

HUME HIGHWAY

SECTION: AYLMERTON TO HODDLES CROSS ROADS

including

MITTAGONG BYPASS

BERRIMA BYPASS

National Highway No. 31



ENVIRONMENTAL IMPACT STATEMENT

Department of Main Roads N.S.W

SUBJECT: State Highway No. 2 — Hume Highway.
Shire of Wingecarribee.
Section: Aylmerton to Hoddles Cross Roads,
Including the Mittagong and Berrima Bypasses.
National Highway No. 31.
Environmental Impact Statement Clause
59 Certification.

This is to certify that the subject Environmental Impact Statement has been prepared in accordance with Clauses 57 and 58 of the Environmental Planning and Assessment Regulation, 1980.



Engineer for Environmental Matters.

November, 1983.

INTRODUCTION

Because of the size of Australia and the distance between centres of population, the nation is particularly dependent upon its relatively few communication corridors to overcome what has been termed "the tyranny of distance" (Blainey, 1966). Our quality of life is enhanced by the ease with which we can move people and commodities to required destinations. An efficient transportation network facilitates the movement of resources to their productive uses, assists the distribution of goods and services and thus, the productivity of industries, and contributes to price and market stability (Section 6.4).

New South Wales, by population size and position, forms the centre of the Australian land transport arena. This State accounts for 35-40% of all Australian road tonne-kilometres (McDonnell, 1982). Within the State, the same national factors of geographic size and dispersed population centres have given rise to a situation whereby long distance freight transport is concentrated in a few corridors. Of the four corridors involved, the Hume Highway dominates with 43% of the total, representing 2,667.7 million tonne-kilometres in 1975-76. Since the operating costs of road transport can be directly affected by the nature of the roads that are available, it is essential to the economies of both Australia and New South Wales that the road system in general, and the Sydney-Melbourne National Highway in particular, be in good condition (Sections 6.5 and 10.3.3).

This National Highway, incorporating the South Western Freeway and Hume Highway, has been constructed to divided carriageway standard from the Crossroads south of Liverpool to Aylmerton, five kilometres north of Mittagong. Dual carriageways have also been provided for the twelve kilometres south of Hoddles Cross Roads to the southern boundary of Wingecarribee Shire.

This Environmental Impact Statement has been prepared to cover the proposed connecting section of divided carriageway highway, between Aylmerton and Hoddles Cross Roads. The proposal involves by-passes of Mittagong and Berrima. Freeway standard design will apply on the 25 kilometres of by-pass section, between Aylmerton and Medway Rivulet, while motorway standard design will apply for the 9.6 kilometres of dual carriageway between Medway Rivulet and Hoddles Cross Roads. Approximately 4.8 million cubic metres of excavation are required to construct the Mittagong and Berrima by-passes. It is anticipated that nine bridges and one access culvert will be required for the Mittagong by-pass section, and twenty-one bridges plus two access culverts will be required for the Berrima by-pass section. The longest bridges will be required to carry the dual carriageways over the Nattai River, Gibbergunyah Creek, and Wingecarribee River.

The existing Hume Highway between Aylmerton and Hoddles Cross Roads is below the Commonwealth standards required for the Sydney to Melbourne National Highway. Congestion and noise from through traffic in Mittagong and Berrima are already cause for concern, and this situation will deteriorate further as traffic increases. Heavy vehicles comprise 30 to 35% of the flow, and many of these vehicles travel at night when noise is particularly noticeable.

Various alternative routes for the National Highway have been investigated and subjected to public exhibition. The proposed western route has been favoured by a considerable majority of local residents and most authorities contacted. All of these alternative options are discussed in the Environmental Impact Statement.

In compliance with the environmental policies of both State and Commonwealth Governments, the Department of Main Roads, N.S.W., has undertaken comprehensive investigations into the environmental effects of the preferred route for National Highway No. 31 in the Mittagong-Berrima region, and compared these with feasible alternatives. This Environmental Impact Statement presents particulars of these investigations, in accordance with Part V of the Environmental Planning and Assessment Act, 1979, and associated Regulations.

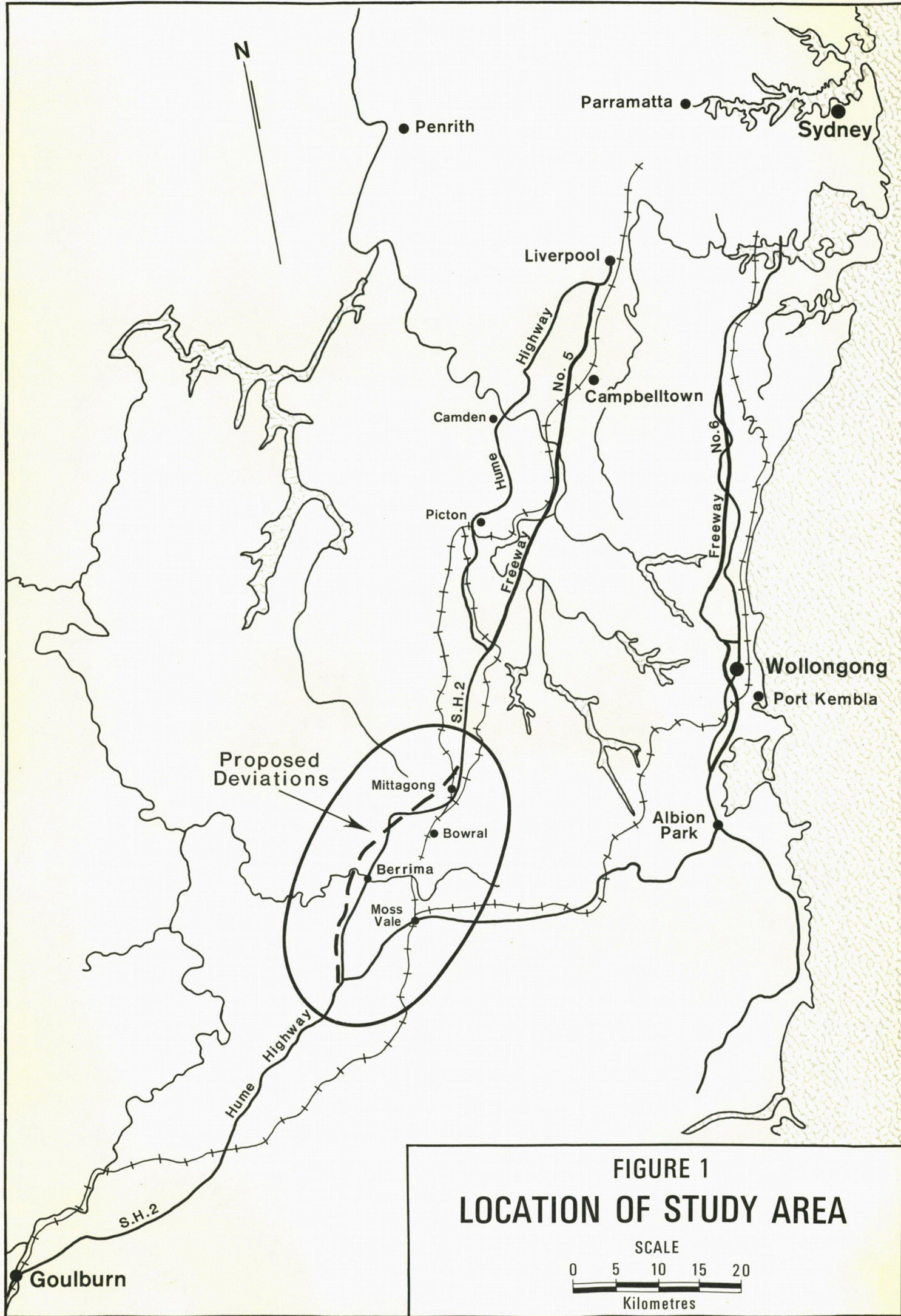


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1. ENVIRONMENTAL IMPACT STATEMENT SUMMARY

1.1 OBJECTIVES

To serve the community's need for the safe and efficient movement of people and goods by developing a high standard road between Sydney and Goulburn.

To contribute towards the Commonwealth Government objective of developing a national highway standard road between Sydney and Melbourne.

