valued. In the longer term new deposits may be discovered in the Bringelly shales. Exploitation of the lenses in Maroota, Marra Marra and Duffys Forest would compromise nature conservation values and should be avoided. Mining the lenses is a soft option compared with developing resources closer to built-up areas.

Where development on the escarpment is unavoidable, building lines should minimise visibility from the valley, floor with a suggested minimum building line setback of 30 metres. No clearing should be permitted within this strip and restoration as necessary should be carried out with indigenous plant material. It is suggested that building materials should be of recessive tones and colours, with a low degree of reflection.

High tension lines have major visual impacts on the Lower Hawkesbury due to the prominent location of towers on the sandstone tops. These impacts could be minimised by the location of towers below the escarpment line on side valleys rather than on the headlands. The use of pole forms rather than skeletal towers would also improve these elements.

The visual environment of the resort areas, particularly above Wisemans Ferry could be improved by screening of views from the waterfront and from the roadside, with dense planting. In future, it is suggested that minimum setbacks for development, including caravan sites should be 30 metres from High Water Mark. Only legitimate foreshore development such as launching

ramps and jetties should be permissible within this zone. All development within the foreshore zone, including the removal of flora such as Phragmites or mangrove stands should be strictly controlled.

Freshwater Wetlands

As the Hawkesbury re-enters the sandstone at Cattai there are extensive wetlands on alluvial fans and sidecreeks ranging from the extensive Broadwater Swamp on Little Cattai Creek, to the estuarine wetlands below Wisemans Ferry. The SPCC has mapped and briefly described the significant wetlands of the valley.

From current knowledge the major resource from a landscape/scenic/recreation/nature study and aquatic birdlife point of view is the Broadwater Swamp on the Little Cattai. High priority should be given to protection of this area because of its proximity to populated centres, and in the longer term it could be included as a westward extension of the proposed Maroota National Park. Sand mining has occurred in the Upper Little Cattai Valley, resulting in some despoliation of an otherwise pristine environment.

More active management of Crown lands adjoining urban areas is desirable to permit legitimate recreation use while preventing the removal of extractive and plant materials, and the dumping of domestic and industrial waste.

Estuarine Wetlands

The estuarine wetlands can be protected by the use of environmental protection measures, reservation under the provisions of the National Parks & Wildlife Act, 1974, or partly protected by the declaration of Marine Reserves by State Fisheries. A Marine Reserve protects only mangroves and seagrasses. The best example of an estuarine wetland on the Central Coast is on Marra Marra Creek.

Recreation

Below Sackville to Wisemans Ferry power boating and water skiing are the dominant activities on the waterway. The private sector services this demand adequately. As capacities have been reached for summer weekend use above Wisemans Ferry, growing demand is likely to extend water skiing further along the river.

The escalation in fuel prices has led to a relative decline in power boating, suggesting a re-evaluation of the Inter-Departmental Committee's (1977) findings which focused on management of power boating.

The IDC recommended the phasing out of water-skiing above Sackville and, in compensation, the encouragement of skiing below Wisemans Ferry where the river is wider and better able to accommodate multiple-use without conflict.

The scenic value of these reaches, particularly along River Road in Baulkham Hills, suggests that public initiatives to improve roadside facilities for stopping, viewing and picnicking are desirable.

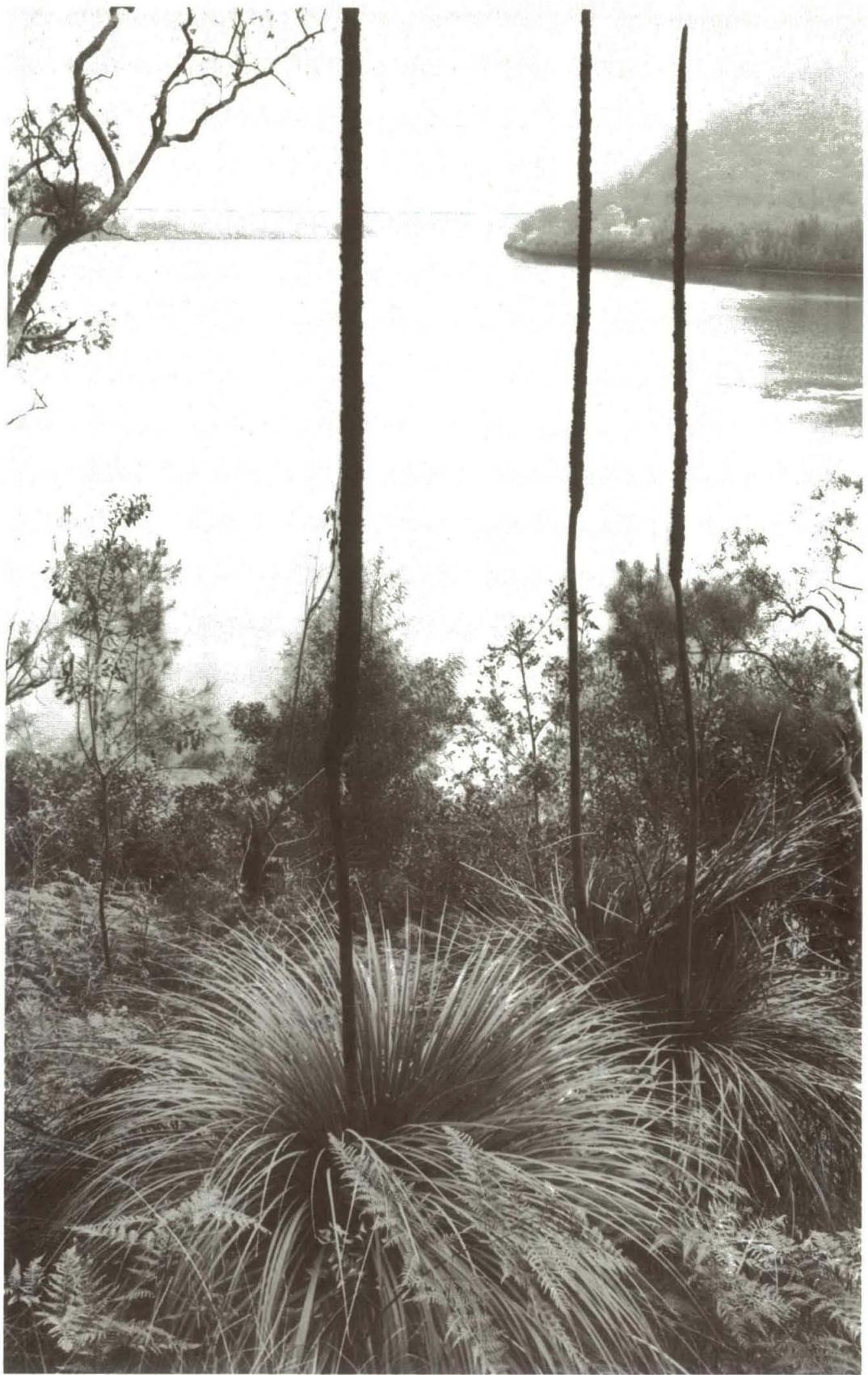
Improved public facilities for launching and landing boats are desirable at Lower Portland and Wisemans Ferry. The Inter-Departmental Committee Report (1977) recommends the acquisition of the Water Ski Association Grounds above Wisemans Ferry as a public launching ramp and recreation grounds. As most of the Ski Parks have excess capacity for growth, no additional caravan park or commercial recreation uses should be permitted between Sackville and Wisemans Ferry and consolidation should be encouraged.

Growth implies increased use of the parks by non-skiers, passive recreationists and holiday-makers, extending use from predominantly summer and weekends to weekdays and throughout the year. Buoyed lines could be set up to delineate foreshore swimming zones and to minimise conflict with skiers. It would be desirable to carry out a landscape study of the foreshores to delineate active and passive areas, intensive and quiet zones with complementary landscaping. At present unsightly ad hoc measures are used to reduce bank erosion. Future consents should be tied to improved landscaping provisions and the creation of a public foreshore zone a minimum of 30 metres from High Water Mark.

Resort zones should be established where caravan parks are permissible. Commercial recreation facilities such as hotels, motels, ski lodges and holiday units should be permissible only in the village zones at Lower Portland and Wisemans Ferry. Caravan parks and other commercial uses would then be prohibited in the other rural zones. Some of the smaller and sub-standard caravan parks should be discouraged by non-conforming status.

Access below Laughtondale is discouraged by the dead-end, unmade Singleton Rd. With major conservation resources on both sides of the river and scenic values of the highest order, development on the foreshores should be extremely restricted and discreet. In accordance with these objectives Gosford has established a small number of resort zones where recreational activities and small subdivisions already occur, and will encourage other development only in villages such as Spencer. Apart from the Laughtondale proposal no intensive recreational uses such as caravan parks should be permitted on the southern shore in Hornsby but lower key recreational uses such as youth camps, recreational grounds and camping areas should be permissible.

Singleton Road should be promoted as a low speed scenic route with roadside laybys for stopping, fishing and picnicking. The IDC report suggested the development of a trail from Singleton Road to Gentlemans Halt along the alignment of a convict road with primitive camping facilities at the Halt.



One Tree Reach

In the long term it would be desirable for all the remnant foreshores below Laughtondale still in private ownership to be acquired for inclusion in Marra Marra National Park. Some of these remnants may be suitable for intensive recreation and could be managed as part of the Laughtondale proposal. Thus the control and entry point to the Park and proposed State Recreation Area would be at Laughtondale.

The Inter-Departmental Committee Report (1977) proposes a major recreational development at Laughtondale to service social skiing upstream, and professional skiing and ski-racing downstream. This development was proposed as a trade-off to regulate power boating and to achieve the release of the upper Hawkesbury above Sackville from water-skiing. It will segregate social skiers from the professionals, eliminating considerable conflict currently found at Wisemans Ferry. The Laughtondale proposal will also cater for passive users and campers as the river is wide enough in this location for multiple use. The acquisition of Laughtondale and the rezoning of skiing areas will produce large benefits from permitting more intensive use for passive recreation above Sackville. Therefore, its acquisition should be seen as a major priority.

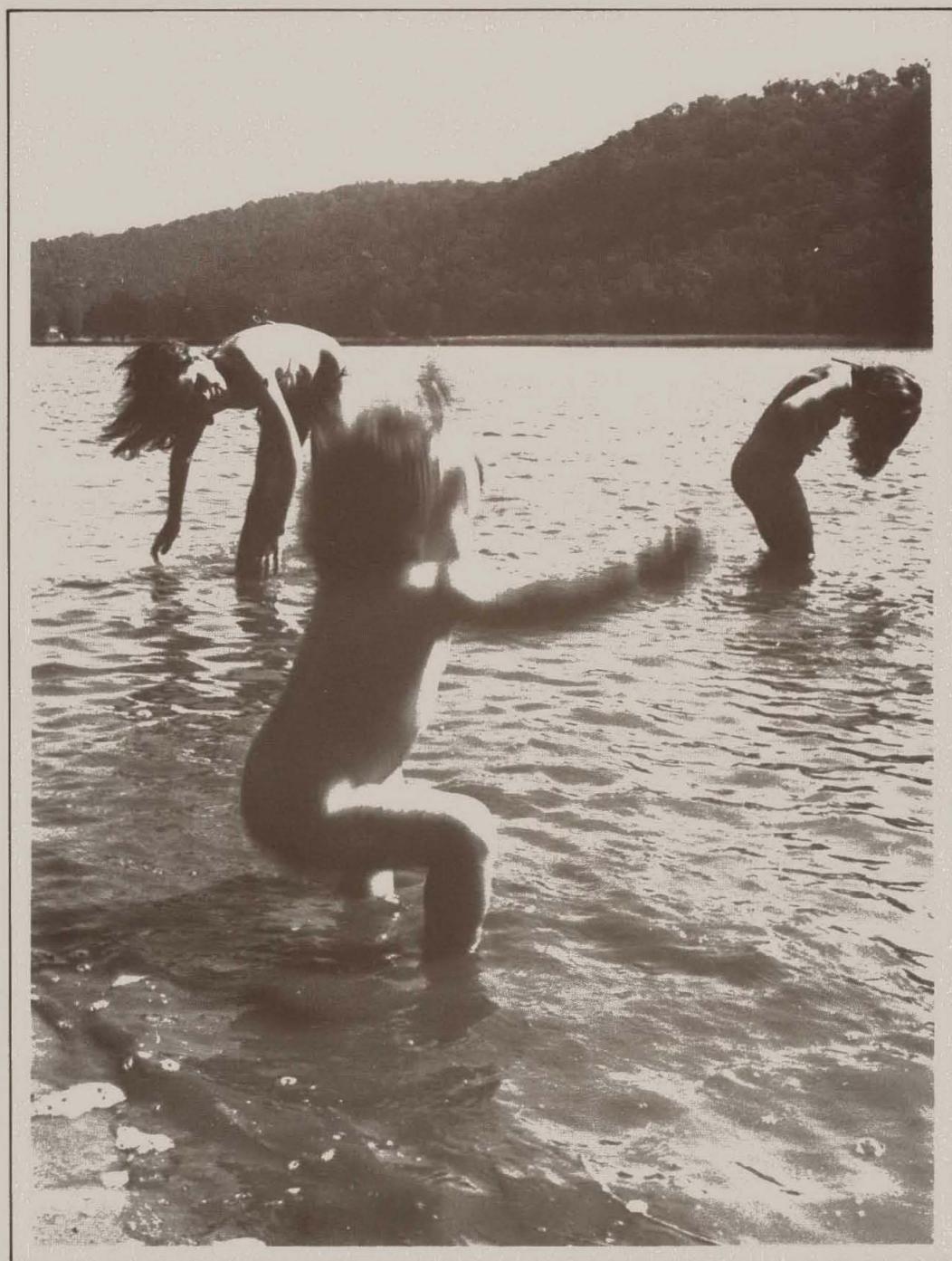
Brooklyn - An examination of the problems of Brooklyn was beyond the scope of this study and there is little to add to the studies for the improvement of the foreshores of Brooklyn for recreation and boating done by the Public Works Department and the Shire of Hornsby. It is desirable to encourage improved facilities for boating and to build up the resort character of Brooklyn, provided that the viable mangrove communities are not affected.

Conclusions

1. The Lower Hawkesbury is visually the most spectacular unit in the valley. The sandstone areas should be conserved for their value as natural areas and for their scenic qualities. Consolidation of development in the existing resort areas and villages on the floodplain would be visually acceptable.
2. Development adjoining wetlands and mangrove communities should be minimised and it would be desirable to introduce environmental protection measures. The estuarine wetlands could be considered for partial protection by the declaration of Marine Reserves by State Fisheries.
3. A minimum foreshore non-disturbance line could be established 30 metres back from High Water Mark and environmental protection controls applied.
4. Scenic protection controls covering the whole visual catchment up to the adjoining ridge lines are desirable. Developments outside the village/resort zones should be subject to detailed and restrictive aesthetic controls and landscaping provisions so as to minimise their visual impacts.

5. The imposition of the 8 knot limit above Sackville will release some 20 kilometres of the Hawkesbury for passive recreation and general boating, permitting more intensive use of its foreshores. Both the public and private sectors have a role to play in its development.
6. Below Sackville a consolidation and upgrading of existing private recreational uses is desirable with development encouraged in the villages of Lower Portland, Wisemans Ferry, Spencer and Brooklyn except for the proposed development at Laughtondale.

Part 2 Recreation and Regional Open Space



Bathurst Reach above Wisemans Ferry

RECREATION AND REGIONAL OPEN SPACE

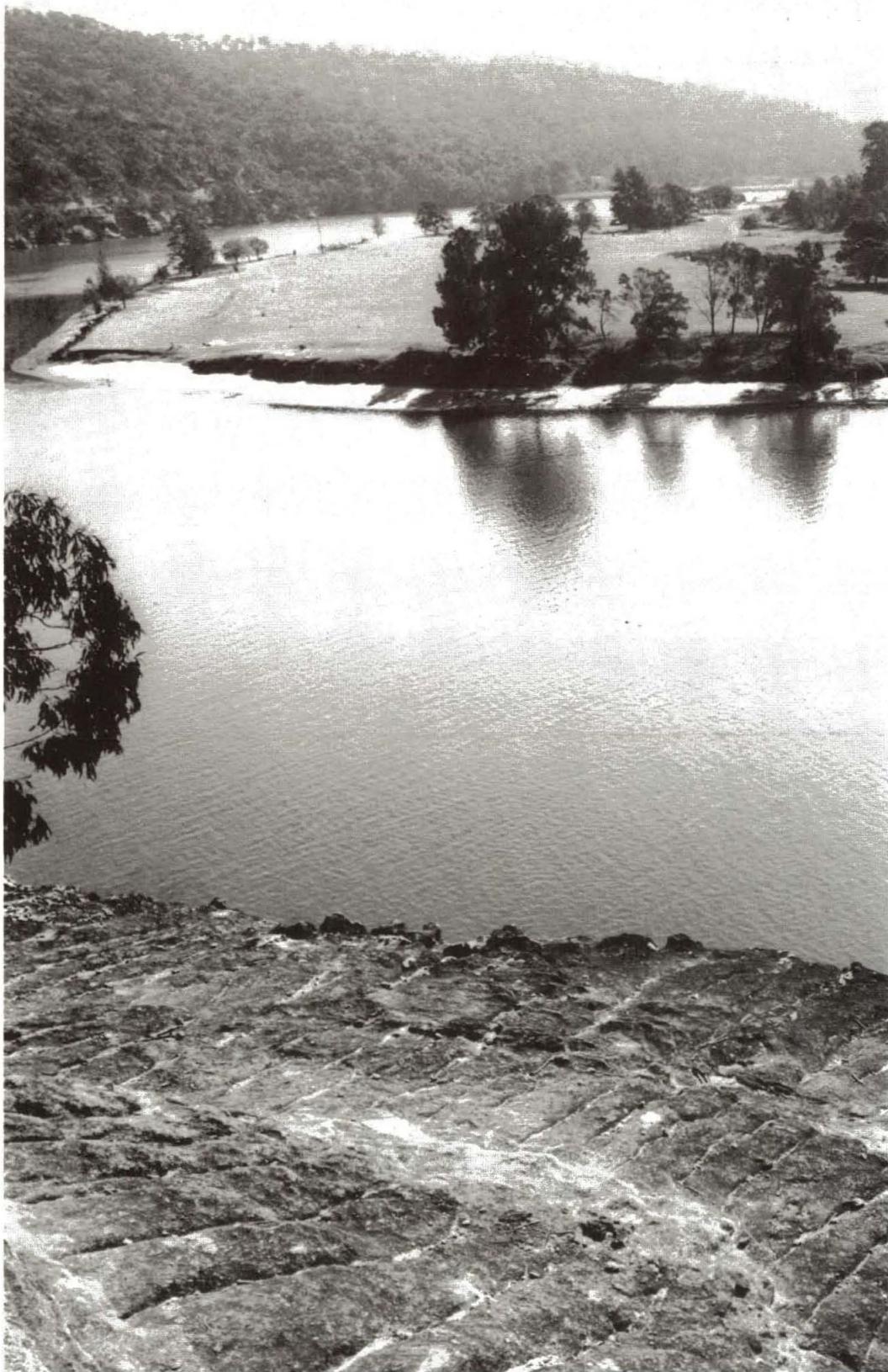
Objectives

The three main objectives of recreation planning in the valley are as follows.

- (1) Public access to the waterway should be improved by a selective program of acquisition for regional open space to balance distribution and provision equitably. Provision of open space should complement the role of the private sector in recreation development while minimising alienation of viable farmlands or the compromising of conservation objectives.
- (2) 'The recreational facilities and attractions of the Hawkesbury/Nepean Rivers should be fully realised. To this end the river and its foreshores should form a regional open space system, appropriately landscaped, and in suitable areas, offering opportunities for public recreational activities. It is not envisaged however that all existing agricultural and other rural uses on the foreshores will be replaced by public recreational uses'. N.S.W. State Planning Authority (1968).
- (3) New outlets should be sought for resource-based and passive recreation away from the national parks which have come under intense pressure in their dual use for both recreation and nature conservation. As much of the valley's prime recreational areas border national parks and prime conservation areas, regional parks can serve as intermediate use recreation areas, and as buffer zones.

Background

Historical sources indicate an extensive use of the valley's recreation resources at the turn of the century with a surprising emphasis on historic qualities, such as the old buildings at Windsor and Penrith and the historic homesteads at Campbelltown. Mass tourism began with the railway to Penrith in 1863, Richmond and Windsor in 1864, Camden in 1882, and Brooklyn in 1887. Anthony Trollope was engaged by the N.S.W. Government in 1874 to advertise the 'Rhine of Australia'. In 1900 there were 390 tourist beds in Richmond, Windsor and Brooklyn as most excursions were overnight if not of several days duration. Rail/river steamer excursions between Brooklyn and Windsor became common after 1873. Boating trips from Camden to Penrith were promoted and trips up the Fairlight Gorge to Nortons Basin from Penrith were common. To quote Bladen from the Tourist Bureau Handbook, 1909, on the Hawkesbury there were 'unlimited facilities and attractions for the tourist, whether in search of health, sport, or beautiful scenery'.



Leets Vale

This part of the report discusses two complementary proposals to achieve the objectives stated above:

- (1) a proposed regional open space system as suggested in the Sydney Region Outline Plan and
- (2) proposed development standards to be applied along the river by all relevant authorities.

Regional Open Space Systems

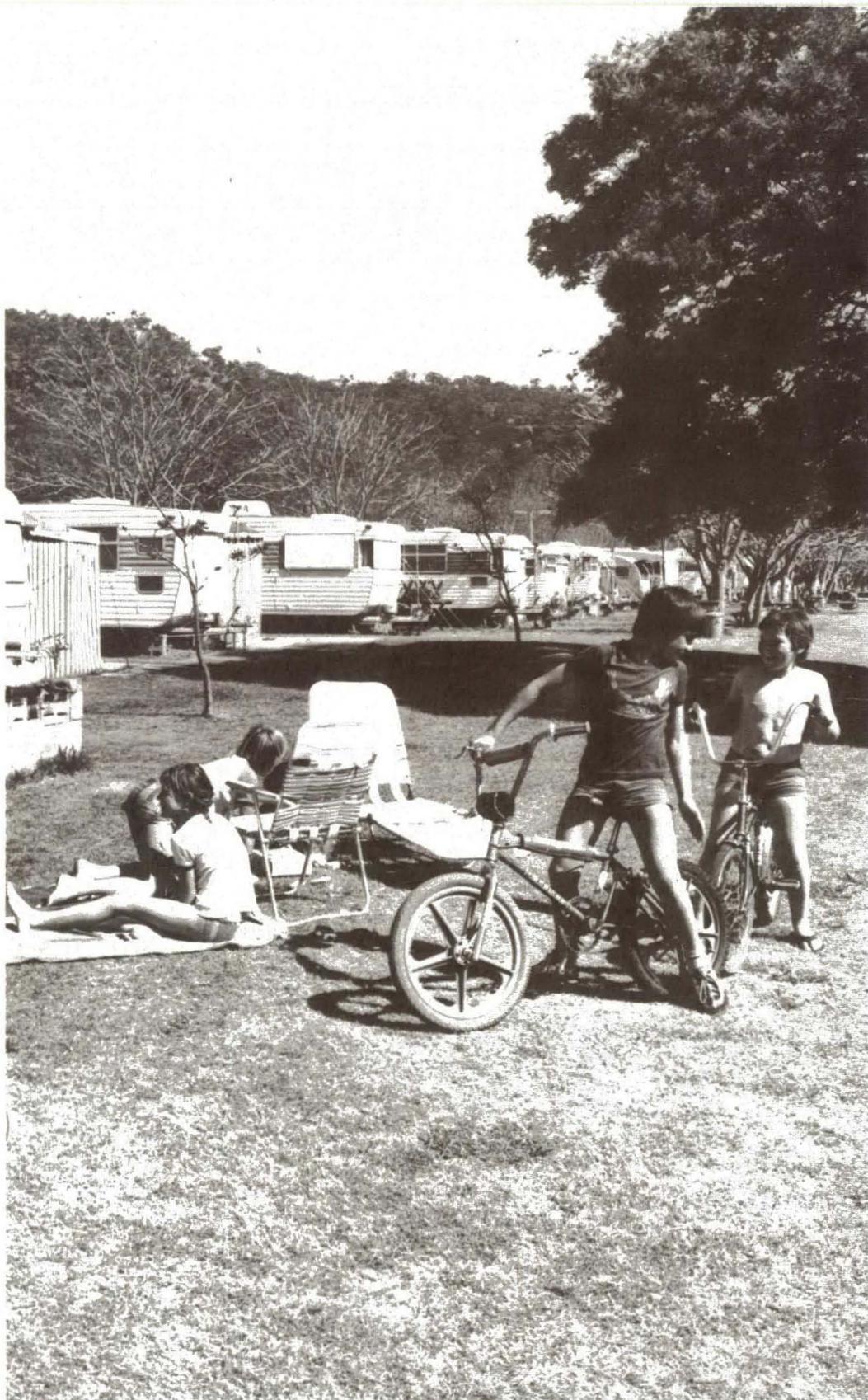
The Sydney Region Outline Plan (SPA 1968) intention was shown by means of a green swathe on the Outline Plan Map of 'proposed open space'. The feasibility and/or desirability of achieving some sort of lineal open space in part or whole, on one or other of the foreshores has been examined together with other open space strategies for the valley.

Three configurations of open space have been considered in the examination of the Sydney Region Outline Plan concept for the valley:

- (a) a continuous public foreshore on one or other or both banks so as to achieve continuous public access, while allowing other land uses including private recreation uses, to occur behind the foreshore strip;
- (b) a distribution of open spaces located at key points according to their attributes for recreation and accessibility/demand criteria, complementing the role of private recreation uses. The waterway itself would provide some linkage along the system by improved access for small boating and canoes on the Nepean and for general boating on the Hawkesbury; and
- (c) a combination of (a) and (b) where a network of open spaces are connected by public foreshores on one or other of the banks, facilitating both continuous land-based recreation and access for water-based recreation. This would permit trails for walking, nature study and camping, as well as possible bicycle and horse trails.

Establishing some sort of lineal open space system in the valley in part or in its entirety would not only provide alternative outlets to the national parks for resource-based recreation but it would permit a much fuller, more diverse and natural experience of the valley while enhancing its conservation attributes.

The river where it passes through sandstone gorges is in a primarily natural condition, although the lands above (such as the farmland between Douglas Park and Menangle) are often cleared and cultivated. Such gorge areas, although only a few hundred metres wide, manage to sustain a rich vegetational diversity and



Caravan Park, Bathurst Reach

serve as important wildlife habitats, as well as providing a natural scenic experience very close to population centres. They should be given priority in any attempt to achieve a lineal open space in the valley by consolidating public lands.

Overseas experience suggests that lineal open space systems are most successful in wilder and more natural settings such as the Appalachian trail in the United States or the Pennine Way in the United Kingdom where walking/camping trips may be of several days or a week's duration. Metropolitan parkways tend to be used on a day-trip/weekend basis, by car, and to be tied to a point location generating a loop trip from the access point. A loop trail system was proposed in the landscape study of Bents Basin.

The limited navigability of the Hawkesbury/Nepean system has generated a similar pattern of use and has limited people's perception and experience of the valley's diverse scenic and recreational qualities.

The creation of a lineal park would greatly enhance the recreational experience. However, current priorities suggest the need to concentrate on improved public access in a few key locations, as set out below.

Wallacia to Richmond as a Future Open Space Corridor (Units E and F)

The best opportunity for a lineal park in the next decade would be along the river from Wallacia down to Richmond. There are already substantial public ownerships in this area and priorities suggest that future acquisitions in this area are desirable. Acquisition of the foreshores to the Nepean in Wollondilly below Blaxland Crossing Bridge would give access to the Basins, including Nortons Basin, the Warragamba Confluence, and the Fairlight Gorge. Currently public access to this magnificent area is very restricted.

Below Wallacia Weir there is public ownership via Water Board lands to Warragamba Park above Nortons Basin. Below the confluence to Regentville is public land within the Blue Mountains National Park. Consolidation of public foreshores through Regentville and Penrith would ensure public access through to the Penrith Lakes area and Castlereagh. Public ownership of the western side along the monocline starts at McCanns Island and runs downstream to Mill Dam Falls (Castlereagh). The Mill Dam Falls/Shaws Island area (Crown lands) should become regional open space within the next two years on termination of the permissive occupancy for extraction.

Below the Falls area on the western side public foreshores could be achieved by some additional acquisition between existing reserves to Yarramundi Bridge. The proposed Yarramundi regional park runs down to Clarks Island. The western foreshores from Clarks Island to Richmond Bridge are in public

ownership except at St. John of God Hospital. A foreshore strip could be acquired, thus achieving a lineal open space system from Wallacia to Richmond mostly on existing public lands (approximately 60 kilometres long). This portion of the valley is perhaps scenically the most diverse and important in its recreational attributes. With recreational capacities of the order of 30,000 persons per day such a resource would exceed the projected capacities for the Penrith Lakes Scheme.

Menangle Park through Camden

The only other portion of the valley in which the lineal open space concept could be applied in the near future is the Nepean between Menangle Park through Camden to the Camden Aerodrome riverfront. Much of this land which is designated under the Growth Areas Act is, or will become substantially publically owned. Passive and active recreational uses have been proposed for most of the floodplain areas adjoining Camden and Menangle to serve the Growth Area. The large scale, low relief, and uniformity of the open agricultural landscape suggest that it has value for canoeists, horse-riding and bicycle trails. It lacks the visual diversity and detailed interest of wilder areas of the river for walking trails.

Management Issues

The use patterns identified in the background studies suggest that larger facilities are better used and managed than smaller ones. Multi-purpose facilities such as Mitchell Park (Public Reserve - Department of Lands) and Paradise Gardens (Private) tend to be more intensively used for longer periods, with an average stay of 4 to 6 hours.

Infrastructure economies are evident in the locating of fewer larger facilities close to main roads and the provision of adequate water supplies and sewage treatment, given the water quality problems in the Hawkesbury/Nepean system. The same arguments have been advanced in this report for the consolidation of commercial recreation uses in resort zones.

Local Government has insufficient resources and expertise to manage regional parks and is not motivated to service regional catchments. The most suitable State agency is the National Parks and Wildlife Service (NP & WS) in its dual responsibilities for nature conservation and State recreation areas (SRAs). Their expertise is of particular value where environmental fragilities and recreation use co-exist, e.g. Bents Basin.

Therefore the most suitable agency for the management of major new public recreation areas in the valley is the NP & WS through its responsibility for SRAs, with local government retaining responsibility for smaller and local open space.

With an expanded role for SRAs a compensating reduction in accessibility into the national parks should be anticipated. The



Sackville

NP & WS has a multi-disciplinary team able to survey existing use and establish Statewide priorities relating future recreation development to population centres and tourist movement criteria. As well it is able to produce management plans for SRAs.

SRAs can complement the nature conservation role of the national parks and take pressure and demand for intensive recreation use off the parks system. An expanded role for SRAs will also provide greatly increased and diversified recreation facilities for the projected rapid growth in demand. It will also provide opportunities to create designed and managed facilities for problematic activities such as trail-biking which cause considerable damage in national parks and on vacant Crown lands.

The Department of Lands, the Forestry Commission, and the MWS & DB, also have a role to play in the recreational aspect of multi-purpose management of lands in their care. The Department of Lands recently opened up an extensive trailway system near Berowra Waters with primitive camping areas. The Department of Lands is also responsible for public recreation reserves. These include foreshore reserves where the fragile resources in the inter-tidal zone need protection, while allowing public access and granting permissive occupancies to adjoining land owners.

The National Parks and Wildlife Service has agreed in principle to filling the recreation management role and specifically to manage the proposed priority areas for regional open space. The Service currently envisages that such an open space system could best be managed as one Hawkesbury/Nepean Valley SRA and that this would aid marketing the resource.

Funding

A larger role for SRAs implies increased funding, particularly for capital works. Operational costs can usually be recovered from users, concessionaires, etc. To date the Department has acquired land and used the County of Cumberland Fund to acquire open space administered by local government. SRAs which traditionally have utilised Crown lands have been funded by the Department of Lands and recently the NP&WS. If the major future need is to create major regional open spaces on the periphery of our urban areas some commitment of the Government's resources for this purpose should be considered.

Employment Opportunities

The public works and stimulated private sector investment in recreational and tourist development are likely to create jobs in priority areas. Also ongoing service employment in the leisure industry is likely to generate more jobs than other land use options in the valley. Employment in both agriculture and extractive industry is small and unlikely to be displaced by recreation development.

Tourist Roads

The valley contains an intricate network of local roads created to service the farming areas and connect them to the villages, which are the local service centres. This role has been overtaken by their usefulness for pleasure driving and as access routes to recreation facilities. These roads are mostly circumferential to the urban area, following the valley floor and responding to local geographical features. Their design encourages low speeds and they are ideal scenic routes, defining immediate viewsheds of the valley and possible 'scenic protection zones'. Maps of the area are inadequate, but with some perserverance most of the valley can be traversed on these roads, avoiding most urban areas except the villages. Thus with some improved linkages and better signs and maps this network could be promoted as 'Valley Tourist Roads'. The major deficiency is the lack of connection between Cut Hill Rd at Bringelly Creek and Wolstenholme Avenue Greendale.

Water Safety

Examination of records supplied by the Inter-Departmental Committee on Water Safety over the past 2 years fails to show any particular locations which might be regarded as being dangerous. However, the river is recognised as being generally dangerous due to the presence of deep holes and a tidal channel adjoining the sand bar. In the two years to June 1982 there were 2 drownings in the Nepean River and one in the Hawkesbury River.

It appears that there is a tendency to regard still waters as being safer than ocean beaches. Within the State approximately 200 people drown each year. The ocean beaches account for an average of 12 drownings whereas rivers claim 46 lives. Not only do secluded, quiet streams claim more lives than ocean beaches but when the level of use is taken into account it is apparent beaches are much safer than inland waters and of course, controlled beaches have the highest level of safety.

Weight should be given to the safety factor in developing proposals for recreational uses on the Hawkesbury/Nepean system.