1.2 DESCRIPTION OF THE STUDY REGION

1.2.1 Natural Environment

Situated in the south-western section of the Sydney geological basin, the "Southern Highlands" or Tablelands sector of Illawarra is dominated by a mature sandstone plateau, about 670 metres above sea level. Isolated hills rise above the plateau surface, which is also deeply incised by the major rivers flowing to the west and north. Massive Triassic sandstone and shale, capped with Tertiary basalt, form the most common geological units underlying the plateau. Other rocks include various volcanics and some Tertiary sands and gravels.

On the weathered shales, basalts and volcanics, relatively fertile soils have developed and the natural vegetation has been largely cleared for grazing and agricultural purposes. This relatively fertile area is fringed by rocks of the underlying Hawkesbury Sandstone. More rugged and dissected landforms with skeletal soils are associated with the sandstone. These erodible, low nutrient sandstone soils remain largely uncleared of their native vegetation cover.

1.2.2 Human Environment

Although Aborigines with a traditional hunting and gathering society inhabited the tablelands for at least 5,000 years, European settlement of the area resulted in the virtual destruction of the Aboriginal population and way of life within four to five decades. Since the 19th Century the Aboriginal population of the Illawarra region has increased, but the traditional way of life is no longer practised.

European settlement in the study area began in 1816. By 1830 most of the suitable agricultural land had been taken up. The first village to be formed was at Bong Bong. However, because of water problems, urban settlement moved to Berrima, where a new road crossed the Wingecarribee River, then to the towns of Bowral, Moss Vale and Mittagong with the establishment of the railway in the late 1860's.

The economy of the Southern Highlands has traditionally been rural in nature, and this is reflected in the major land use pattern. Industrial activity has been intermittent. Coal mining and quarrying have also been traditional activities. However the percentage of the workforce employed in agriculture and mining has recently declined. A restructuring has been occurring with increases in the manufacturing, retailing, finance and business sectors. There has been a continuing significant percentage of the workforce employed in such community services as health and education, and in tourism. In addition to the rural and urban land uses, other significant uses are water catchment and state forest.

The population of Wingecarribee is concentrated primarily in an urban axis centred on Mittagong, Bowral and Moss Vale. Of the alternatives investigated, the preferred western route affects the least number of people. Population growth in the Shire recently more than doubled the State level. At the 1981 Census, 56.2% of the population had moved residence within the previous five years.

Two transportation corridors, containing road and rail links, pass through the study area. They are the north-south Sydney to Melbourne corridor and the east-west Wollongong to Moss Vale corridor. There is heavy freight usage of both road and rail. While rail was the dominant transport mode from the second half of the 19th Century to the early 20th Century, since mass production of automobiles in the 1920's the Illawarra

transport system has developed primarily for road transport. Within Wingecarribee Shire the trend towards increasing car ownership has continued.

1.2.3 Planning Policies

The stated purpose of the Draft Illawarra Regional Environmental Plan is to provide a framework for co-ordinated action between government agencies, private agencies and individuals to ensure: the best utilisation of resources, a good investment climate, optimised quality of life, and integrated planning. To retain valuable agricultural land now under residential and industrial expansion pressures, planning objectives have been set which define specific growth areas.

1.3 EXISTING MAIN ROAD SYSTEM AND ITS DEFICIENCIES

The Hume and Illawarra Highways are the principal north-south and east-west roads, respectively. As part of the National Highway System, the Hume Highway connects Australia's two largest cities while forming part of the main access to the National Capital. It is also a major freight artery but passes, at present, through Mittagong and Berrima. The sub-standard design of the subject section of road, a large percentage of heavy vehicles, and through traffic mixing with local traffic, are factors which result in a low level of service. Congestion, disruption of residential and commercial environments, and numerous accidents occur.

1.4 ALTERNATIVES

The "do nothing" and "improve existing highway" options have been examined and discarded because they would not improve the existing unsatisfactory situation.

Four alternative bypass routes have been examined and subjected to public comment. Only one alternative, the preferred western route, gained substantial public support.

1.5 JUSTIFICATION OF PROPOSAL

A high standard, inter-capital city highway is proposed between Sydney and Melbourne by the Commonwealth Government as part of its National Highway System. The existing road does not meet the design criteria established to provide an adequate facility.

Construction of the proposed section of national highway will improve access to other major centres and thus, the relative location of the study area. This should further stimulate the industrial expansion which has occurred, assisting local employment prospects.

At the state and national levels, improving transportation in the heavily trafficked Sydney-Melbourne corridor will help reduce the transport costs of both raw and finished products and contribute to price stability. Individuals, commerce and industry will be able to enjoy the benefits of the improved travelling conditions. A benefit/cost ratio of 2.7/1 has been assessed for the Aylmerton to Hoddles Cross Roads section. An annual saving of 10 lives and 140 injury accidents is possible with the proposal.

1.6 DETAILS OF PROPOSAL

To meet both national and state road requirements in the study area, the design provides for a four-lane, dual carriageway road with shoulders, grade separated interchanges for the Mittagong and Berrima bypass sections, and a safe travel speed of 110 km/hr. No frontage access from adjacent properties will be available.

Approximately 4.8 million cubic metres of excavation, 30 bridges, 3 access culverts, and 3 interchanges are entailed in constructing the 25 kilometres of bypass between Aylmerton and Medway Rivulet. A further 9.6 kilometres of carriageway duplication is required between Medway Rivulet and Hoddles Cross Roads.

1.7 FEATURES OF THE PROPOSED CORRIDOR

Detailed geological, soils, vegetation, faunal, archaeological, and land use studies have been undertaken. The most significant aspects are the talus slopes through the Nattai Gorge, areas of moderate to highly erodible soils, eight plants communities with a total of 257 species, platypus in the Wingecarribee River and the peregrine falcon in the Gibbergunyah Creek area, and 24 Aboriginal relic sites.

1.8 POTENTIAL IMPACTS AND PROPOSED SAFEGUARDS

During the planning stage the location of the highway was reviewed in light of geological, engineering, economic, environmental, land use and public representation considerations. This is reflected in the choice of the preferred route. All of the alternatives have been subjected to public analysis.

Detailed geological investigations are being undertaken along the Nattai Gorge section to determine jointing and weathering distribution as an aid to better design. The grades of the two carriageways will be separated at this location to suit the steep side slopes.

Most of the soils are moderately to highly erodible. Effective control of runoff during construction and early revegetation of cut and fill slopes will reduce erosion potential. A comprehensive erosion control programme will be undertaken to cover both the construction and operation stages.

Little extraction of coal has occurred under the proposed route. Since some subsidence may occur, further information regarding likely extraction dates and possible ground movements is being sought.

Although most of the route has been cleared, some areas of native vegetation remain. Clearing will be kept to the necessary minimum and a regeneration and revegetation programme will be undertaken. This will minimize the loss of native fauna habitat and discourage invasion by flora and fauna alien to the area. Bridging the Nattai River, Gibbergunyah Creek and Wingecarribee River will maintain movement corridors. A special research project is being investigated for the protection of platypus in the Wingecarribee River.

It appears that evidence of Aboriginal occupation may be found in the area almost anywhere that a level location is situated near a watercourse. Of the 24 sites located, only 3 will be wholly affected and another 3 partly affected by the project.

Provision will be made to maintain access on the local road network and to properties affected. Access across the highway reserve will be maintained for existing roads and for bush fire trails. All public utilities and services adversely affected will be re-established or adjusted, where necessary.

1.9 INTERACTIONS WITH THE ENVIRONMENT

1.9.1 Physical

Most of the soils which would be affected are erodible. The safeguards proposed should be adequate to control potential erosion and siltation problems. There are no known geological hazards which cannot be controlled using current design and construction methods. The flow of existing watercourses will be maintained.

Since calm periods occur most frequently during winter, there is some potential during this period for stable atmospheric conditions restricting the dispersion of automobile emissions. The present situation should be improved by removing through traffic out of the Mittagong and Berrima areas onto the free-flowing bypasses.

1.9.2 Biological

The highway will traverse a region which has been extensively cleared of native

vegetation. Remaining areas of vegetation will experience some clearing and fragmentation. Some of the cleared areas will be allowed to regenerate. Only one of the three plant species listed as being "vulnerable" will be affected. However, it is common in the Nattai River region.

Constructing the 34.6 km of highway will result in the loss of approximately 65 hectares of bushland and faunal habitat. The populations of native fauna appear to be low along the proposed route. They have suffered from 1½ centuries of European settlement. Constructing the highway will provide a barrier between the built areas and extensive bushland to the north-west.