The incidence of drownings on inland waters suggests the need for better public education on the use of unfamiliar waterways. Most drownings have occurred at secluded locations with inadequate surveillance.

The safety factors support the case put forward in this report for larger and better managed public and private recreational facilities with better surveillance of their waterfronts. Most of the areas proposed for open space are relatively safe because of broad, shallow, slow flowing waters and sandshoals such as those at Yarramundi.

Development Standards

An Inter-Departmental Committee was formed (chaired by the Public Works Department) to examine recreational use of the tidal Hawkesbury. The consultant study done by Soros, Longworth, McKenzie (N.S.W. Inter-Departmental Committee, 1977) generated data on recreational use of the tidal waterway. In parallel a survey of uses of the non-tidal river was undertaken by De Leuw Cather (1977) for the N.S.W. Planning and Environment Commission.

This data was used to formulate internal policies for public and private recreation development of the valley. Sieve mapping of environmental, land use and tenure constraints was used to establish recreation suitability. Accessibility and demand parameters were used to establish capability. The resulting Recreation Capability Map constitutes a structure plan for recreation use in the valley.

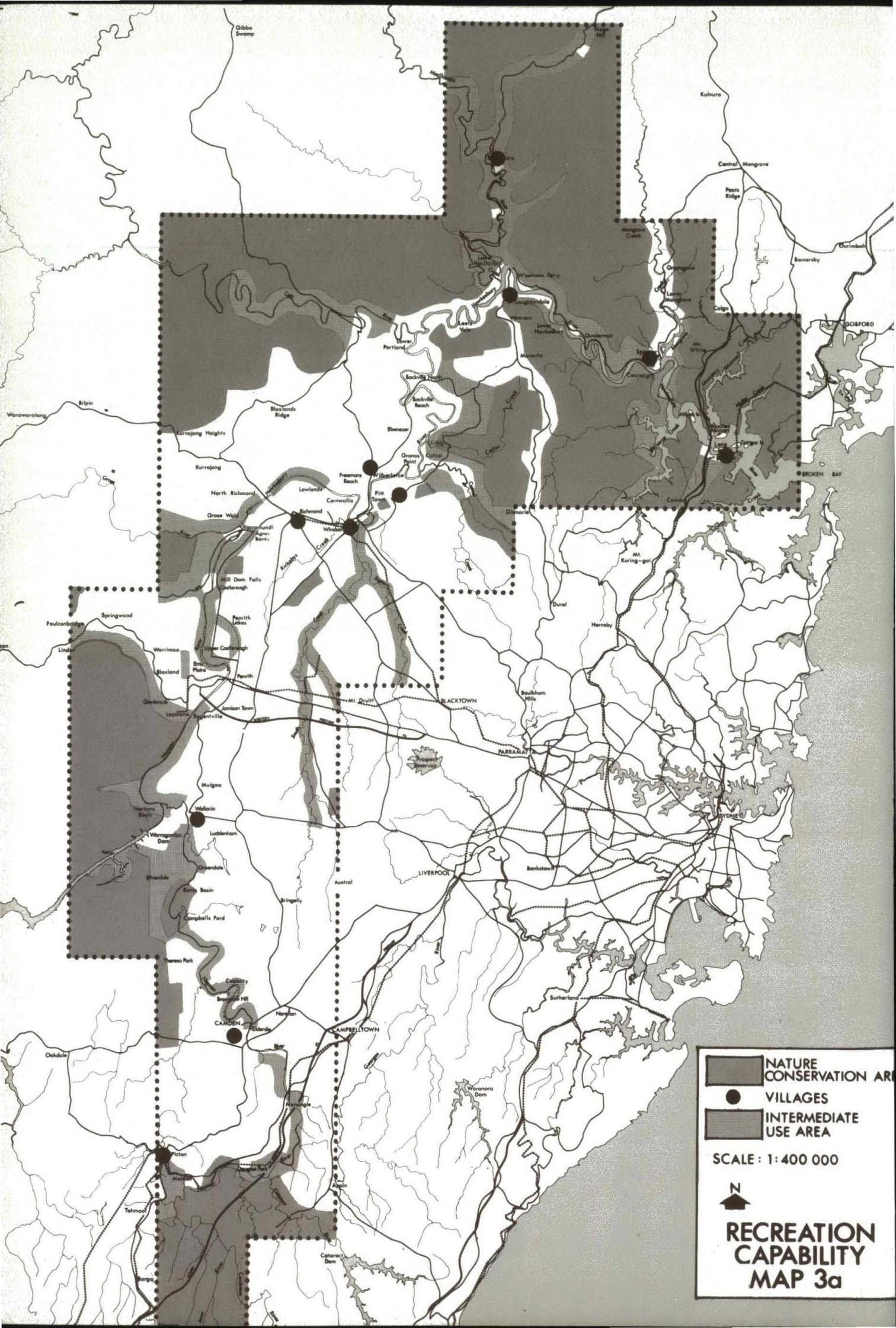
Three grades of capability were delineated, reflecting intensities of use. These are shown on the Recreation Capability Maps (No. 3a and 3b). Development standards have been developed and tested by planning casework for each grade.

Grade (1) Nature Conservation Areas (Map 3a) are areas where low intensity resource-based recreation is subservient to the conservation goal. These include designated water catchments, existing and possible future national parks, and vacant Crown lands. Thus no zoning changes are anticipated. Capacities would always be considerably less than 1 person/hectare for day and overnight use. As virtually no development is desirable in these areas, development standards are inapplicable.

Grade (2) Intermediate Use Areas (Map 3a) are moderate use areas in natural and rural landscapes. Waterfront and water-based recreational uses, including picnic grounds, horse-riding clubs, golf courses, youth camps, informal camping, and boating, should be considered as legitimate recreational uses in rural zones (40 ha minimum) and no special zonings are recommended.

Suggested standards for application within Grade (2) areas are:

- (1) The 40 hectare minimum policy should apply to new subdivisions but the minimum site area for 'Recreation Establishments' on existing lots should be 10 hectares.
- (2) The maximum site coverage by permanent buildings should be 1 per cent. This would permit the normal level of development on a rural holding of a dwelling and outbuildings. A greater site coverage than 1 per cent would be detrimental to the visual qualities of rural areas in the valley.

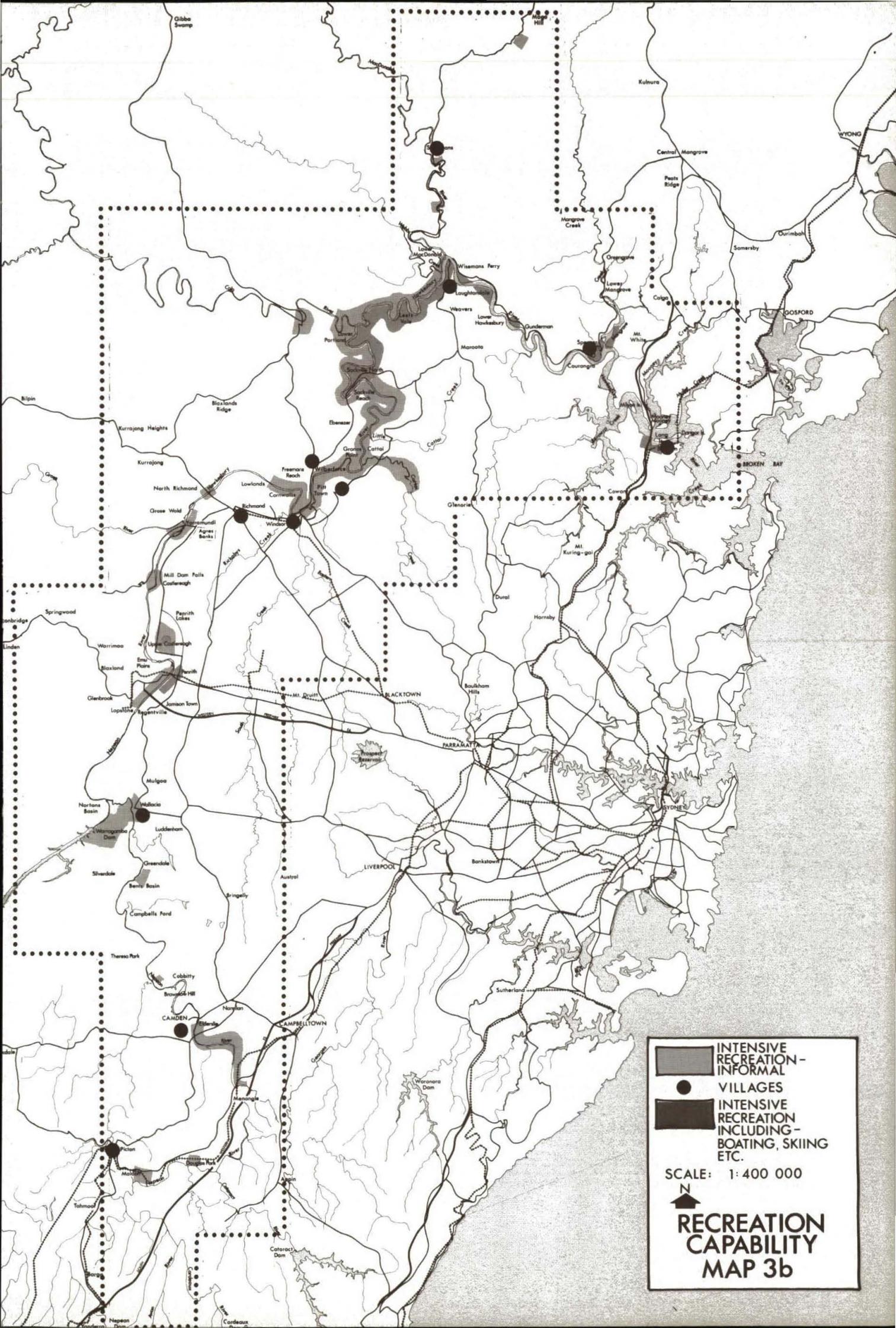


- NATURE CONSERVATION AREA
- VILLAGES
- INTERMEDIATE USE AREA

SCALE: 1:400 000



**RECREATION
CAPABILITY
MAP 3a**



	INTENSIVE RECREATION - INFORMAL
	VILLAGES
	INTENSIVE RECREATION INCLUDING - BOATING, SKIING ETC.

SCALE: 1: 400 000

 N

RECREATION CAPABILITY MAP 3b

- (3) The maximum site coverage by buildings and hard-paving, including recreation facilities such as tennis courts, swimming pools, roads and parking should be 10 per cent.
- (4) A minimum of 50 per cent of the site should be landscaped with indigenous plant material and used for passive recreation only.
- (5) Where the development fronts a major waterway a foreshore public reserve 30 metres wide may be desirable, conditional on consent. Development facilitating water-based recreation and boating, such as landing ramps, jetties, fuel supplies and so on, could be considered on their merits in such 'reserves' as permissive occupancies. This is consistent with the Department of Lands' policy on waterfront reserves.
- (6) A maximum density of 5 persons/hectare should be set for overnight use, whether in cabins or in tents. For example the YMCA Camp at Yarramundi accommodates 120 people on 17.8 hectares, a density of 7 persons/hectare. This higher density is acceptable for the camp with adjoining bushland. However, if it became an established standard in rural areas, the rural character of the countryside would be eroded. The Teachers College Camp at Yarramundi accommodates 80 people on 65 hectares (approximately 1.2 persons/hectare). Approximately 40 hectares of the College Camp is bushland.
- (7) A maximum density of 10 persons/hectare should be set for day use only, defined by car parking spaces set at 3 persons/car. Thus a 10 hectare site for day use recreation should have a maximum of 33 parking spaces. Mitchell Park on the Cattai is an example of a predominantly day use facility in a rural area. Approximately 1,000 people (300 cars) use the park at capacity, on an 120 hectare site of which 24 hectares is used, intensively. Mitchell Park conforms to the proposed standard while using only 20 per cent of the site intensively, including grassed playing fields. The remaining 80 per cent is bushland used for walking along trails, resource-based recreation and a limited amount of overnight camping (maximum 100 persons/day).
- (8) In addition to these suggested density controls provisions relating to building materials and colours should be used to promote unobtrusive development as well as landscaping and siting controls to minimise visual impacts of buildings. Buildings heights should be a maximum 8 metres above natural ground level.

Grade (3) Intensive Recreation Areas/Resort Zones (Map 3b). Areas with capabilities for intensive recreational use should be given a resort zone where public acquisition for regional open space is not anticipated. Intensive

recreation uses such as active recreation grounds, caravan parks, restaurants, and so on should be confined to designated resort zones. More permanent accommodation such as motels, hotels, holiday flats, and so on should be confined to village and urban zones.

The following standards are suggested as applicable to recreation uses in resort zones.

- 1) A minimum site area of 5 hectares should be set.
- 2) The maximum site coverage by buildings, hardpaving, roads and van/camping sites should be 30 per cent.
- 3) A minimum of 50 per cent of the site should be soft landscaping with planted material, trees/scrubs/grass of which 25 per cent should be devoted to passive recreation only.
- 4) Where development fronts a major waterway the dedication of a public foreshore reserve 30 metres wide could be conditional on consent. Development by the adjoining use in such a reserve to facilitate water-based recreation, including launching ramps, jetties and fuel supplies could be considered on their merits as permissive occupancies.
- 5) A maximum density of 50 persons/hectare or 20 caravan sites/hectare should be set for overnight use of caravans or tents.
- 6) A maximum density of 80 persons/hectare should be set for day visitation defined by car spaces at 3 persons per car space. Paradise Gardens, an entertainment park at Cattai is an example of a multiple use facility suitable for a resort zone. Paradise Gardens has 1,000 car spaces which accommodate an average of 4 persons/car (predictably more children than a typical facility) spread over 157 hectares. This is 25 persons/hectare (day use only). Ko-Veda, an example of a well managed caravan park on the Hawkesbury with reasonable provision for passive recreation and landscaping has 87 van sites on 14 hectares. In addition they cater for up to 100 day-trippers. This is well below the suggested standards.

Most of the existing resorts/caravan parks on the Middle Hawkesbury should be given a resort zoning. The smaller existing and substandard private recreation facilities should remain within the rural 1(a) zone and be subject to non-conforming constraints. The few remaining large floodplain sites in Hawkesbury and Baulkham Hills suitable for intensive recreational uses (i.e. with suitable beach frontage to the waterway) should be given such a resort zoning, except for the areas proposed for regional open space. Some consideration should also be given to creating a resort zone on the floodplain adjoining Wisemans Ferry in

Hornsby. No other intensive recreation uses are recommended below Wisemans Ferry with the exception of Loughtondale and those included in I.D.O. 122 for Gosford.

Permissible uses within the resort zones should include, picnic grounds, entertainment facilities, such as Paradise Gardens, caravan parks, camp grounds, mini-bike and horse riding trails, boat storage facilities and moorings, restaurants and so on. It may be feasible to allow trail bike circuits within the resort zone subject to environmental assessment. Establishing such circuits in suitable areas is a prerequisite to controlling trail-biking in more sensitive areas.

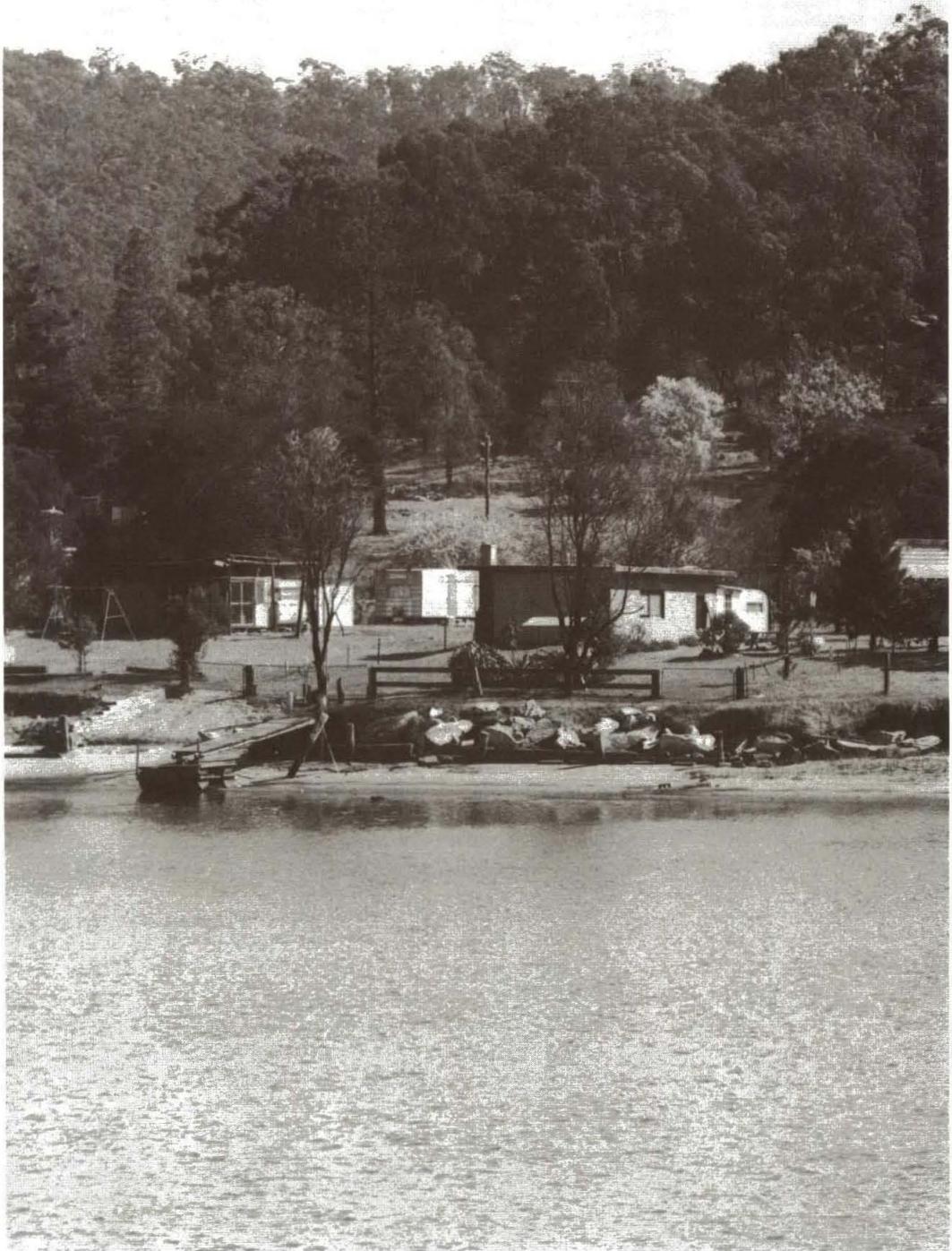
The resort zoning has been proposed to both contain and control commercial and private recreational uses as well as to encourage them in appropriate places. Consequently such uses should be specifically excluded from other rural zones in the valley. One of the major problems in the valley at present is the proliferation of small-scale and often substandard private recreation uses in rural zones.

The use of both resort and village zones to accommodate intensive recreational uses enables their environmental effects to be contained. Consolidation is likely to permit the establishment of local water supply systems and package sewage treatment works, thereby reducing the major pollutant hazards of such development.

It is preferable to locate resort development on the remnant alluvial foreshores rather than on the steeper sandstone terrain. Where the foreshores are flood liable controls should ensure that structures are designed to withstand periodic flooding, and that caravans are maintained in a mobile condition and are removed in the event of floods. The use of 'bonding' to guarantee compliance is desirable. Any such facilities should have flood free holding areas in the event of floods.

The construction of a dwelling unit should be permitted for the proprietor of such facilities which could take an 'elevated form' to minimise flood risk. All habitable floorspace should be a minimum of 500 millimetres above the 100 year flood level. A maximum building height of 8 metres above natural ground level should apply. The use of building materials of recessive tones and colours and a low degree of reflection should be required. Landscaping should ensure screening of development from the roadside and the water. A minimum setback of development of 30 metres from High Water Mark should apply (the suggested environmental protection area) and the practice of leasing foreshore sites should be prohibited.

Village Zones should provide the focus for the provision of accommodation of a permanent nature for residents, tourists and holidaymakers in the region.



Caravan Park at Leets Vale

The village zone at Wallacia should be adequate to contain its possible growth as a tourist and recreational centre. The development of the recreational resources of the Nepean between Penrith and Richmond may justify the creation of a village or resort zone, possibly at Castlereagh, to accommodate more intensive uses, including tourist accommodation, clubs, caravan parks and restaurants.

Because of anticipated demand the adequacy of current village zonings at Lower Portland and Wisemans Ferry requires investigation. The Draft Rural Local Environmental Plan for Hornsby increases the village zone at Wisemans Ferry and adjoining tourist/resort zones.

Conclusions

1. The valley contains many areas suitable for intensive recreation, other areas capable of accepting moderate and passive use, and undisturbed natural areas where uses should be limited so as to conserve the resource.
2. There is a considerable imbalance in current use in the valley both in relation to potential resources and to centres of population. This can to some degree be corrected by improved access, and public and private initiatives. However, in general the tidal reaches have greater recreational capacities than above without environmental problems.
3. The Recreation Capability Map should be used as a structure plan for recreation use in the valley.
4. Development standards as outlined are devised to ensure maximum recreation use of the river with minimum impact.
5. The Sydney Region Outline Plan (SPA 1968) concept that the valley could become some sort of lineal open space system requires refinement in view of increased knowledge of the environment of the river and its attributes for recreation.

UNIT (A): The Nepean between Douglas Park and Menangle has important but limited capacities for resource-based recreation.

UNIT (B): The Nepean between Menangle to Campbell's Ford has limited value for water-based recreation but the floodplain has considerable value for land-based active and passive recreation for the Macarthur Growth Area.

UNIT (C): Conservation values should limit recreation use in the Bents Basin Area.

UNITS (D, E, F.): The river from Wallacia to Yarramundi has the greatest potential for improved public access and for land and water-based recreation in a diverse and scenically rich section of the valley, close to population centres.

UNIT (G): The Hawkesbury from Windsor to Sackville has considerable potential for intensive recreation use when power boating is phased out. Both the private and public sectors have a role to play in its development.

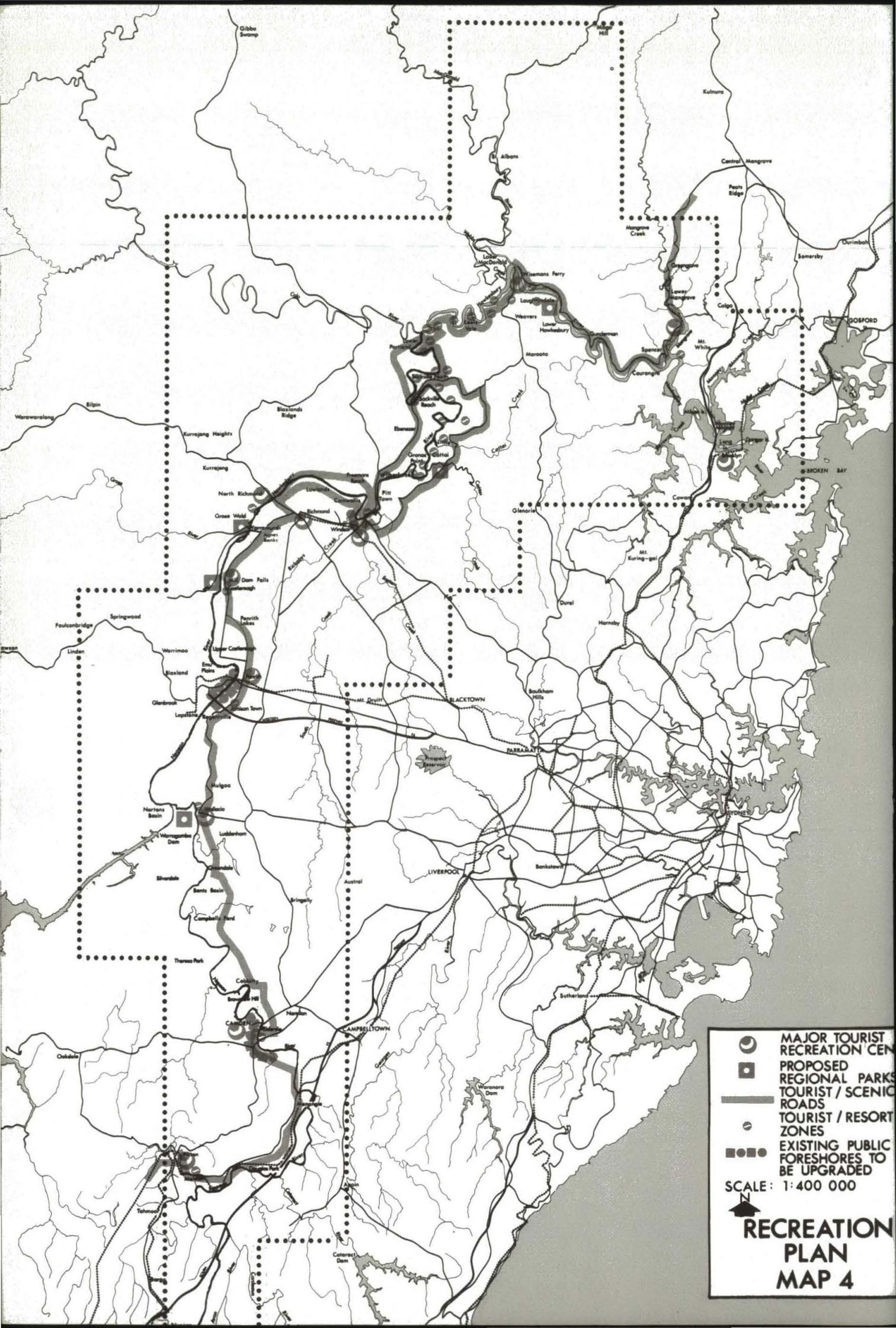
UNIT (H): Below Sackville a consolidation and upgrading of existing private recreational uses is desirable with development encouraged in the villages of Lower Portland, Wisemans Ferry, Spencer and Brooklyn, except for the proposed development at Loughtondale.

All the recreation proposals are shown on the Recreation Plan (Map No. 4).

6. In the long term recreation should be considered to be the dominant land use of the river's foreshores below Wallacia. However, in many areas this would not preclude the continuance of agricultural use behind a foreshore strip. In the river's sandstone phases recreational use should be compatible with the high conservation value of the resource. The scenic value of continued agricultural use in the valley also requires recognition.
7. In general, extractive industry is not compatible with recreation use and from a recreation point of view the gradual cessation of extraction from the bed and banks of the river and progressive rehabilitation should be encouraged. Extraction from the bed does not improve the river's attributes for recreation. The River Improvement Program on the Nepean has no clear benefits from a recreation point of view and it reduces the river's scenic diversity and value for small boating.
8. The public and private sector can play complementary roles in recreation development. Where the user-pay principle and intensive recreation uses are appropriate the private sector has a major role to play both in capitalising and managing recreation facilities.
9. Apart from the possible location of Sydney's second international airport in the valley, the best land use option from the point of view of employment generation is recreation and tourism.
10. The management and recreation planning skills of the National Parks and Wildlife Service are likely to become increasingly important in the valley with regional open space being most efficiently managed as State Recreation Areas in the future.

Priorities for Regional Open Space

In light of the above, the following areas have been identified in conjunction with the National Parks and Wildlife Service as priorities for open space on the basis of recreation attributes

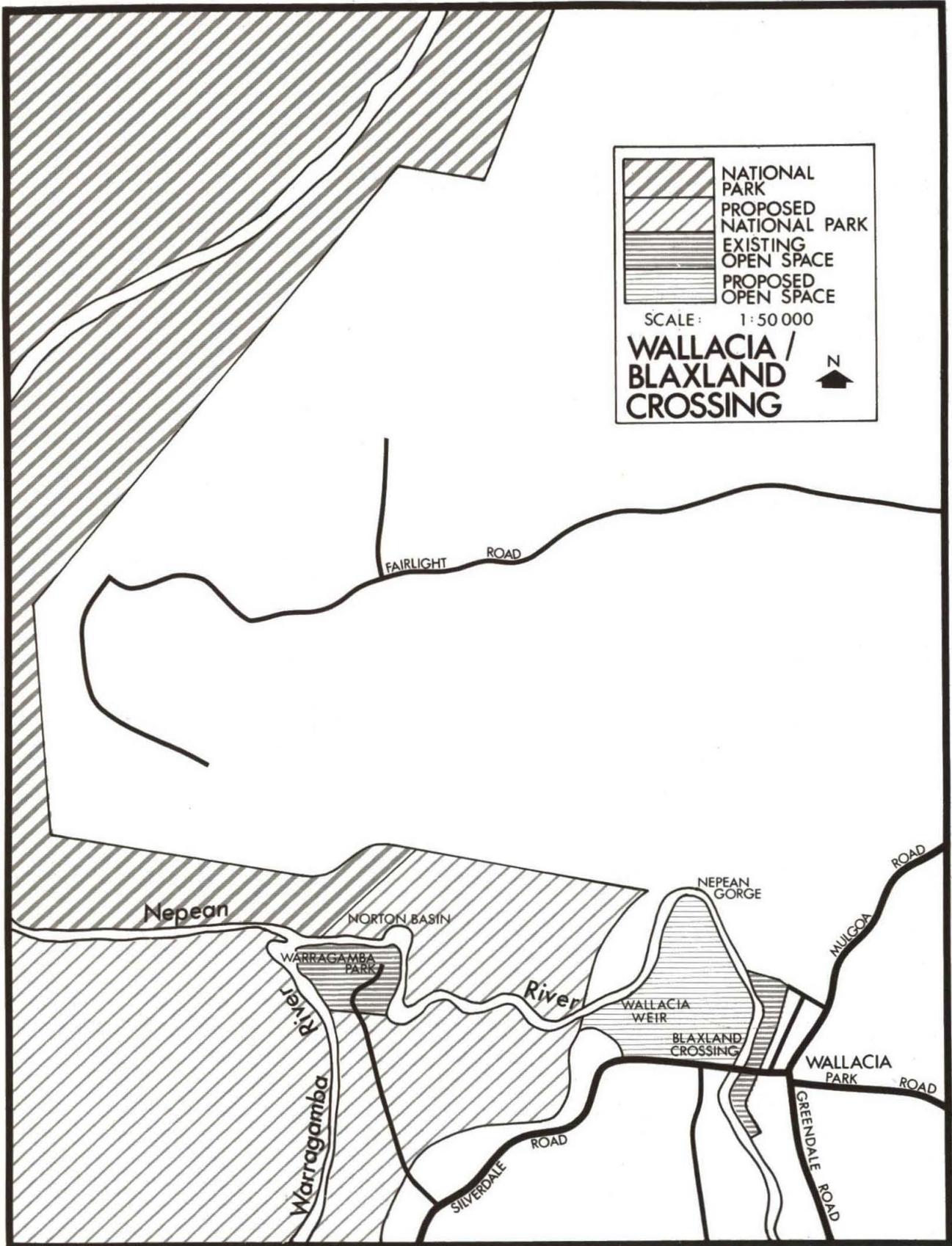


-  MAJOR TOURIST RECREATION CENTRE
-  PROPOSED REGIONAL PARKS
-  TOURIST / SCENIC ROADS
-  TOURIST / RESORT ZONES
-  EXISTING PUBLIC FORESHORES TO BE UPGRADED