1.9.3 Human

Most of the land which will adjoin is rural. Other land uses affected are open space for recreation or special purposes, and the town of Welby. Provision is being made in the local planning instruments for the highway reserve. However, the tentative boundaries proposed south-east of the Nattai River for a National Park would be affected.

It is anticipated that 10 houses will need to be demolished or moved. One school is also affected. The population of the Shire has generally been very mobile, 56.2% having changed residence within a five year period. Household moving, whether voluntary or involuntary, involves some stress, varying according to personal circumstances and traits. Consequently, each case involved will be given individual consideration.

About 16 houses lie within 100 m of the proposed highway and will experience some noise increase. Consideration is being given to ways for keeping this to acceptable levels.

Individuals, commerce and industry will be able to gain direct benefits from reduced travel costs and time as a result of the improved accessibility between Sydney, the Southern Highlands, and Melbourne. The Hume Highway carries over 40% of the total New South Wales long distance road freight. Consequently, the community as a whole will benefit through lower transportation costs, quicker delivery of raw and finished products, reduced accidents and energy savings.

1.10 SUMMARY ASSESSMENT

The potential savings in lives, accidents, energy consumption, travel times and costs clearly favour providing a new, divided carriageway road bypassing the built up areas, compared with the "do nothing" or "improve existing highway" options. Investigations of the environment and public opinion have shown that the most appropriate location is the preferred western route.

There are potential erosion and sedimentation problems but comprehensive control measures are proposed. Calm conditions are most likely to occur during the winter, allowing stable atmospheric conditions to restrict the dispersion of automobile emissions. The present situation should be improved during these periods by removing through traffic from the congested built up areas. Approximately 65 hectares of indigenous vegetation will be cleared, resulting in some loss of habitat. Special measures are being investigated to protect a platypus colony.

Apart from the loss of 10 houses and one school, the effects on the built environment will be mainly beneficial. Job opportunities will be created, the existing town centre improved with the removal of through traffic, and there will be savings in the number of accidents, energy used, travel costs and travel time. It is considered that construction can be undertaken in an environmentally acceptable manner.

2. STATEMENT OF OBJECTIVES

Because the Hume Highway forms part of the declared National Highway System, the objectives are multipurpose, involving both State and Commonwealth Government goals.

At the State level, general goals are:

- to assist in achieving the intention enunciated in the Sydney Region Outline Plan, of regarding Sydney-Newcastle-Wollongong as a closely related urban complex, by improving a major arterial road between the Sydney and Illawarra regions; and
- to assist in the objectives outlined in the Illawarra Regional Plan for the regional economy, industrial land, living areas, commercial and service centres, transport, corridors, recreation and tourism, and historic buildings and sites.

More specifically,

- to serve the community's transportation need for the safe and efficient movement of people and goods by developing a high standard, dual carriageway road from Liverpool to Goulburn;
- to reduce traffic congestion, accidents, fuel wastage and pollution through the Mittagong-Berrima area; and
- to achieve both Commonwealth and State objectives jointly while undertaking all works in such a manner that the disturbance to the natural environment is limited and the physical appearance of the road and roadside is enhanced.

At the Commonwealth level, the criteria for inclusion in the National Highway System are "roads which:

- (a) encourage and contribute, to a major extent, to trade and commerce, overseas and among the States; and/or
- (b) assist industry located in major centres of population to be complementary to industry located in neighbouring major centres; and/or
- (c) reduce, significantly, transport costs of the products of rural and/or secondary industry, between points of production and points of export or consumption; and/or
- (d) provide for long distance movement associated with recreation and tourism; and/or
- (e) improve movement between defence production centres, defence supply and storage locations, and defence establishments generally".

By constructing the connecting dual carriageway section between Aylmerton and Hoddles Cross Roads, the Hume Highway will be able to fulfil more effectively its role as a principal National Highway. It meets all of the above criteria, assisting trade, commerce, industry and tourism while also substantially reducing transport costs and improving defence mobility potential between Sydney, Canberra and Melbourne.

3. DESCRIPTION OF THE REGION

3.1 THE NATURAL ENVIRONMENT (Figures 2 & 3)

3.1.1 Physiography

Situated in the south-western section of the Sydney Basin, the study area is dominated by a mature sandstone plateau, about 670 m above sea level, which has an area of deeply incised valleys in the Nattai Gorge sector. Throughout the region isolated hills, associated with remnant basaltic caps, rise above the plateau surface. The most prominent is Mount Gibraltar which forms part of the Mittagong Range (see Figure 2).

Deep incision by the Nattai River and Gibbergunyah Creek has produced prominent cliff and talus landforms in the Nattai Gorge just north of Mittagong. The Wingecarribee River has also incised deeply into the sandstone downstream of Berrima. The remaining rivers and creeks of the plateau are generally in a late stage of maturity. Most of the rivers in the study area flow to the west or north, ultimately contributing to the Warragamba River or to the Nepean River in water catchment areas (Figure 3). Many of the flat headwater valley floors are poorly drained and swamps have formed.

3.1.2 Geology

Massive Triassic sandstone and shale, capped with Tertiary basalt, forms the most common geological units underlying the plateau. Other rocks include various volcanics of Tertiary to Jurassic age, and some Tertiary sands and gravels which have been preserved under the remnant basalt cappings. While the sedimentary rocks generally dip gently, there is a dome structure in the Nattai Gorge which has tipped the beds up to 30 degrees in places. Incision by the Nattai River has exposed Narrabeen Group and Illawarra Coal Measure rocks in the gorge area.

The deeply dissected gorges have resulted from the rapid headwater recession of the major watercourses, caused by the erosion of the soft shales and sandstones of the Narrabeen Group beneath the massive sandstone beds of the Hawkesbury Sandstone. Hawkesbury Sandstone is distributed throughout the study area, frequently outcropping as cliffs and exposed in cuttings.

Ashfield Shale is the major component of the Wianamatta Group in the area. The Ashfield Shale is typically deeply weathered and exposures are restricted to pits and cuttings. Narrabeen Group and Illawarra Coal Measure rocks occur in the Nattai Gorge. There are very few exposures of Narrabeen Group rocks. They either occur as a lithological change in the cliff-forming sandstones or are buried below sandstone talus. Cappings of Tertiary basalts occur on most of the higher sections of the area, overlying Wianamatta Shales or Tertiary Sands and gravels. The remnant caps often consist of basaltic boulders in deeply weathered soils (S. Summerell, 1983).

3.1.3 Soils and Vegetation

The distribution of soils is a reflection of the parent materials. Soils downslope of basalt caps have had a considerable input of colluvial basaltic material while elsewhere the soils tend to reflect the underlying geology. In turn, the vegetation patterns have also been influenced by the local geology. On the weathered Wianamatta Shales, on the basalts, and on the volcanics of the extensive plateau area, relatively fertile soils have developed and the natural vegetation has been largely cleared for grazing and agricultural purposes. There are isolated stands of exotic or native trees. Soil types range from medium quality clay to good quality, well drained loam soils, although low lying areas tend to be swampy.

This relatively fertile area is fringed by rocks of the underlying Hawkesbury Sandstone, generally to the west of the Hume Highway and to the north of Mittagong. The more rugged, dissected landforms and skeletal soils are associated with the sandstone, and they remain largely uncleared of native open-forest to woodland cover. The soils derived from the sandstone are erodible, difficult to revegetate, and have a low nutrient content.

A more detailed description of the soils and vegetation along the proposed corridor is given in Sections 8.2 and 8.3 respectively.



(1) Typical plateau topography
(SECTION 3.1.1)



(2) Incised valleys in Nattai Gorge
(SECTION 3.1.1)

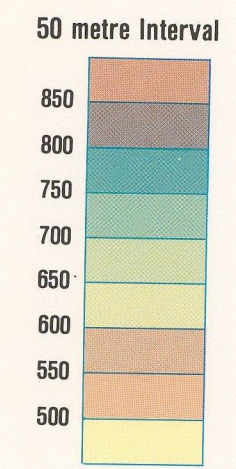
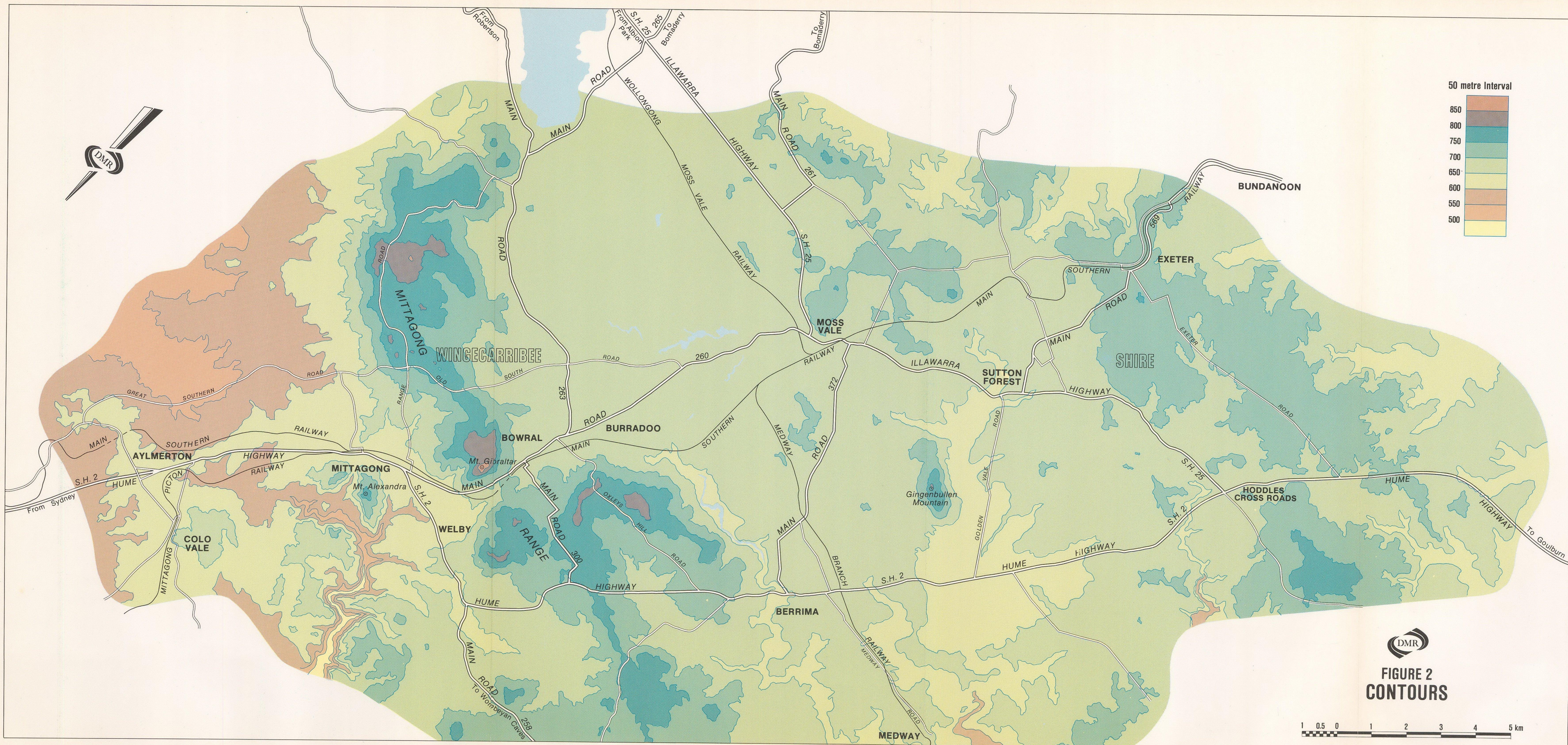
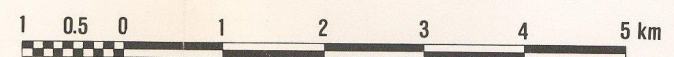
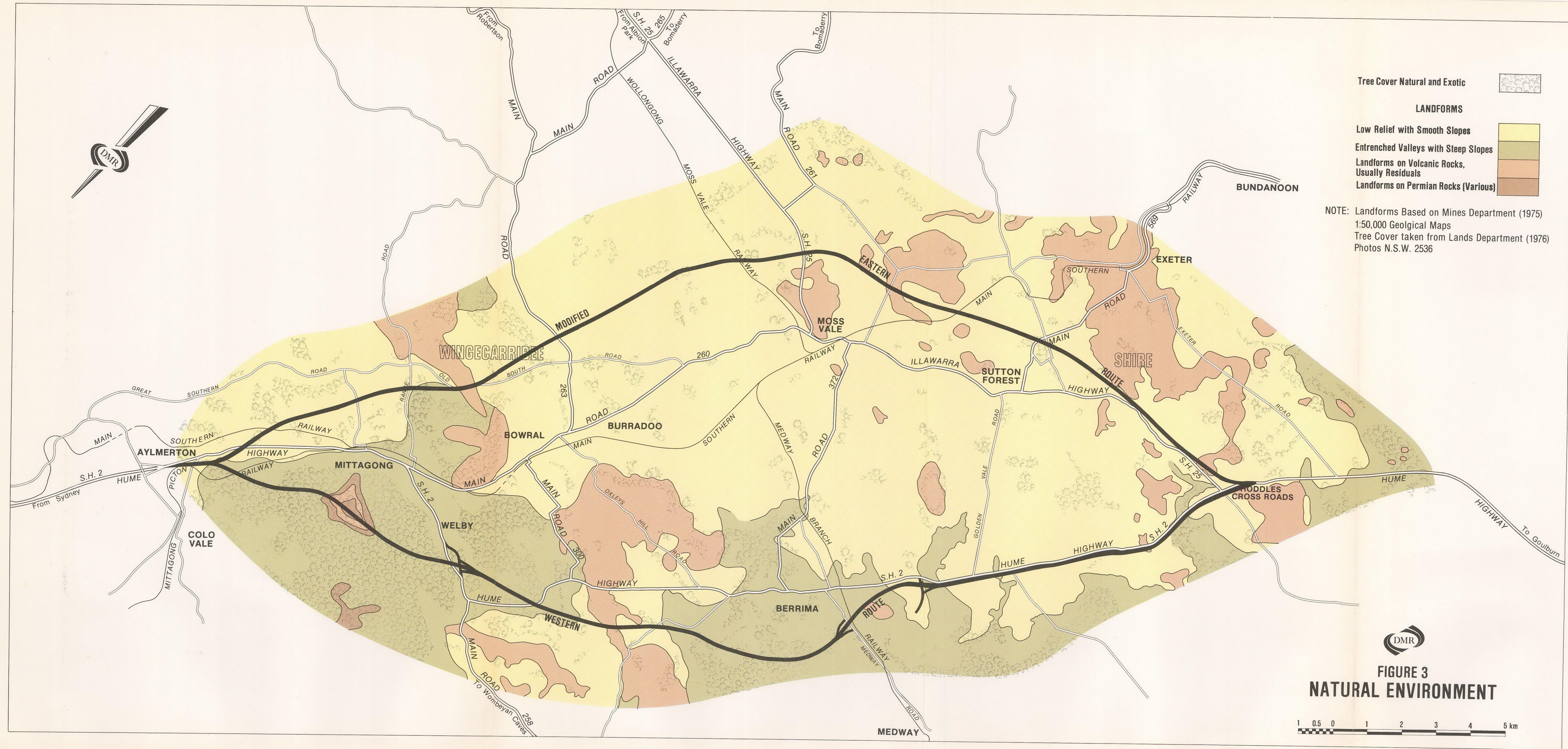


FIGURE 2
CONTOURS



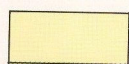


Tree Cover Natural and Exotic

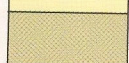


LANDFORMS

Low Relief with Smooth Slopes



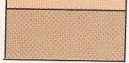
Entrenched Valleys with Steep Slopes



Landforms on Volcanic Rocks,
Usually Residuals



Landforms on Permian Rocks (Various)



NOTE: Landforms Based on Mines Department (1975)
1:50,000 Geological Maps
Tree Cover taken from Lands Department (1976)
Photos N.S.W. 2536



FIGURE 3
NATURAL ENVIRONMENT

1 0.5 0 1 2 3 4 5 km

3.1.4 Climate

The study area is situated immediately to the west of the high rainfall zone centred on Robertson. It has an annual rainfall of from 900 mm to 1000 mm compared with 1648 mm at Robertson. Data from two meteorological stations (Bowral and Moss Vale) is summarised in Table 3.1. While rain can occur on average throughout the year (27% of the days), the wettest season is summer with an average of 90 mm per month. The relatively driest period is mid-winter to early spring, which has an average of 60 mm per month. Mean temperature maxima range from 25°C in the summer to 11°C in winter, while the mean temperature minima range from about 13°C in summer to just above 0°C in winter. Evaporation rates are relatively low throughout the year, by New South Wales standards (Edwards, 1979).