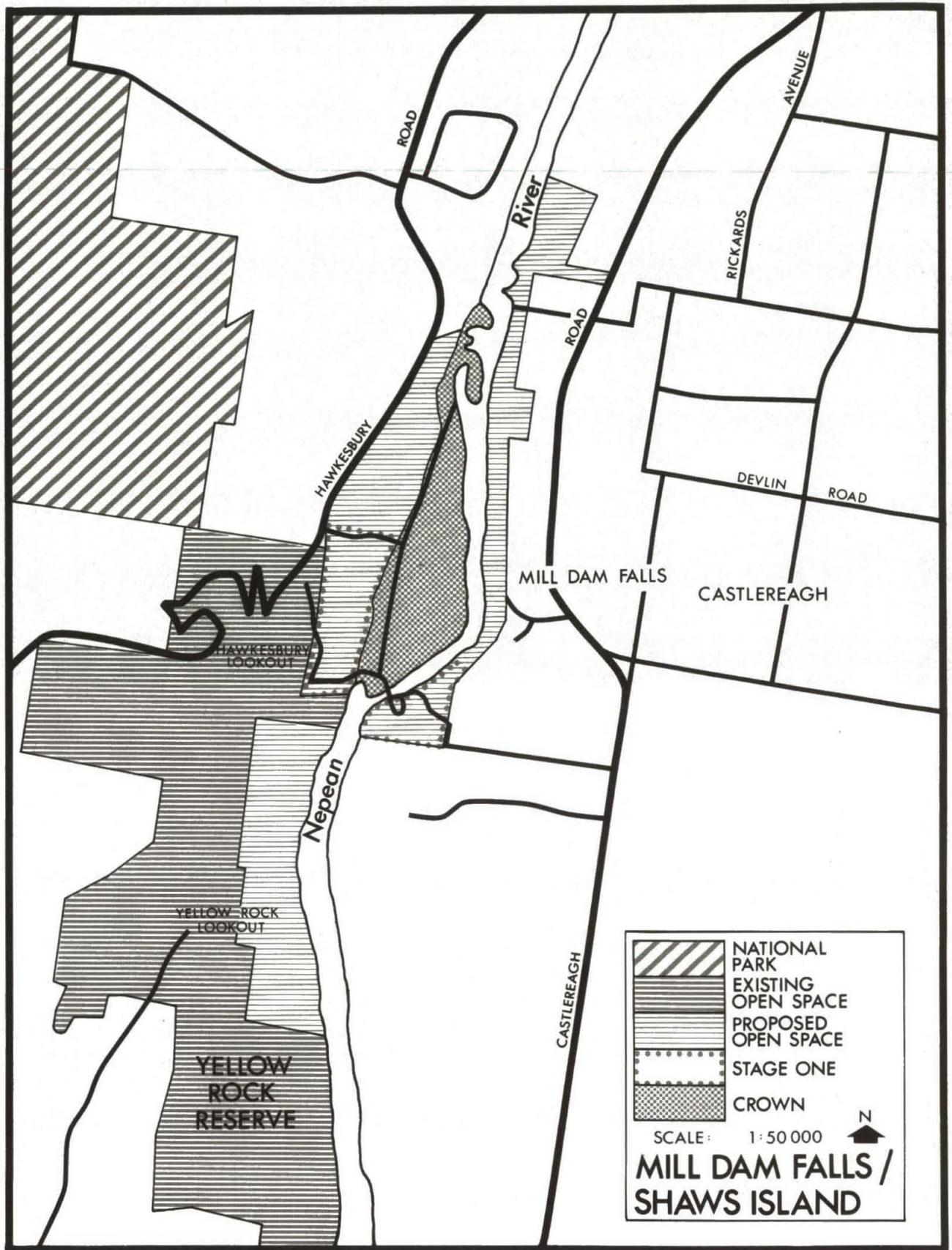
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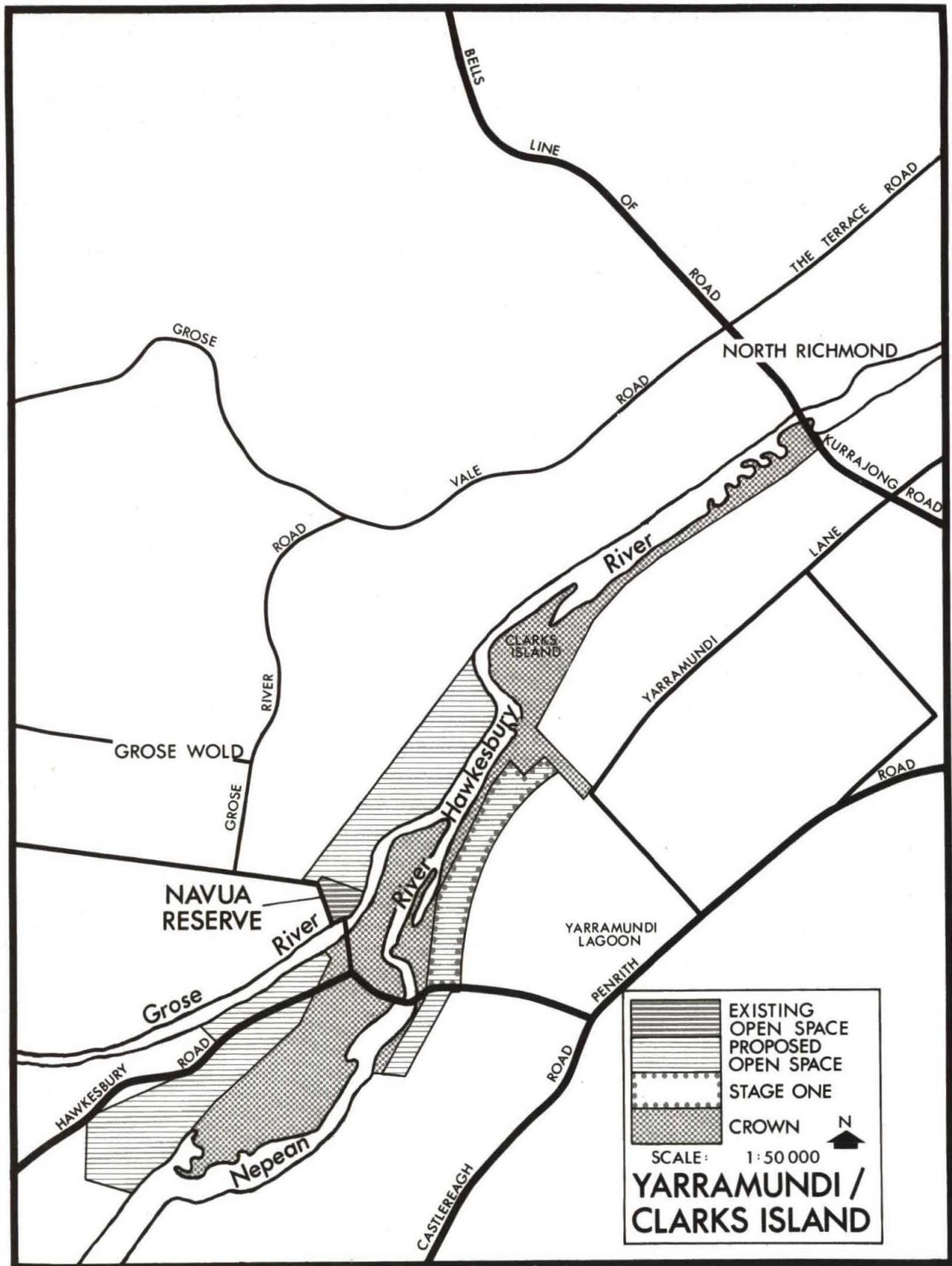
**RECREATION
PLAN
MAP 4**



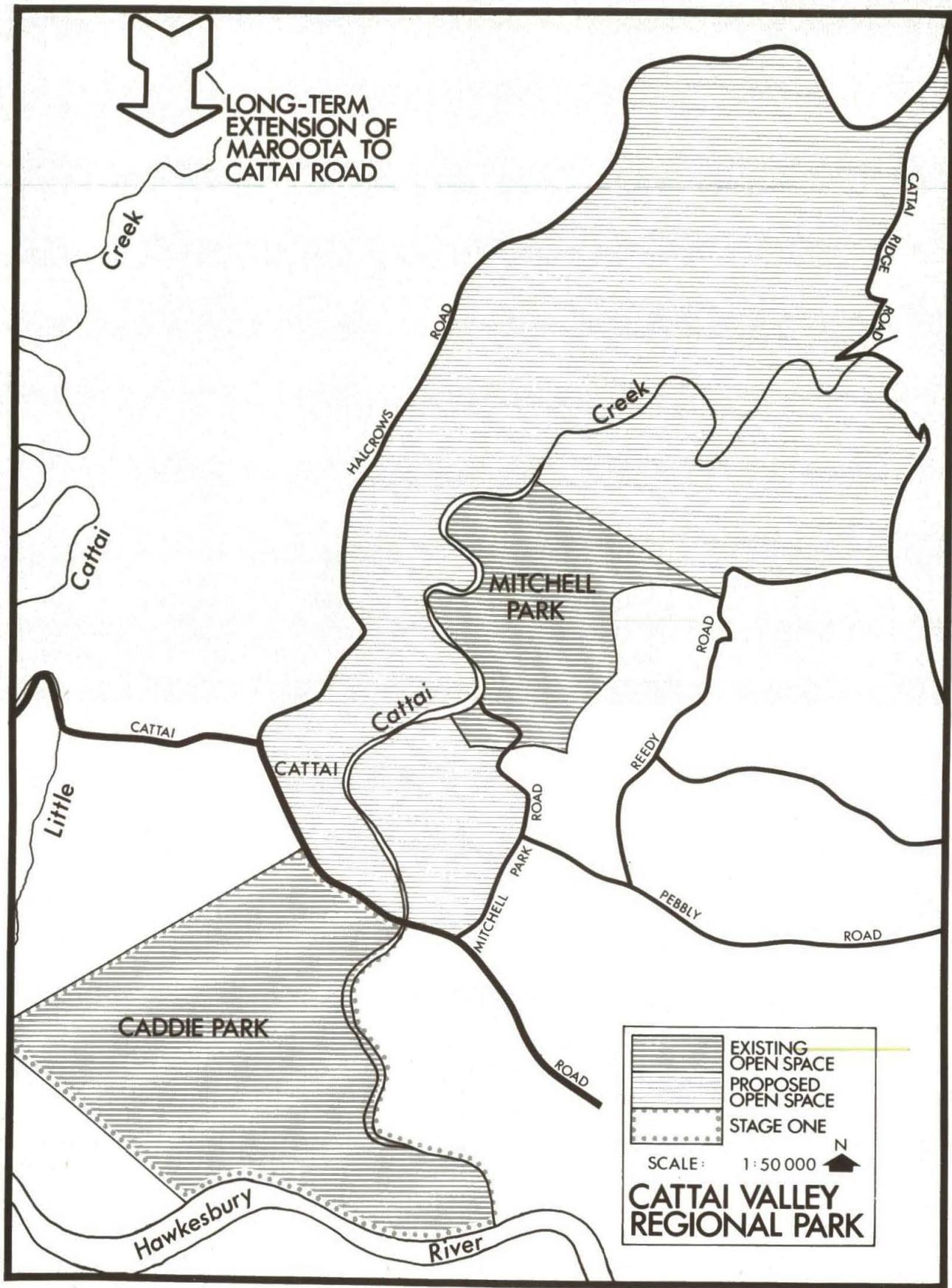
MAP 5



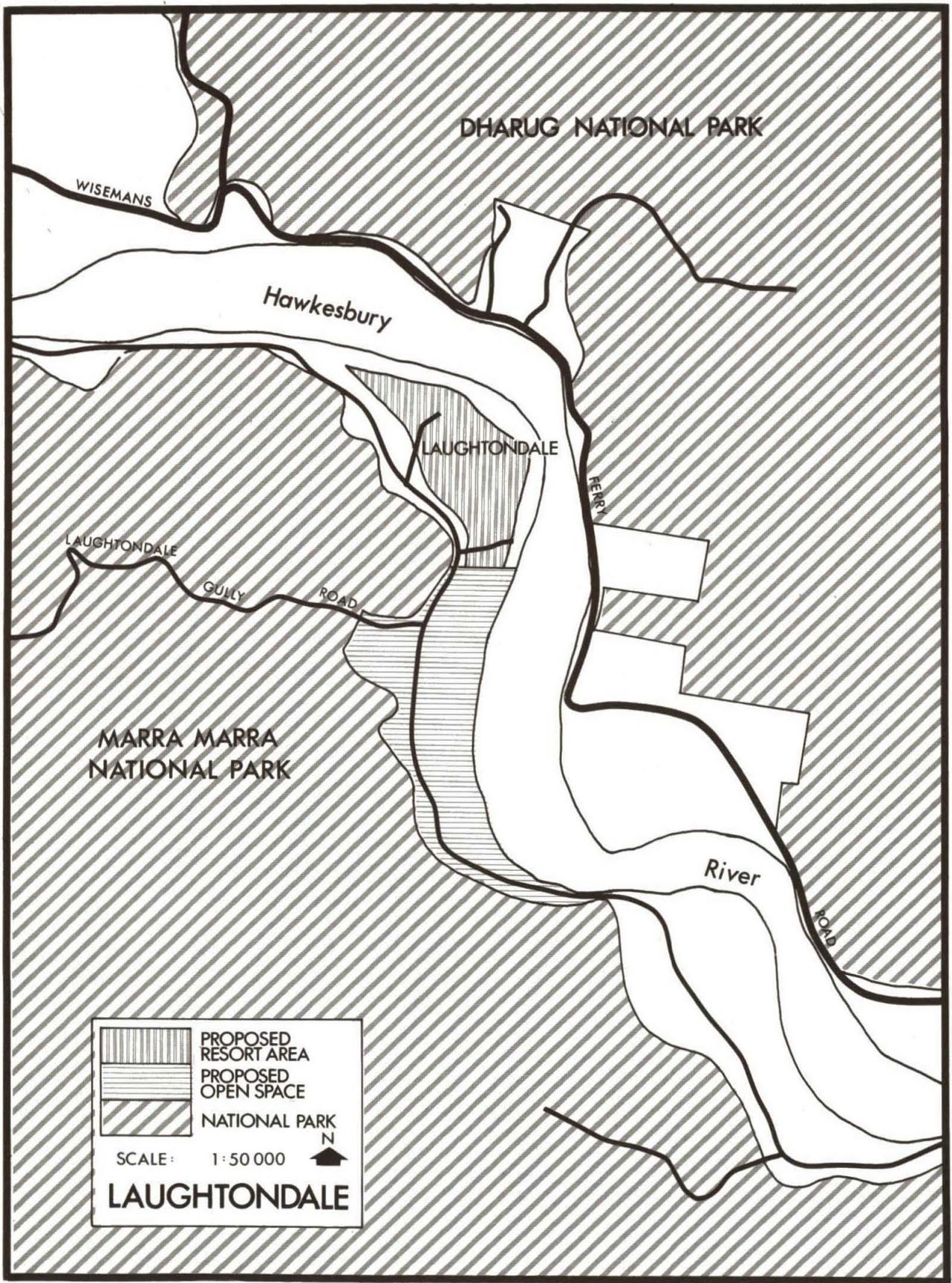
MAP 6



MAP 7



MAP 8



MAP 9

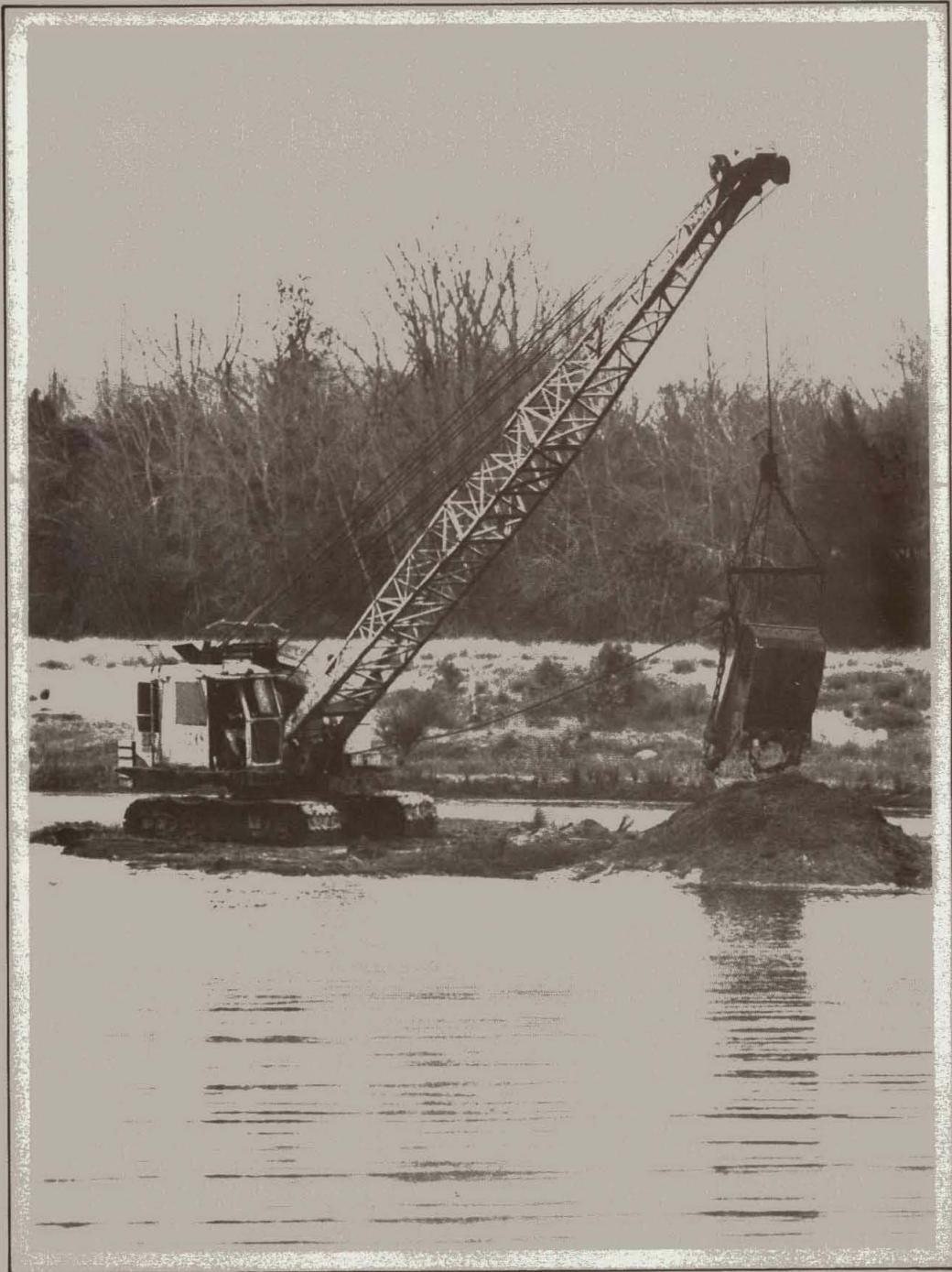
and access and demand criteria. It is proposed that they be managed as part of a Hawkesbury/Nepean Valley State Recreation Area. However, identification of these areas does not preclude the consideration of other areas in the next few years.

- (1) **Unit D - Wallacia:** The foreshores of the Nepean below Blaxland Crossing Bridge could be developed to permit service facilities and access to the Fairlight Gorge. (Map No.5)
- (2) **Unit F - Shaws Island (Castlereagh):** Some 100 hectares of Crown lands under extraction should be released for open space shortly. To exploit the high recreational potential and scenic value of features in the area, such as extensive rapids, the inclusion of adjoining foreshores is required. (Map No.6)
- (3) **Unit F - Yarramundi Point Bar to Clarks Island:** Development of the potential of the Bar, the Grose Confluence, and Clarks Island requires access and service facilities on the adjoining foreshores. The extensive sandshoals and scenic surrounds are ideal for water-based informal recreation and small boating. (Map No.7)
- (4) **Unit G - Cattai Valley:** The Cattai Valley has a wide range of recreational and scenic attributes. The current facility, Mitchell Park, is overcrowded. The first phase of the proposal, Caddie Park, on the confluence with the Hawkesbury has been acquired. It includes extensive beachfronts, wetlands, cleared pasture, rugged bushland, and an historic homestead. (Map No.8)
- (5) **Unit H - Loughtondale:** Loughtondale was proposed by the Inter-Departmental Committee on the Hawkesbury as a multiple-use and boating facility. It is one of the few large beachfront sites available in the dramatic scenery of the Hawkesbury below Wisemans Ferry. (Map No.9)

Note:

Other areas have been identified in this report, the background reports and by local government for their open space potential. These should be evaluated by the local government authorities concerned and acquired and developed as funds permit.

Part 3 Extractive Resources



Yarramundi

EXTRACTIVE RESOURCES

*History of
Extractive*

The valley has been identified by the Department of Mineral Resources as a major future source of sand and gravel for Sydney.

In the report, **Extractive Industry in the Hawkesbury Region**, (prepared by a Technical Advisory Committee for the SPCC, March 1977) it was suggested that the N.S.W. Planning and Environment Commission had a major role to play in the planning of extraction in the valley.

The report recommended:

(pt. 13.3) 'that the Planning and Environment Commission define the strategic planning requirements for the study area relating extractive industry's needs to other land use'.

(pt. 13.4) 'that extraction of sand and gravel on the floodplain be limited in the short term to the areas covered by the proposed Penrith Lakes Scheme and in the longer term to the Richmond Lowlands'. *Bank reshaping is opposing this intention*

(pt. 13.6) 'that as far as possible sand and gravel extraction be confined to areas where optimum resource utilisation can be achieved with least environmental impact. In these areas the operations should be co-ordinated so that they are planned, programmed and conducted to minimise overall environmental problems and create areas that can be put to useful purpose as quickly as possible. A co-ordinated lakes scheme is an example of an approach that could be considered.'

It also suggested that planning policies be adopted in order to facilitate the Penrith Lakes Scheme.

Demand and Supply Factors

The valley is a major economic source of supply for construction sand and gravels. The assessment of resources contained in the SPCC's report indicates that the supply in high level deposits and on the floodplain exceeds the supply in the bed and banks of the river by a factor of 10:1. In the past most extraction has occurred from the bed of the river.

The estimates for projected future consumption of sand and gravels contained in the above report (Tables 1 and 2, pages 24, 25) were based on population projections from the N.S.W. Planning and Environment Commission's Technical Bulletin 8 (August 1976) for the region and on projections of consumption through the boom period 1972-73 when a growth of 6 to 8 per cent per annum was occurring.

Current growth estimates for sand production are much lower (e.g. Wallace, 1980). This will substantially modify the State Pollution Control Commission report's findings and extend the life of major deposits such as Penrith Lakes beyond the year

2000. It is now assumed that extraction will continue at Penrith for 25 years or more, making a likely completion date for the system of 2010 or later.

In view of the recreational importance of the Penrith Lakes Scheme its development should be facilitated. Indeed the Government's support of the scheme is based on its regional recreation benefits. If the scheme goes ahead, extraction and rehabilitation will be carried out so as to create a variety of landforms suitable for a range of further uses.

In respect of any subsequent large-scale extraction at Richmond Lowlands, some of the factors to be considered include the environmental sensitivity of the lowlands which are flood plains; the historic and tourist significance of the Macquarie Towns; the downstream effects of extraction; and water quality problems associated with a probable lakes scheme. Adequate planning for such extraction will involve long and detailed study and will therefore require that an 'in principle' decision to extract from the lowlands be made well in advance of any projected demand.

The lower projections for sand requirement reinforce the need to bring into effect planning policies which concentrate extraction at a few sites including Penrith, while protecting future resources such as the Richmond Lowlands from alienation.

To ensure adequate supplies a wide safety margin and an appropriate time period is necessary in estimating consumption of non-renewable resources such as sand and gravel. However, other planning policies and trends may assist attempts to reduce consumption per capita. Urban consolidation policies together with recycling of building materials and buildings, and changes to engineering design practices and drainage methods could act in this way, although the overall effect will probably be small. The very significant cost element in the transport of sand/gravel (fuel) is likely to escalate and this will favour the substitution of lighter weight and lower bulk building materials, while accelerating the trend to recycle.

Extractive Industries

Other sections of this report deal with the impacts of extraction from the bed and banks of the river on the landscape and the river environment, and on recreation use. The value of such extraction is contentious from an environmental and river management standpoint and its long-term effects on the river regime are unknown. Until adequate study enables a firm policy on river extraction to be drafted environmental impact procedures need to be able to demonstrate the remedial benefits of such extraction.

The river is an important source for the economical supply of sand and gravel for the region. However, caution should prevail and regulatory bodies and planning policies should discourage

inappropriate extraction from the bed and banks. This source will remain for future use should it be shown that there are significant environmental and economic benefits to be gained from extraction.

As it is desirable to facilitate the extraction of major deposits and for these areas to be rehabilitated as soon as possible it is difficult to justify a proliferation of extractive sites on the floodplain. The wide scatter of small operations exacerbate management and environmental problems such as traffic generation, air, water and noise pollution. Concentration on fewer larger sites allows containment of these problems, and the larger operators have the capital for better technical and managerial skills to both observe controls and to rehabilitate sites.

Similarly it is easier for the regulatory agencies to control such operations. The larger sites also demand a connection to the primary road system, obviating the nuisances caused by trucks using local and residential streets. Small operators have a continuing role to play on specialised operations and smaller sites but consolidation into larger units seems likely to continue and is desirable from a planning and control point of view.

LOLO A major problem area in the control of extractive industry, is the proliferation of extraction by landholders and small operators, sometimes under the guise of agricultural regrading. Such activities, usually involving the removal for sale of topsoil, have done extensive damage to the banks of the river, with the removal of vegetation, visual disturbance, and generation of dust and trucking on unsealed roads. The 'designation' of extractive industry and the stronger penalties under the Environmental Planning and Assessment Act (1979) should be used to achieve better control in future.

It is desirable for the industry to meet any costs it imposes on the community as a result of its activities, e.g. wear and tear on local roads. As these costs will largely become apparent at the development application stage, it seems appropriate that levies imposed should be determined then, reflecting local circumstances, rather than imposing any overall levy on the industry. This is currently the policy of several councils in the Sydney area.

It would be preferable to allocate leases on a competitive tender basis, which suggests the need for public ownership of the sites. This is unlikely to be feasible in the near future because of high acquisition costs. However as about one third of the Elderslie Deposit is owned by the Macarthur Development Board, extractive leases will be open to public tender. The industry is very competitive with mergers occurring as a matter of course and it is difficult to see any alternative to the free operation of the market at this time.

BANK REGRADING



Extraction in the Yarramundi area

Management

The Department of Mineral Resources (Geological Survey) is responsible for determining resources, preparing projections, and forward planning except in the case of Crown lands where the Department of Lands is responsible. However, the Department of Mineral Resources has no statutory control over the resource. Sand and gravel is not considered a mineral within the terms of the Mining Act (1973). To date management has largely been exercised at local government level as part of planning consents and under permissive occupancies issued by the Department of Lands on Crown lands. The environmental impact assessment procedures available under the Environmental Planning and Assessment Act permit more rigorous environmental management and where issues of regional and State significance are apparent proposals may be examined at a State rather than local level.

The Department of Environment and Planning is currently conducting a Regional Environmental Study of the non-metallic mineral resources of the Sydney Region, to develop regional policies on allocation and control. That study report contains detailed information on some of the issues raised in this report.

A number of separate bodies have been overseeing extraction in the region:

1. **Joint Councils River Committee:** Representing the Councils of Wollondilly, Camden, Campbelltown and Liverpool, including representation from the Water Resources Commission, Department of Mineral Resources, the Macarthur Development Board and the Department.

This committee is concerned with carrying out the 'Desnagging Program' under Commonwealth grants by the Water Resources Commission, River Management Branch and the

control of privately owned and funded extractive industries adjacent to the river bank.

2. **Macarthur Development Board Extractive Industries Committee:** Chaired by the Department of Mineral Resources, with representatives from Wollondilly, Camden, Campbelltown and Liverpool, the Macarthur Development Board and the Department.

The role of these two committees is complementary, the latter being concerned largely with floodplain deposits, clay and shale extraction and future resource planning, including the Elderslie deposits.

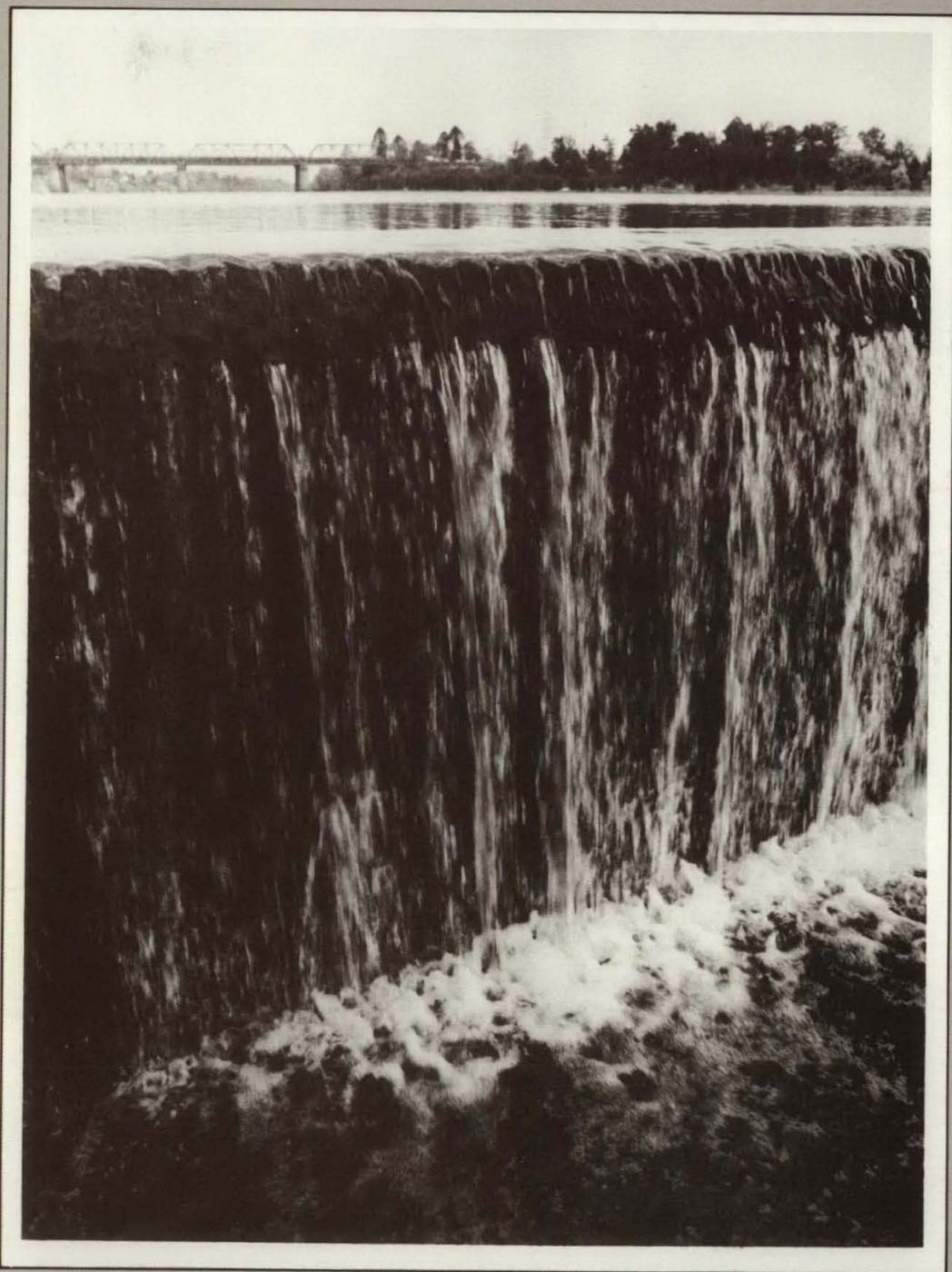
3. **The Penrith Lakes Steering Committee:** Set up to co-ordinate Regional Environmental Studies into the feasibility of the Lakes Scheme. This committee is chaired by the Department with the representation of Penrith Council, the Water Resources Commission, the Department of Mineral Resources and the Penrith Lakes Development Corporation.
4. **Technical Advisory Committee's Subcommittee on the Extractive Industry:** This Subcommittee was disbanded on completion of the report published by the State Pollution Control Commission.

The large number of authorities involved in the management of extraction of sand and gravel from the river points to the need for further and continued inter-departmental and interdisciplinary communication on river management issues.

Conclusions

1. The valley is a major source of sand and gravel for the Sydney market and will remain so for some time.
2. Because the longer-term effects of extraction on the river downstream are largely unknown, land-based extraction should be favoured where possible and reliance on the river as a source should be decreased.
3. Concentration of extraction into fewer, larger sites would enable better planning control.
4. It is desirable for the industry to pay levies to meet any community costs associated with extractive operations. The appropriate stage for the levy to be struck is at the development application stage.
5. Where possible, extraction should proceed by lease on competitive tender.
6. The contents of this report should be reviewed following completion of the Department's regional study on mineral resources.

Part 4 River Management



Penrith Weir

RIVER MANAGEMENT

The river management issues, all of which have an impact upon the complex problem of water quality, are the most intractable in the valley.

The large number of bodies with area-based and resource-based responsibilities generates different views of the system and considerable policy conflict and duplication in control. This creates a formidable co-ordination task in management of the catchment, including its land and water resources.

The single purpose bodies were set up before there was an understanding of the interdependence of their functions. Thus linear thinking and practice is in conflict with the need for integrated management of the catchment.

River management issues have most influenced the arguments from the conservation movement and from the local government authorities for the creation of a Valley Authority for the Hawkesbury/Nepean Valley and for river systems generally.

This report takes the view that such an authority would not be an efficient or politically feasible method of managing the catchment. However, there is a need to strengthen the inter-organizational and interdisciplinary communication that is currently occurring.

Examples of the sort of interdisciplinary research and dialogue required to overcome catchment management problems are the State Pollution Control Commission's Hawkesbury/Nepean Basin Water Pollution Control Study (1981) and inter-departmental collaboration on flood policy, and the Water Resources Commission's negotiations with the Metropolitan Water, Sewerage and Drainage Board on the operation of Warragamba Dam and flow levels at Penrith. There was collaboration in the SPCC study with the Water Board, Water Resources Commission and the Public Works Department on data collection.

Hydrology

Due to limited resources it has not been possible for the study to analyse and arrive at findings on the whole of the 22,000 square kilometres of catchment. This would require a much broader study based on land-capability techniques as well as area-specific studies on urban and proposed urban release lands. The study has confined its interest to the main waterway corridor, including its floodplains, from Douglas Park to Brooklyn. For most purposes this includes all lands within 2 kilometres of the rivers.

The geomorphic units reflect the two main landform types in the valley, i.e. (1) the sandstone units where the river is incised into sandstone plateaux and the alignment is controlled by structure, and (2) the sedimentary floodplain units where the

river passes through the softer shales of the Cumberland Plain and alignments are more dynamic.

The gorge units (sandstone) are relatively undisturbed and are intrinsically stable. Management implies minimal intervention and sustenance of a natural, fully vegetated environment to ensure stability. Due to high relief and skeletal sandy soils these units are vulnerable to runoff and erosion problems if cleared or developed. Appropriate adjoining land uses should be conservative in nature, i.e. nature conservation, forestry (selective logging), low intensity recreation, residential retreats (not cultivated), and pastoral rather than horticultural uses.

The floodplain units have more problems because of their inherent instability and because access and capability make them much more useful to man. Their fertile alluviums are used for intensive agriculture, the low relief is ideal for urban development, and the deposited materials, sand, gravel, topsoil and clays as well as the water resource are all major elements in the sustenance of the region.

These demands led to development before the natural order of the region was understood and to subsequent changes and ongoing impacts. The lack of sufficient data on the environment before major works such as the dams were carried out makes constructing a picture of the natural regime difficult and speculative.