Seasonal surface wind patterns at the Bowral and Moss Vale meteorological stations are shown on Figures 4 and 5 respectively. For both stations the most frequent winds through autumn, winter and spring are westerlies, morning and afternoon. In summer northeasterly winds prevail, although Moss Vale also receives south to south easterly winds. The more sheltered location of Bowral at the foot of Mount Gibraltar is indicated by the relatively high percentage of calm periods, compared with Moss Vale where there are virtually no calm periods recorded.

Data on fog occurrences indicates that the main period of incidence is between midnight and 7.30 am from March to June. Fogs in other months are predominantly of a less intense nature.

3.2 THE HUMAN ENVIRONMENT

3.2.1 Aboriginal Settlement

"Australians of Aboriginal descent and their ancestors have lived in Illawarra for at least 20,000 years and many traces of their long occupation still remain. Most of the sites are not large or very spectacular because the Aborigines, being hunter gatherers, did not make the permanent settlements and buildings necessary for agricultural or industrial societies" (D.E.P., 1982b, p.88).

The earliest reference to the Aborigines of the tablelands area appears in Wilson's Journal of the 1798 expedition. He refers to the large skin cloaks that they were wearing at the time (Koettig, 1981). No estimate was given of their population. Jervis states that "an extensive native outbreak occurred in March and April of 1816, and it was necessary to take punitive action against the aborigines" (Jervis, 1937). Another source indicates that the stockmen of a prominent early settler "had frequent encounters with the aborigines in the 1820s but by the 1850s, many had been killed and others moved away from the District. By the 1870s, there were no aborigines living in the District" (Wild 1970). The total number of full blood Aborigines estimated to be living in the Wollongong, Shoalhaven, Richmond and Kiama administrative areas was only 33 by the end of the nineteenth century.

The Aboriginal population of the Illawarra region has increased since that time, though the number of pure-blood Aborigines is not known. Approximately 3,000 people in the region claim Aboriginal descent. The traditional way of life is no longer practised, and much of the settlement is in the coastal urban areas (D.E.P. 1982b).

3.2.2 Early European Settlement

Historically, the tablelands, or "Southern Highlands" developed as a small but productive agricultural district. "Settlement began here as early as 1816, and by 1830 most of the land fit for occupation had been taken up . . . The pioneer settler was Lieutenant John Oxley, Surveyor-General of New South Wales, who occupied land as a grazing run, first at Bargo and later at Wingecarribee" (Jervis, 1937). Steps to form a settlement were taken by Governor Macquarie, naming it Sutton Forest in 1820. After Oxley's death in 1828 a deed of grant for 2000 hectares was issued to his widow and two sons on land which was later to be part of the town of Bowral. Probably the earliest settler

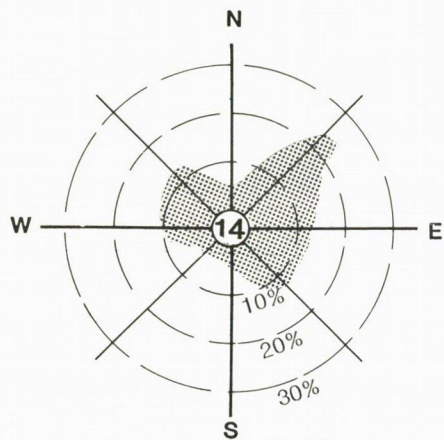
TABLE 3.1: RAINFALL AND TEMPERATURE DATA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Rainfall (mm)													
Bowral	100	80	80	76	64	84	32	69	55	83	102	100	925
Moss Vale	96	95	90	84	89	99	84	63	59	77	71	82	990
Median Rainfall (mm)													
Bowral	102	58	65	56	42	56	28	56	45	70	71	99	1002
Moss Vale	90	75	72	72	54	67	60	41	44	60	62	65	983
Mean Number of Raindays													
Bowral	14	13	14	12	14	11	10	12	10	13	13	13	149
Moss Vale	11	11	11	10	10	10	9	9	9	10	10	10	120
∞ Mean Daily Temperature °C													
Bowral													
Maximum	25.0	24.3	22.4	20.3	15.2	12.6	12.0	13.1	15.9	19.3	20.8	23.7	18.7
Minimum	12.5	13.0	10.2	6.1	3.2	2.1	0.2	1.8	3.3	6.5	8.4	10.4	6.5
Mean Daily Temperature °C													
Moss Vale													
Maximum	24.5	24.4	22.4	19.3	14.6	12.1	11.3	12.7	15.9	18.9	21.1	23.4	18.4
Minimum	13.0	13.3	11.4	8.0	4.7	3.2	1.6	2.8	4.6	7.3	9.2	11.2	7.5

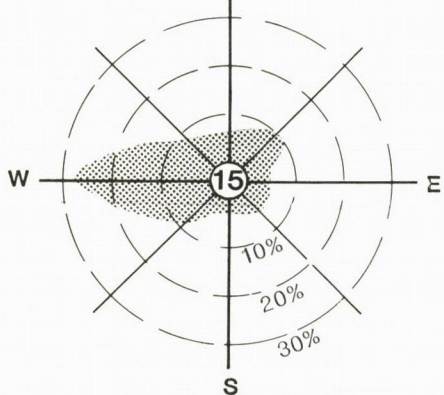
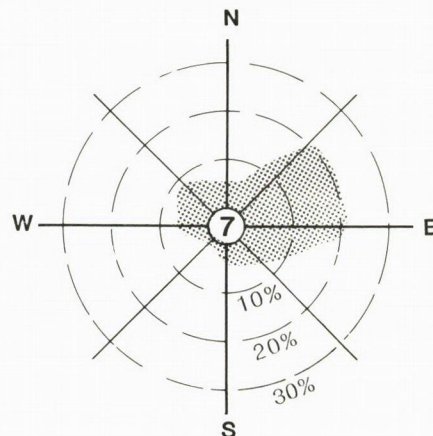
Elevation of Bowral Station: 661.4 m Elevation of Moss Vale Station: 672.1 m

0900 hours LST

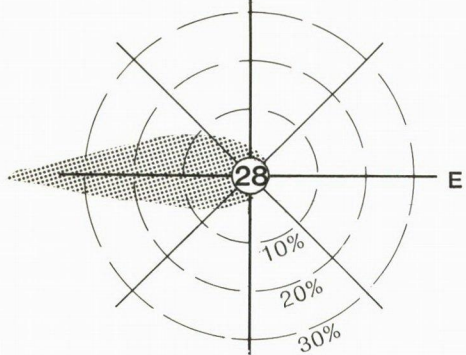
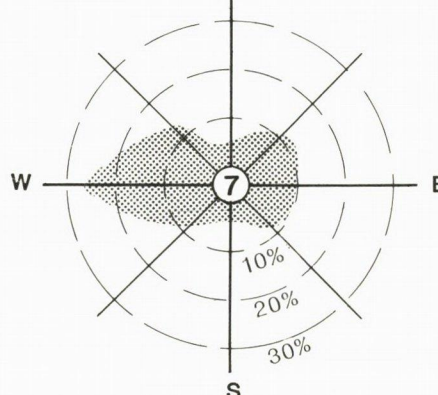
1500 hours LST



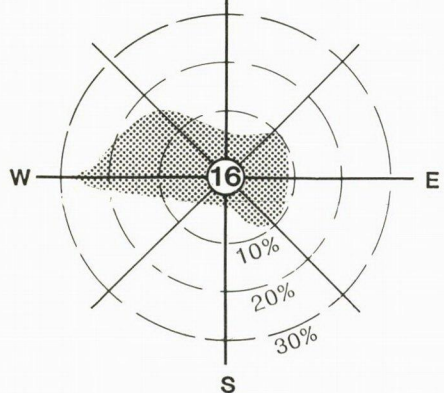
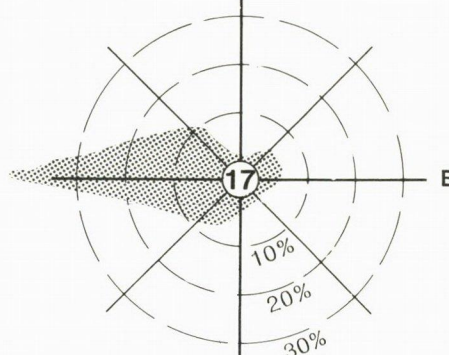
JANUARY