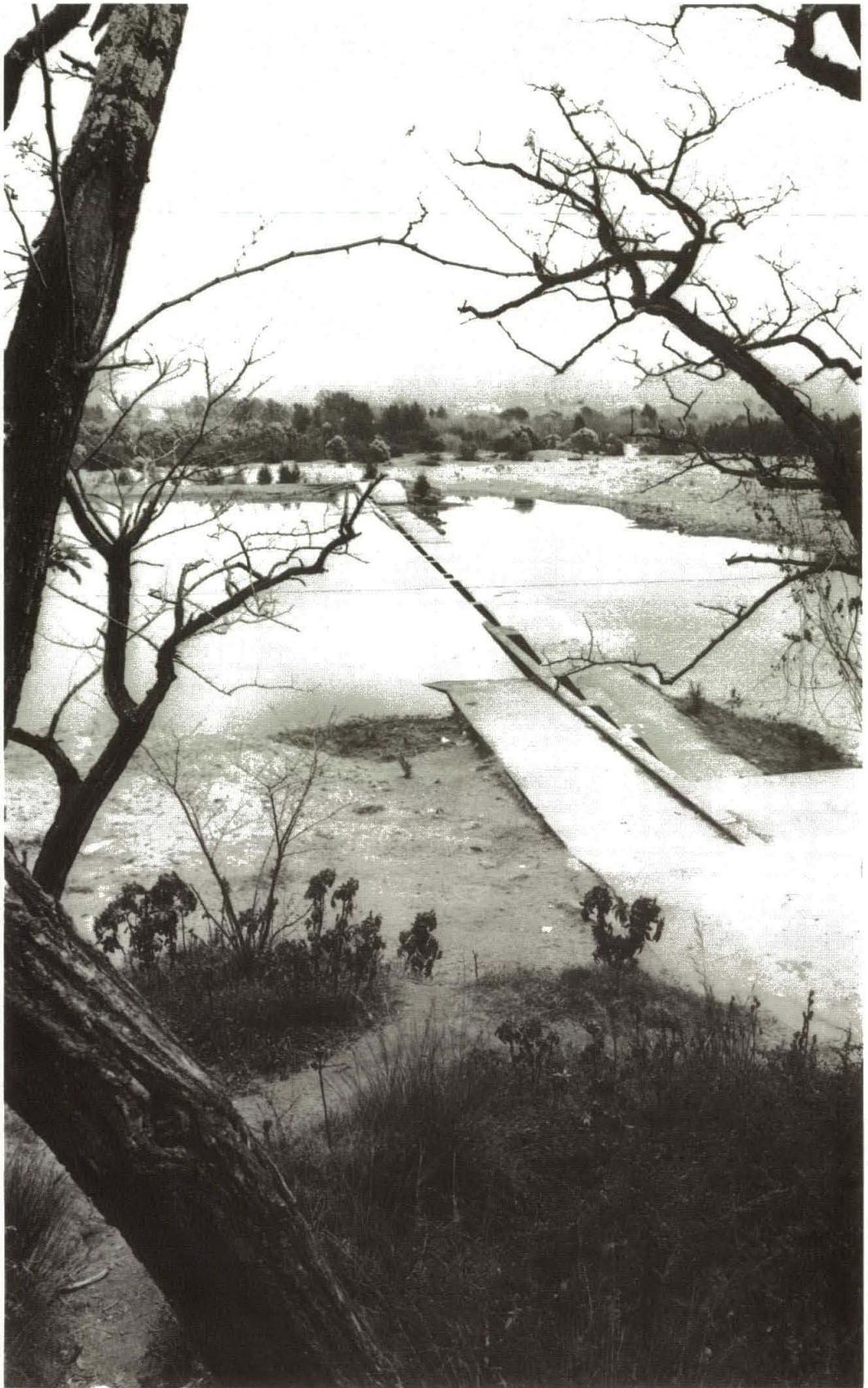
Effect of the Dams

Dams have had two main effects on the river:

- (i) Firstly the transport of sediments, sand, and gravel has been substantially reduced by entrapment above the dams. Thus the sand and gravel resources in the bed and banks of the river below the dams is renewable only to a limited degree.

Thus extraction is likely to lead to a long-term deficit with unpredictable effects on the stability of the system. It is argued by Scholer (1974) and others that the lowering of the bed and gradients is likely to lead to compensating adjustments in stream alignments. These effects are likely to be most pronounced as the river reaches the tidal limit and attempts to dissipate hydraulic energies by increased bending. These effects are most evident along Freemans and Argyle Reaches just below the tidal limit where extensive bank stabilisation measures have been required. As the river is naturally dynamic in this location it is difficult to assign cause and effect.

In the absence of data the long-term effects of such activities are speculative. A considerable research effort is required, including channel monitoring and possibly hydraulic modelling, to test strategies before any useful conclusions can be drawn.



Penrith Weir

This does, however, reinforce a strategy of conservative interim management, especially as market arguments do not support continued extraction from the bed and banks of the rivers (see Part 3). ?

- (ii) Secondly the reduction in base flows and flushing action, except during major storms when over-topping may occur, has substantially altered the channel form. |

Normal flows are very low and flow ceases for periods of time. The effects on channel morphology is minimal in the gorge units but very significant in the depositional units, where there has been siltation stabilised by vegetation and reduction in the permanent channel widths. This has led to demands for channel clearing and desnagging, with the accompanying sale of extracted materials. } Need to carefully assess these assertions

By the entrapment of silt and snags the frequent irrigation weirs on the Nepean above Wallacia contribute to this adaptation of the channel form during 'normal' flows. This adds to demands for channel dredging to maintain riparian supply above the weirs. ?

As the altered water regime, and therefore the channel adaptation, is permanent any demonstrable benefits of channel clearance are likely to be short-lived and to require ongoing maintenance to be effective.

However, it is likely that the natural high bank condition has been maintained as the dams have had little effect on the flood regime that forms them. Normal annual and biannual flooding is contained within the high banks and siltation maintains the profile. Floods of higher intensity top the banks and encompass the floodplains.

It is also argued that the adaptations of channel form to the new regime have exacerbated so called 'nuisance' flooding. There is currently no geomorphic/hydrological basis on which such conjectures can be debated and quantified. There is also an insufficient data base for modelling. | ?

Flood Mitigation

Although the Government now has a policy of discouraging development on flood prone land (set out in the Circulars to Councils N.S.W. Planning and Environment Commission 15, 22 and Department of Environment and Planning 31) man's use of the floodplain to date has not been tolerant to the natural regime, giving rise to attempts to mitigate flooding by increasing the channel capacity as well as by other engineering solutions.

The SPCC's publication, *Environmental Impact Assessment of Flood Mitigation Works and Dams* (1978), attempts to summarise

Doesn't seem to account for the implications of (i) on previous page - channel degradation might be expected.

The SPCC's publication, Environmental Impact Assessment of Flood Mitigation Works and Dams (1978), attempts to summarise information on flood mitigation in the context of an integrated approach to catchment management.

The publication states that structural methods of flood mitigation aim to minimise damage by:

- (1) reducing flood levels;
- (2) minimising overbank flow - containment;
- (3) reducing period of inundation; and
- (4) stabilising banks and reducing erosion.

The publication's review of the literature suggests considerable limits to the ability of engineering methods in meeting these objectives. Mitigation measures frequently displace problems upstream or downstream when piecemeal solutions are applied. This emphasises the need for a total systems view.

Minor floods can be beneficial by maintaining channel efficiency and stability, and fertility of the floodplain by silt deposition.

The complaint against minor (nuisance) flooding is loss of productive crops. However it may be preferable both in cost/benefit and ecological terms to use the floodplain for crops tolerant to minor flooding. Major floods are more destructive in terms of crop loss, erosion and heavy depositions of sands, etc. Therefore mitigation measures which do not control major floods are of limited value.

Operation of the dams to ameliorate major floods would be a huge benefit. The Inter-Departmental Committee on Hawkesbury/Nepean Flood Problems in its report of 1971 on operation of Warragamba Dam to ameliorate flooding was split in its findings. Two departments recommended that the gate and operation procedure should be modified, and that it should include flood forecasting aspects in certain cases, leading to a reduction of outflow rates for the majority of large floods. Another department did not agree with the reliability of forecasting and recommended no change. Submissions to the committee argued that the rapid rise and fall of floods caused most of the damage and that overseas practice, particularly in North America, used manual operation and forecasting to mitigate floods. It can be argued that if the Water Board was to be given a broader statutory role in water management than the conservation of water for human consumption these methods might be given more attention.

The SPCC publication suggests that the main economic effect of structural methods of mitigation is, in most cases, to shift costs of flooding from the private to the public sector (there are some examples of structural flood mitigation works being undertaken by the private sector, for example, in the cotton industry). This discourages an adjustment of land use to the natural regime. It would seem more equitable for the user to

take responsibility for the costs of at least normal flooding. This does not however obviate the need for better public control and dissemination of flood information.

The SPCC's publication devotes much attention to the effects of mitigation measures on riverine ecosystems. The report (1978) states: 'The flora and fauna of rivers and estuaries extensively utilise river substratas so alteration of natural characteristics such as river sediments and bank structure affects the survival of many species and clearing of trees along river banks may reduce available sources of food for many species and areas of shade and coolness which act as refuge sites in summer months'.

These comments apply equally to terrestrial fauna which benefit from the diversity of habitats in the terraced form of the natural channel, including fallen logs, and a range of vegetation communities.

The Water Resources Commission has reached agreement with State Fisheries on the protection of fish habitats with river clearance programs. The Water Resources Commission is currently negotiating with the National Parks and Wildlife Service about flora/fauna aspects.

There has been a fairly limited application of flood mitigation measures in the valley, mainly for historic reasons. The valley was settled early, before our greater technological advances and people wisely adapted to the natural regime. The founding of the Macquarie towns was a response to earlier lessons. However, the flood heights reached in the 1867 flood were not anticipated.

River Management Programs

The only measure being systematically applied in the Hawkesbury/Nepean Valley is a river management program. The Water Resources Commission establishes ideal alignments for the Nepean to widen and deepen the channel within stable banks. This is achieved by allowing commercial extraction of sands, gravel, and loam from the bed and banks. The controls imposed for such extraction are; minimum 1:30 bed slopes below low flow level, a 3 to 9 metre non-clearance zone along the toe of the bank and 1:50 slopes above the toe. The banks are then grassed and planted with native species.

Additionally, between Menangle and Wallacia the Water Resources Commission, in co-operation with Camden and Wollondilly Councils, carries out desnagging operations under a Federal grant scheme. This is aimed at clearing the river bed of stabilised vegetation and sandbars, as well as removing fallen trees and logs from the waterway.

Within the terms of hydraulic efficiency these programs may have some validity but their effectiveness both in flood mitigation and bank stabilisation has not been conclusively demonstrated.

BANK
REGRAIDING

At present the rationale and data supporting specific programs have not been published. Without quantified studies it is not possible to make an informed judgement. There is also a need to examine the displacement effects of sporadic and piecemeal channel clearance measures.

Future channel clearance programs in the Hawkesbury/Nepean River should be subject to environmental impact assessment in terms of the total system. If they are shown to be beneficial then the optimum rate and method of extraction needs to be established. Final landform, channel cross sections, rehabilitation measures, and landscaping should be determined before implementation. At present desnagging is carried out at a rate determined by the availability of funds. Private contractors extract at a rate suitable to meet the demand for sand.

Sporadic channel clearance determined by such economic considerations rather than ecological need increases the resultant turbulence, damage to banks and stream instability during floods. If clearance is found to be desirable the rates of progress should be determined by hydrological considerations and funding should be sought accordingly.

While it is unclear that river clearance ameliorates the effects of minor floods, it is clear that such measures do not have any significant effect on major floods, which are much more damaging to property, productivity and the environment. The SPCC report states: 'A well vegetated and stable catchment helps to minimise damage by floodwaters, especially low-level nuisance flooding'.

Water Quality

Water quality is the most technically complex issue considered in this study as most land use and resource management decisions have an impact upon it. The vulnerability of the system to water quality problems must add considerable weight to this issue in such decisions.

The SPCC has measured water quality and nutrient loads transported by the river system in order to develop mathematical models describing the system. The models have been used to predict the distribution and concentrations of nutrients and their effects on the river. The study has measured and estimated the input of both point and diffuse sources of nutrients in the river system. Thus the model can be used to test various management and growth strategies in the catchment. The study's interim findings (SPCC 1981) tend to confirm the views expressed in their publication on Sydney's waterways (1977a), with harder evidence to support the warnings sounded.

The river is under stress due to eutrophication, that is, excessive nutrient concentrations which result in an increase in aquatic plant growth such as algae and a decrease in dissolved oxygen. The main source of concern is that increased population in the catchment will result in increased volumes of effluent being discharged to the waterway. Unless alternative effluent disposal strategies are adopted or effluent qualities are improved, increased aquatic plant growth will occur.



Lemna minor (Common Duckweed) growing downstream of Macquarie
Grove Road Bridge, Camden

The main source of nutrients during periods of low-flow is from sewage treatment plants. On an annual load basis non-point sources contribute significant loads of nutrients to the river although these loads are less than those from the sewage treatment plants. They include the runoff from urban and rural areas. Runoff from urban areas is highly polluting during wet spells when saturation of soils prevents absorption, and septic systems overflow. Runoff from rural lands includes pesticides, weedicides, and fertilisers.

These problems are discussed in the SPCC's publication, *The Quality of Sydney's Natural Waterways in Relation to Its Growth* (1977a). As the major nutrient inputs are from urban development, particularly sewage effluent, concern is expressed about continued urban development in the catchment. The publication argues for a re-evaluation of urban growth strategies to consider these impacts on water quality.

The study (SPCC 1981) shows that three sections of the river below the Camden and Penrith Treatment Plants and South Creek are under stress due to eutrophication. Currently approximately 100 kilometres of the river is affected and it is predicted that this will extend to 130 kilometres by the year 2000 unless disposal practices are altered or nutrient removal facilities installed at sewage treatment works.

The input at Camden is much lower due to the lower population to be served but dilutions are also much lower.

The Nepean above Wallacia is a highly retentive system because of low flow rates which are retarded further by the effect of natural sand/gravel bars and irrigation weirs. Its normal condition is more akin to a chain of ponds than to a flowing stream. A given water parcel can take several weeks to travel from Camden to Wallacia. The combination of low flows, high nutrient levels, high retention times and high temperatures is favourable to rapid algal growth.

The SPCC's (1981) data shows that inputs at Penrith affect the Nepean 20 kilometres down to Yarramundi and that the river functions as a polishing system for sewage effluent. If the biological health of the Nepean is to be maintained and its recreational capability realised it is imperative that the effluent be treated to a higher standard level before discharge.

The other major effluent inputs come from the treatment plants for the Western Corridor in South Creek which enters the Hawkesbury just below Windsor. As tidal flushing at Windsor is minimal the pollution problems are acute, especially in view of the intensive recreation use of the river below Windsor.

Sewage Treatment and Disposal

As sewage effluent is the main identified threat to water quality, methods of treatment and strategies for disposal are of critical importance.

All sewage plants in the catchment currently provide secondary treatment and most plants include tertiary processes or have these under construction. Provision has been made at the larger plants, including Camden, for the inclusion of nutrient stripping, if required.

There are several stages of nutrient stripping. The first step is nitrification of sewage effluent to reduce ammonia toxicity effects, followed by phosphorus removal and some degree of nitrogen removal.

In view of these problems and the evident caution of the authorities concerned, the solution often favoured is to pump the effluent out of the river system, preferably to a deep ocean outfall.

The Water Board is examining the feasibility of connecting the Camden effluent via the Glenfield and Liverpool systems to the Malabar outfall, and also of connecting the western plants to the proposed amplification of the northern trunk sewer to North Head. These solutions are long-term and imply large capital costs.

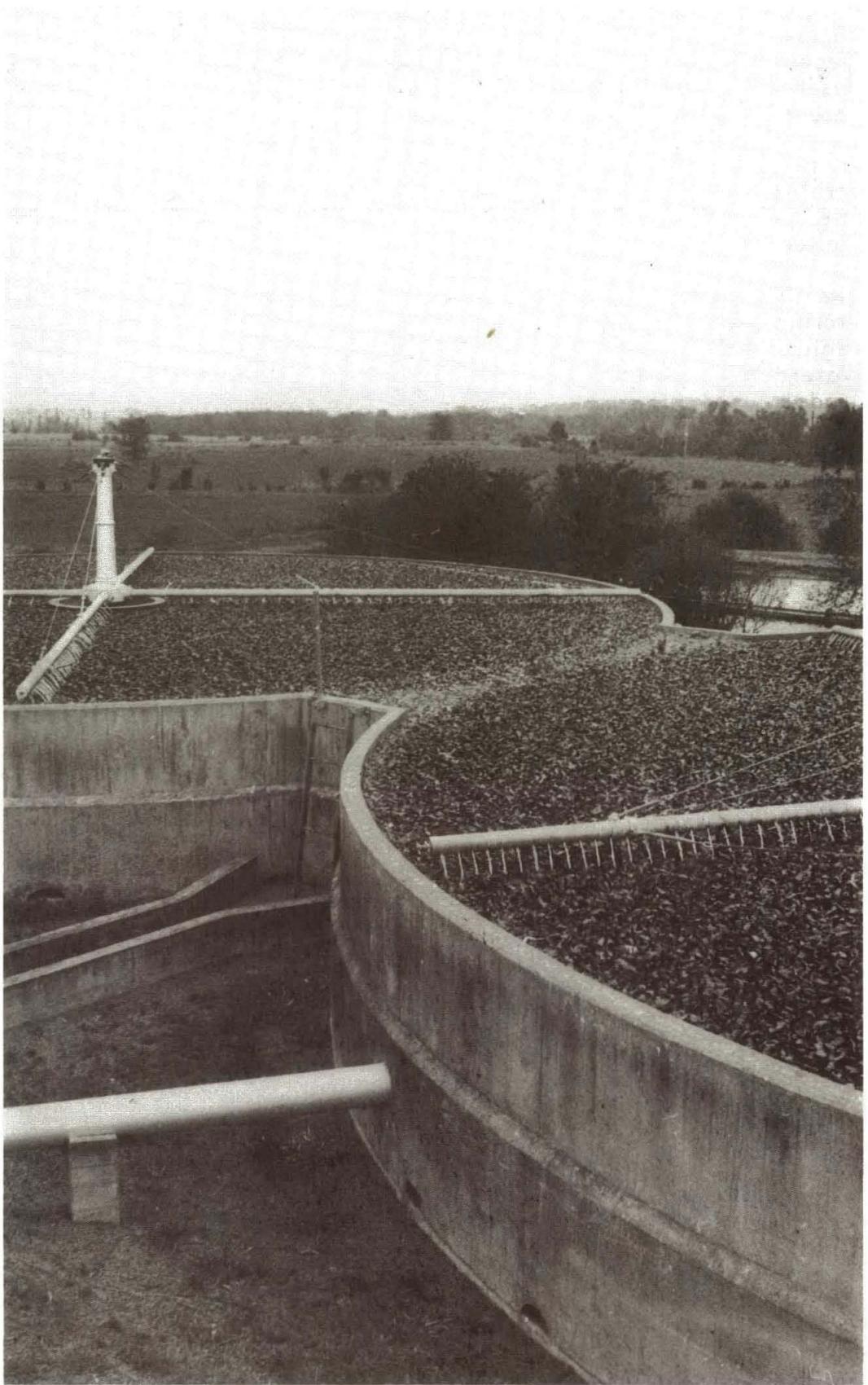
Ocean Disposal would eliminate the need for nutrient stripping with its consequent costs. A cost comparison of the alternatives depends on the projected populations to be served. The higher the population the more viable a pump-out solution becomes. The Department of Environment and Planning median projections in the catchment for 2001 suggest that the costs are of a similar order. This suggests an evaluation of other factors may be decisive.

While the ocean disposal would help resolve the nutrient load problem it would simultaneously remove a substantial source of water supply to the rivers. Many of the problems, including saline intrusions, in the waterway are induced by the low flow regime. Purified effluent, by assisting supply during normal periods of low flow could assist the biological and hydrological health of the system and improve its recreational value.

Ocean disposal will not reduce the high nutrient inputs from diffuse sources such as agricultural runoff or from the Blue Mountains settlements via the Grose River and Fitzgerald Creek and Lapstone Creek.

It is possible that methods of nutrient control other than in-plant removal could be implemented at lower community cost. These would include improved agricultural practices, improved stream assimilation, and land disposal of effluent from smaller treatment works.

Nutrient stripping or secondary treatment methods could be combined with retentive methods, including using water bodies to polish the effluent, using land irrigation, and experimenting with relatively untried techniques such as urban forestry. This would ensure lower nutrient loads being transported to the



Sewage treatment works, Camden

main stream as well as productive use of effluent. Composting of sludge in order to recycle wastes should also be considered. Decentralised systems including dry methods of disposal also deserve more serious examination in view of finite water resources.

A task force has been convened to look at water re-use strategies, including land disposal methods. This may assist in the critical water supply problem for agriculture above Wallacia.

The limits on the use of retentive systems for both effluent and stormwater management is the erratic rainfall pattern in the region, which results in periods of saturation when treatment waters would need to be held or overflowed into the system. A trade-off could allow overflows during such periods. Resulting heavy pollution would occur for fairly short periods due to the rapid flushing following storms, although increased water flow may mean that dilution is also higher. It may be acceptable to prohibit recreation use during such periods.

Such methods would restore to a seriously depleted system a large and constant water source with considerable benefits to the river regime, to environmental amenity and recreation use and to productive use in agriculture and forestry. Pilot applications would seem to be a prudent first step.

Retentive systems could be tried in the extensive lands in the valley, in the service corridors (South and Eastern Creek), on the floodplains at Camden (proposed open space), or in the proposed Penrith Lakes system. Currently Richmond's effluent is irrigated onto Hawkesbury Agricultural College lands.

It is likely that a mix of systems will be the solution rather than wholesale ocean disposal or tertiary discharge into the river.

The sewage and stormwater management options for the valley need to be subject to much broader social, economic, and environmental impact assessment before any conclusions can be drawn.

Agriculture

The section on hydrology has pointed out the need to monitor non-point sources of pollution such as runoff from urban and agricultural lands. Urban runoff is a major source of pollutants but as these normally discharge into the waterway during major storms they are flushed fairly readily. As runoff from rural lands occurs more slowly, the contribution of fertilisers, pesticides and weedicides into the system may be a significant source of pollution.

Extractive Industry

The SPCC's study (1977b) has indicated that extractive industry is not a significant source of turbidity and that the apparent turbidity of the mainstream is the result of brown algae.

Effect on Recreation

The Sydney Region Outline Plan and this study suggest that the major future role for the valley in relation to the region is for recreation and tourism. The maintenance of a viable flow regime is essential to fulfil these regional objectives.

Turbid water and algal blooms are aesthetic constraints to recreation use. It is also possible that the nutrient load in the system already presents some health problems to swimmers. Some ear, eye, and throat infections and skin irritations have been attributed to the toxic effects of algal growth in the Hawkesbury below South Creek. However, this has not been studied by the SPCC.

To date this does not appear to significantly deter water-based recreation but it does threaten the viability of the future recreational role foreseen for the valley.

Water Management

The well watered eastern seaboard and the supplies entrapped in its dams have given Sydney an abundance of high quality water by world standards. Supply and quality compare favourably with the other mainland capitals where restrictions on supply are common during dry periods.

The vast bulk of Sydney's water supply is drawn from the Hawkesbury/Nepean system. An immeasurable price has been paid for this resource in terms of permanent alteration of the flow regime. There has been, and undoubtedly will continue to be, growing resistance to attempts to dam the remaining tributaries, as evidenced by the Colo proposal which is now protected in the Wollemi National Park. While such resistance is usually motivated by nature conservation allied to recreation, some attempt needs to be made to measure the value of such resources in cultural, scientific and economic terms. In nature conservation terms freshwater habitats are inadequately protected and represented in national parks.

Currently the water resource is priced in response to the capital and maintenance costs of works, reticulation, etc. The indirect costs are not priced. These include lost recreation and nature conservation resources, lost biological productivity, and ongoing river management costs resulting from the altered river regimes.

The opportunity for further water entrapment on the Central Coast is very limited. As both population and consumption per capita are growing it is evident that pricing mechanisms and other water conservation measures will be necessary in future.

A case has also been made out in this report for a broader allocation of water, i.e. controlled releases to facilitate recreation use below Warragamba and possibly release strategies to mitigate major flooding. A value needs to be placed on

maintaining the system for recreation and agriculture. The recreation capability of the Nepean above Wallacia for water-based recreation is limited and there is a critical riparian supply problem.

0.6 m³/s
As agreement has been reached between the Water Board and the Water Resources Commission to sustain flow over Penrith Weir (50ML/day), it is highly desirable to reach a similar agreement for the Camden area of the river. Baseflow conditions at Camden are 5ML/day or less.

Conclusions

1. Catchment Management:

In the past, intervention in river systems has been accepted as an inevitable and necessary corollary of development and protection from floods and land loss. Now, with greater knowledge of the costs and environmental effects of such solutions, (and in the case of the Hawkesbury/Nepean River, the major problems of water quality) non-structural solutions should be examined. These problems are insoluble without integrated studies and management policies for the waterway. Functions such as water supply for human consumption and agriculture; pollution control; land use planning; land and river management; and conservation of natural areas require co-ordinated management and consensus decision-making.

The catchment should be analysed for its land use suitability and capability and urban development sited accordingly. The impacts of development on the landscape, vegetation, wildlife, and hydrology should be minimised. This favours development on the low-relief alluvium/shale units in preference to the sandstone.

The clearing of vegetation and the use of hard impermeable surfaces should be minimised. Rather than managing the run-off that occurs it should be minimised at source. Porous pavements and retentive drainage systems should be used where practicable. Techniques of groundwater recharge should be used to take up excess run-off in order to maintain natural drainage patterns.

2. Extraction:

Extraction from the bed and banks is likely to lead to a long-term deficit in the sediment load with consequent lowering of the bed with unpredictable effects on the stability of the system.

The effects of extractive industry on water quality and turbidity are local only. The turbid quality of the mainstream is the result of brown algae.

The extent of the effects of extractive industry on water quality and turbidity are not known. The SPCC is concerned that sand mining may be extending the zones where blue/green algae may proliferate and is undertaking further studies.

Removal of bank vegetation and channel widening exposes larger areas of water to direct sunlight, increasing photosynthesis and temperatures with adverse effects on water quality and biota.

Continued extraction from the bed and banks of the river is a contentious issue and all future proposals should be subject to careful consideration.

3. Flood Mitigation:

A well vegetated and stable catchment helps to minimise damage by flood waters, especially low-level nuisance flooding.

Desnagging and extraction within the context of river channelisation policies have no demonstrable flood mitigation benefits.

Flood mitigation should not be used as a means of shifting costs of normal floods from the private to the public sector.

The cost-effectiveness of using structural methods of mitigation for minor floods is questionable, quite apart from their environmental effects.

A combination of structural and non-structural methods may be applicable to mitigation of major floods.

Consideration should be given to the manual pre-release operation of the Warragamba Dam combined with forecasting to minimise peaks and rise and fall rates during major floods.

4. Recreation:

As both the Sydney Region Outline Plan and this study sees the major future role of the valley to be recreation all efforts should be devoted to maintain and enhance the waterway for this purpose. This includes the maintenance of adequate water supply of potable quality for water-based recreation.

Nutrient stripping, perhaps combined with natural systems approaches to effluent treatment and stormwater management is required to secure the valley's future role for water-based recreation.

5. Water Quality:

The full implications of sewage effluent management

strategies for the valley need to be aired, probably in the form of a social, economic and environmental impact assessment.

More attention needs to be given to diffuse sources of pollution, in particular urban stormwater run-off. The capability of the valley to accept urban development needs to be ascertained. It would be desirable to prepare guidelines for urban development which should address the following problems:

- (i) the minimisation of run-off at source;
- (ii) the supplying, conservation, recycling and disposal of water;
- (iii) the designing of urban areas to minimise hydrological impact;
- (iv) the adoption of run-off control standards;
- (v) the mitigation of flooding and pollution from stormwater in existing urban and future urban areas.

6. River Management:

Inter-Departmental liaison is required as well as interdisciplinary studies such as the SPCC's current water pollution study (1981). Systematic data on channel morphology as a prelude for hydrological models of the system is a prerequisite for reaching firm conclusions about the river's past and therefore predictable future behaviour.

Until such studies are done, the evidence and caution would suggest the need for conservative management minimising intervention and encouraging rehabilitation of the natural regime.

Laughtondale

General Conclusions

Need for Co-ordinated Management

1. The river and the valley have been extensively modified by damming of the major tributaries for water supply; insertion of low level weirs to regulate supply for irrigation; clearance for agriculture and urban development; the mining of sand, gravel and topsoil from the bed, banks and floodplains; and by flood mitigation and bank stabilisation measures. There is little knowledge of the natural system before European settlement and subsequent changes have not been systematically monitored. An understanding of the river as an integrated system and consequent co-ordinated management has been hampered by the disparate responsibilities and actions of single-purpose authorities. A co-ordinated interdisciplinary and inter-departmental effort is desirable to reach solutions to the complex questions of hydrology, water quality and the maintenance of natural systems.

Need for a Minimal Intervention Policy

2. Because there is a lack of knowledge of the natural order and of the effects of human intervention, caution and conservative management policies are desirable. Further intervention should be carefully assessed and non-structural solutions explored. As implicit in recent government policies on flood-prone lands and coastal protection, it is often preferable and cheaper for people to adapt to the natural pattern, thus avoiding extensive intervention with unpredictable effects, usually incurring long-term ongoing costs.
3. This policy of minimal intervention was recommended in a report of the Technical Advisory Committee of the State Pollution Control Commission on the extractive industry in the Hawkesbury/Nepean Valley, published in 1977 by the State Pollution Control Commission. The Committee recommended that extractive effort until at least the turn of the century should concentrate on high level and floodplain resources, which will have minimum environmental effects on the waterway itself. Following extraction each site can be rehabilitated as retention ponds or lakes, or land-fill sites for urban development. This will minimise impacts on the natural regime of the river itself.
4. Parallel with such conservative policies the natural environment should be rehabilitated as far as possible.

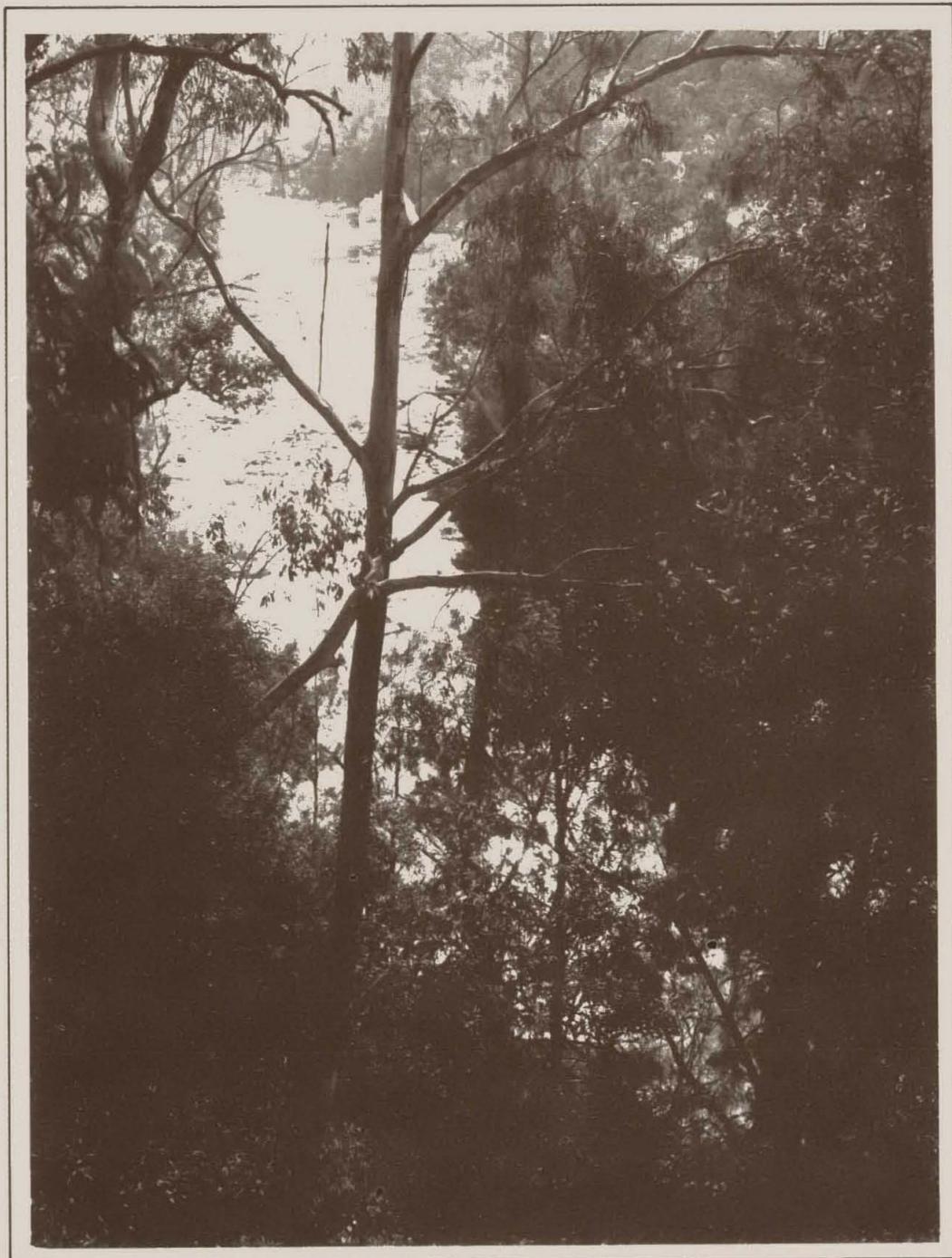
Need for a Conservation Management Policy

5. Sydney is fortunate to be one of the few large cities in the world with abundant, relatively undisturbed natural landscapes on its periphery. Although the rugged terrain and infertility of the Hawkesbury sandstone plateaux which encircle the Cumberland Plain have inhibited the growth of the region, they are also resources of uncommon beauty, which support diverse and rare animal and plant communities.

Such assets imply large responsibilities in terms of conservation and management, exacerbated by the growing and changing leisure demands of the metropolis. There has been rapid growth in demand for resource based recreation in natural areas and a relative decline in participation in organised sport.

However, the recent lack of development in the valley has allowed authorities time in which to come to terms with the very difficult problems of managing and developing these resources while maintaining their natural attributes. Management aimed at conservation implies permitting low-impact use while placing limits on access, particularly by motorised transport.

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Nepean River near Nortons Basin

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8. Survey Data: Numbers of Recreation Users: Australia Day 1977
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12. Recreation Action Plan
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