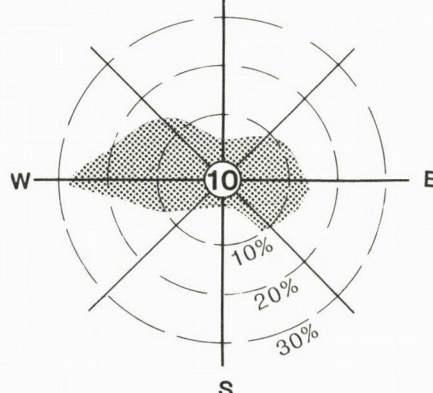
APRIL



JULY



OCTOBER



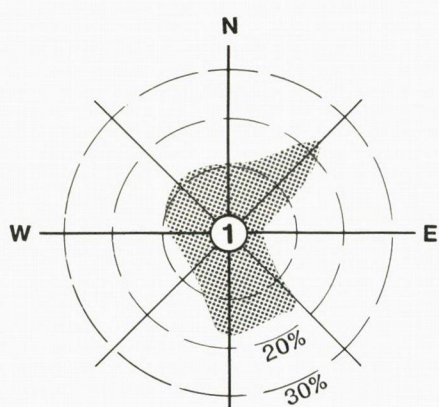
Percentage calm indicated thus :- ⑦

Elevation 661.6 m

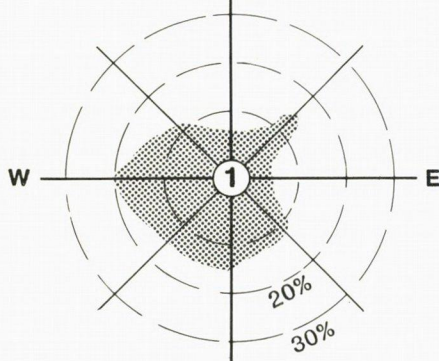
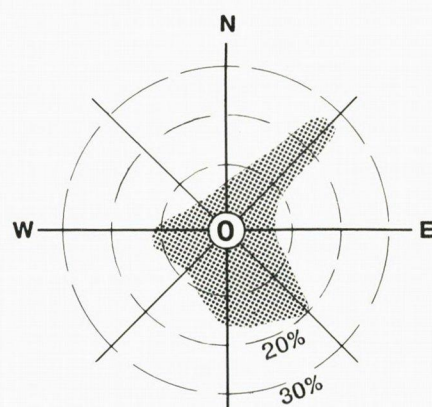
FIGURE 4
SURFACE WIND PATTERN
AT BOWRAL

0900 hours LST

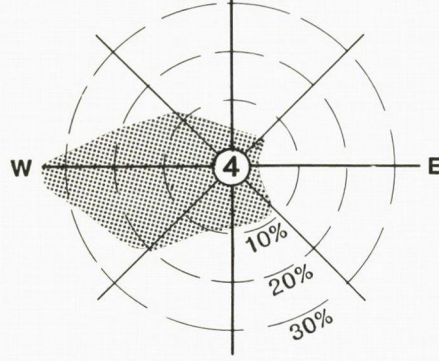
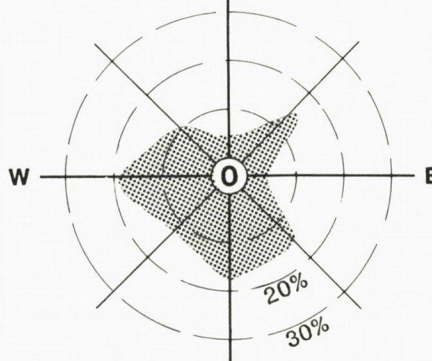
1500 hours LST



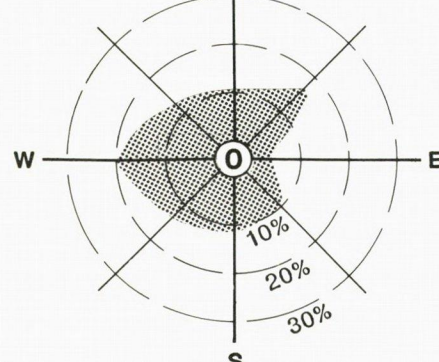
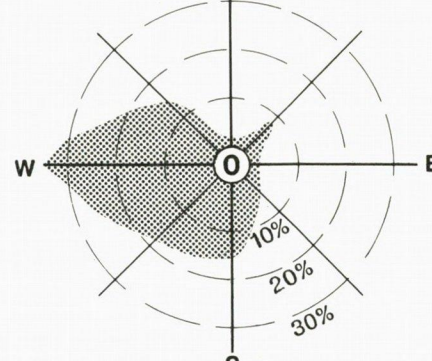
JANUARY



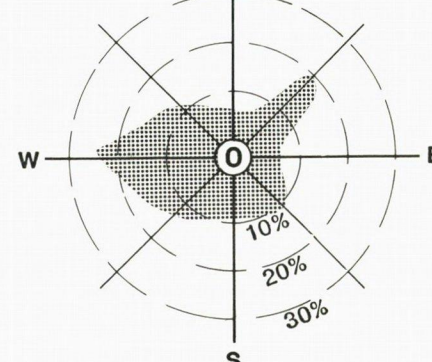
APRIL



JULY



OCTOBER



Percentage calm indicated thus:- ④

Elevation : 672.1 m

FIGURE 5
SURFACE WIND PATTERN
AT MOSS VALE

at Mittagong was William Charker, who received a permit to graze cattle on the Mittagong Range in 1821. He received an order for 80 hectares in 1823 for his services as Principal Overseer of Government Stock.

Early settlement was spasmodic. Access to Parramatta and Sydney was via a cart road, completed in 1821, which followed a line generally to the east of the present Hume Highway. It crossed over the Mittagong Range at "The Gib", passed through Bong Bong and proceeded south over the Cookbundoon Range to just north of the Goulburn Plains (D.M.R. 1976).

The first village to be formed in the district was at Bong Bong, in the mid-1820s. Bowman's Inn was erected, together with barracks for a small force of soldiers and a building for police use. However, because the water at Bong Bong was "very indifferent and in dry seasons, scarce," a new country town was established at Berrima where the newly marked line of road (now known as the Hume Highway) crossed the Wingecarribee River. While plans for the layout of Berrima were approved in 1831, settlement developed slowly, "probably because of the delay in completing the South Road and because the township lay on the fringe of settlement in the district" (Jervis).

The new Court House and Gaol were finally completed in June, 1838 and June 1839, respectively. In August, 1840 traffic through the town was reported to be very great, and the census in 1841 recorded the population as 249. However, in 1848 the Gaol was closed, the Quarter Sessions and Circuit Courts were removed the following year, and by 1851 the population of Berrima had fallen to 192. "By 1855 even Sir Thomas Mitchell had to admit that Goulburn had displaced Berrima as the chief town of the south-west" (Jeans and Spearritt, 1980)

Settlement of any consequence did not develop in the Southern Highlands until 1864 when floods and diseased wheat crops to the north caused farmers to move into the district. This settlement was assisted in 1867 with the construction of the railway. By 1870 "the railway had been established sufficiently long to shift the centre of gravity from the old road through Berrima, and to bring into being the townships of Bowral, Moss Vale and Mittagong" (Jervis). These three towns developed while Berrima, a coaching town, became obsolete and languished. This situation has persisted, with tourism and tertiary industry reinforcing the positions of the three towns while Sutton Forest and Berrima have remained principally as quaint village tourist attractions.

Before 1832 New South Wales was without scientifically designed bridges. In that year, however, David Lennox arrived from England and was soon put to work by Survey-General Mitchell on the construction of a series of stone bridges. Within six months of completing his first, the "Lennox" Bridge on Mitchell Pass in July 1833, Lennox had laid out a site for a bridge over Medway Rivulet on the Hume Highway (known then as the Main Southern Road), five kilometres south of Berrima. A wooden structure supported by masonry piers, this "Three Legs o'Man" Bridge was destroyed by flood about 1860 (D.M.R., 1950, pp.37-38). The convict marked stones were recovered and used in a replacement bridge. Much later, in 1975, a second replacement bridge was located to avoid interference with the remains of Lennox's work.

3.2.3 Economy

The economy of the tablelands district has traditionally been rural in nature. Cattle, dairy products, timber, vegetables and grains were all originally produced, largely for the Sydney market. Industrial activity, heralded by the establishment of the first Australian iron works in 1848 at Fitzroy (later, Mittagong) has been intermittent. The Joadja Creek Shale Oil Works (1870s to 1890s) to the west of Mittagong was a "complete industrial unit, turning out a multitude of oil, grease and wax products for local and overseas use" (Else-Mitchell, 1940). Other early industrial activities included the Nattai Coal Mine (incorporated 1878), the Mittagong Coal Mine (1883), and the Malt House at Mittagong (1898).

The district today is still given primarily to dairying, stud-cattle, and beef production. However, the percentage of the workforce employed in agriculture, while almost double the State level for 1981, has steadily declined to half the level prevailing during the mid-

TABLE 3.2: INDUSTRIAL STRUCTURE OF WORKFORCE

INDUSTRY	TABLELANDS (%)				N.S.W. (%)	
	1966*	1971*	1976	1981	1971*	1981
Agriculture and Forestry	17.9	14.1	12.9	9.2	5.8	4.9
Mining	2.9	3.4	1.6	1.5	1.4	1.4
Manufacturing	16.0	17.3	15.9	18.4	24.5	18.5
Public Utilities	1.5	1.5	1.7	1.5	1.9	2.1
Construction	10.8	9.2	9.5	8.0	7.3	6.2
Wholesale and retail	12.9	14.5	13.1	16.1	18.2	17.3
Transport and storage	4.5	4.3	4.6	4.7	5.3	5.5
Communications	2.4	2.7	1.5	1.7	2.0	2.0
Finance and business	2.4	4.3	4.3	6.2	7.7	9.6
Public admin. and defence	1.7	2.4	3.2	3.3	5.1	5.1
Community services	16.3	15.3	16.9	14.8	9.9	13.9
Entertainment and recreation	8.6	6.7	6.8	6.4	5.4	5.6
Other	2.1	4.3	8.0	8.2	5.5	7.8
TOTAL	7,005	7,170	8,270	10,101		

**Source: N.S.W. Planning and Environment Commission (1975)*

1960s (see Table 3.2). There has been a similar drop in the percentage employed in the mining industry, even though the actual number of persons employed in mining has increased slightly. A restructuring of the workforce has been occurring, with these percentage decreases being offset by increases in the manufacturing (now equal to the State average), retailing, finance and business sectors.

The cool to mild climate and varied scenery, much of it reminiscent of rural England, led to Bowral's early development as a health and tourist centre. In Sydney, the district became known as the "sanatorium of the south", and many boarding houses and country residences were built (Wild). With time, some of these buildings were taken over by schools and convents and the district today still has an unusually large number of private schools and religious institutions. While the percentage of the workforce employed in health and education services has dropped in recent years, it is still above the State average (Table 3.2). Bowral, in particular, is the centre for this activity, with nearly 21% of the workforce involved in health and education services at the 1976 Census.

In addition to the scenic attractions, such as the Fitzroy, Belmore and Carrington Falls, which initially attracted visitors, the "Southern Highlands" are now replete with recognised buildings and areas of historic value, and festivals such as Bowral Tulip Time, Mittagong Dahlia Week and Moss Vale Bush Week have added to the tourist attraction of the district. Tourism is an important aspect of the economic life. Accommodation takings from hotels, motels and guesthouses in the Shire of Wingecarribee for the 1979/80 financial year were just under two million dollars. When caravan park accommodation, and other expenditure by "overnight" and "day tripper" tourists are added, it is estimated that tourists are currently spending in the order of \$84 million annually in the Illawarra Region (Harrington 1981). This is reflected in an above State level percentage of the workforce being employed in the entertainment and recreation category (Table 3.2).

Although coal is still mined at Medway and building stone is quarried at Bundanoon, mining and quarrying employs only 1.5% of the workforce, compared with 3.4% in 1971. Most of the district is underlain by coal, at depths of about 100 metres in the south to 200 metres in the north. However, a considerable amount of this coal is cindered and poor quality. In addition, the district has potentially significant sources of aggregate. Extraction of blue metal has been occurring for over 70 years from sites adjacent to the towns and in more isolated locations. While remnants of old blue metal quarries occur at Mount Gibraltar and Mount Gin Gin Bullen, two quarries currently operate at Exeter and Oxley's Hill. Potential sources of aggregate have been identified in four other areas (D.E.P., 1982a).

3.2.4 Land Use (Figure 6)

During the 1970s, about 85% of the tablelands district was used for pastoral purposes, with grazing of cattle and sheep being the main activity. More than one-third was improved pastures, increasing the carrying capacity of this relatively small but important rural district. Important cattle, sheep and horse studs have been located throughout the district, "and the quality of dairy products in terms of butter fat and production per cow is the highest in the State" (P.E.C., 1975).

In recent years a number of rural holdings have been subdivided into hobby farms, largely as a consequence of increasing land values and pressures from the urban centres. Most of the farms are substantially improved in terms of structures and pastures. As annual rainfall increases from west to east in the study area, the land becomes more productive and hence more valuable, and the farms generally smaller and more numerous.

Three State Forests border on the study area, Meryla, Penrose and Belanglo. The climate of the district is well-suited to *pinus radiata*, which can grow on the thin sandstone soils with some fertilisation. Sizable plantings have been made in these forests.

Another major use is land reserved for proclaimed water catchment areas. While the whole tableland district is located within the Metropolitan and Shoalhaven catchment zones, proclaimed catchment areas shown on the local environmental plans are indicated on Figure 6. Wollondilly and Nattai Rivers flow through a section of the catchment area

for the Warragamba Dam, and there is a smaller dam on the upper reaches of the Wingecarribee River. Town water supplies for Mittagong and Bowral are provided from local storages.

Despite the predominance of rural land uses, there is a marked urban corridor along the Mittagong-Bowral-Moss Vale axis. Indeed, as indicated on Figure 6, not only are the principal urban land uses grouped in this area, but also the majority of non-urban industrial, recreational and special uses.

Industrial functions are generally confined to the existing urban areas and include a wide range of activities such as quarrying, engineering and building. A number of activities, however, are undertaken outside the urban areas, the most notable being: Blue Circle Southern Cement at Berrima, Southern Limestone Pty Ltd at Moss Vale, Berrima District Meats (abattoirs) near Moss Vale, a number of transport and engineering works between Moss Vale and Berrima Junction, Commonwealth Engineering near Braemar, and a number of smaller industries in the vicinity of Braemar. Again, with the notable exception of the Southern Portland Cement Works, these activities are all undertaken in the general vicinity of the eastern urban corridor.

Two coal mines occur in the study area, the only one currently active being at Medway. The mine at Mt. Alexandra is closed at the present time but remains in operational order and could be re-opened if economic conditions were favourable.

Various wildlife refuges and crown land reserves have been registered within the study area (see Figure 6). They are listed below:

1. Bird and animal sanctuary. Proclaimed 24th December, 1930.
2. Bird and animal sanctuary. Proclaimed 21st November, 1947.
3. The Minnows wildlife refuge. Proclaimed 23rd May, 1969.
4. Carribee Farm wildlife refuge. Proclaimed 14th February, 1969.
5. Lancelot Down wildlife refuge. Proclaimed 15th March, 1968.
6. Comfort Hill wildlife refuge. Proclaimed 16th December, 1966.
7. Southlands Wildlife refuge. Proclaimed 14th July, 1961.
8. R.90284 for public recreation. Notified 24th August, 1973.
9. R.57815 for preservation of native birds, trees and flora. Notified 20th February, 1925.
10. Pt. R.91032 for rifle range. Notified 10th February, 1978.
11. R.223 for public recreation. Notified 9th April, 1884 and 20th May, 1885.
12. R.72423 for preservation of native flora. Notified 26th September, 1947.
13. R.85512 for public recreation and resting place. Notified 29th October, 1965.
14. R.26996 for public recreation. Notified 18th December, 1897.
15. R.88144 for public recreation and the preservation of fauna and native flora. Notified 19th February, 1971.

Other non-urban elements of the human environment shown on Figure 6 include the Eastern Australian Natural Gas Pipeline, water supply pipelines, a co-axial cable, high tension power lines, airstrips, and fire access trails.

3.2.5 Statutory Zonings

The former Local Government Areas of Bowral, Mittagong and Wingecarribee (united and constituted as the Shire of Wingecarribee from 1st January, 1981) were covered by Local Environmental Plan No. 1, Mittagong Planning Scheme, and Interim Development Order No. 2, respectively. Figure 6 shows the general zonings outside of the urban areas. The main non-urban zonings are Rural and Rural Environmental Protection, the latter being for scenic and water catchment purposes (Mittagong's local catchment area). Apart from the Special Uses zoning for water catchment purposes, other Special Uses shown include the Bowral sewage treatment works, a place of public worship on the banks of the Wingecarribee River, Bowral East Public School plus other school sites, an historical area, a cemetery, sewerage treatment works, rubbish depot and an Electricity Commission sub-station all within or adjacent to Moss Vale.

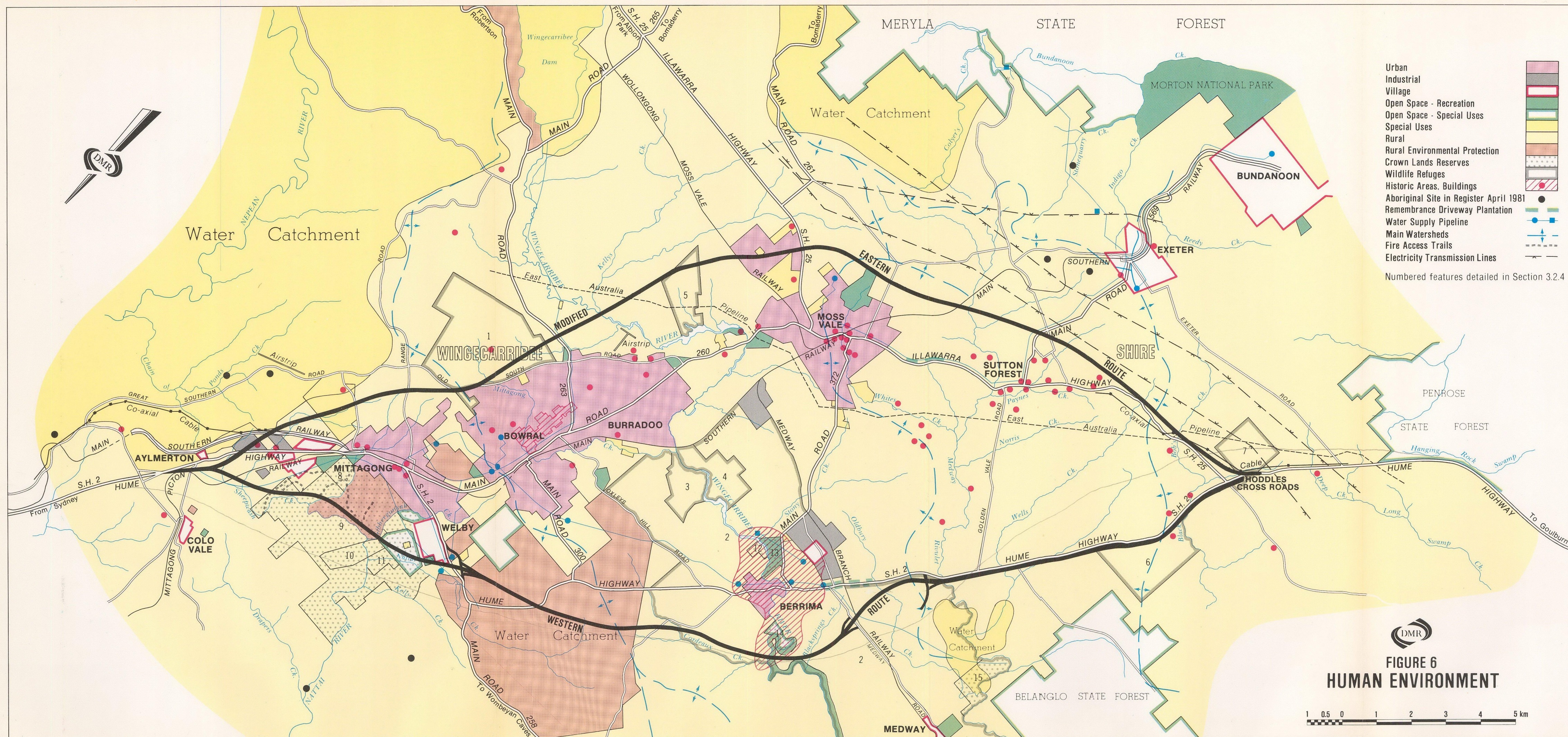


FIGURE 6
HUMAN ENVIRONMENT

1 0.5 0 1 2 3 4 5 km

3.2.6 Cultural and Historical Sites

The number of Aboriginal sites which were on record in the National Parks and Wildlife Service Register early in 1981 suggested that site density was not high in the district, but a range of site types could be expected to occur. The Department's consultant Archaeologist checked the Register for known sites within a corridor of approximately 30 kilometres either side of the Hume Highway and noted a total of 21 sites recorded within this area. These consist of the following number of site types:

Grinding grooves	3
Scarred trees	—
Carved trees (with burial mounds)	3
Open sites	3
Shelters (with art)	11
Shelters (without art)	1

Of the carved tree sites, at least two have been destroyed (Koettig, 1981). Section 8.7 covers the results of the archaeological survey undertaken along the preferred western route, while Section 9.2.10 discusses the potential effects of the proposed highway.

While the National Parks and Wildlife Act, 1974 has sole jurisdiction and control over Aboriginal relics and places, the Heritage Act, 1977 complements it by covering the environmental heritage associated with European settlement. As indicated in Section 3.2.2, European settlement commenced relatively early last century in the Southern Highlands, and today there is ample evidence of this. The Register of the National Trust of Australia (New South Wales) lists numerous items in Berrima, Bowral, Bong Bong, Burradoo, Colo Vale, Exeter, Mittagong, Moss Vale and Sutton Forest, while the Heritage Council lists the Mittagong Maltings plus several buildings at Berrima (see Figure 6). The only Australian Heritage Commission listing for the national estate is "Bindagundra" at Sutton Forest. None of these listed items will be affected (see Section 10.3.4).

3.2.7 Demographic Structure

Figure 7 shows the 1981 Census Collection Districts in the study area, with the proposed western route of the new road compared with an alternative "modified eastern route" (see Section 5.3). The western route crosses six Collection Districts (CDs), while the modified eastern route crosses ten. At the 1981 Census, the total population contained within these CDs represented 14.8% of the Wingecarribee Shire population (24,484) for the western route, and 18.9% for the modified eastern route. The actual number of houses which would be affected by either route represents considerably lower population percentages. For example, the western route affects ten houses and one school over its full length between Aylmerton and Hoddles Cross Roads.

Table 3.3 presents the 1976 and 1981 populations recorded in the affected CDs, plus the populations recorded for the Shire of Wingecarribee and for New South Wales. There was a 10.5% increase in the Shire population over the five year period, compared with 4.3% for the State. However, within the Shire there were marked variations between the CDs. While the rural CDs in the north eastern sector lost population, the urban fringe and south western CDs generally recorded increased population figures. The largest increase occurred at Welby where there was a 69.4% increase within CD 701. Most of the people within this CD at the 1981 Census were new residents, 60.8% having been resident there for less than five years. Over a third of the population (35.1%) was recorded as being under the age of 15.

For the 1981 Census, the former 1976 Census CD 710 in Mittagong was subdivided to form CD 703 and CD 710 because of the increase in population. Most of this increase occurred in CD 710 where 72.6% of the population had been resident for less than five years and 35.8% were under the age of 15. The only other district to have a similarly youthful age structure and high short residency percentage to CD 701 and CD 710 was CD 607 at the northern end of the study area. This large, basically rural district increased in population by 36.3% between 1976 and 1981. There was also a general turnover because 61.7% of the population at 1981 had not been resident there at the 1976 Census. Just over a third of the population was also recorded in 1981 as being under the age of 15.

TABLE 3.3: POPULATION DETAILS

Collection District		Total Population		% Increase	% 0-14		% 65+		Dependency Ratio		% Resident 5 years or less		% Dwellings with no car	
1976	1981	1976	1981	1976-81	1976	1981	1976	1981	1976	1981	1976	1981	1976	1981
N.S.W. WINGECARRIBEE		4914300	5126217	4.3	29.0	24.5	9.2	10.1	0.62	0.53		48.0		16.3
		22150*	24484	10.5	28.9	27.4	11.6	11.6	0.68	0.64	55.6	56.2	12.6	9.4
WESTERN ROUTE														
902	602	298	384	28.9	20.8	26.3	8.4	8.9	0.41	0.54	47.9	51.2	10.0	2.4
908	607	758	1033	36.3	40.8	33.6	8.1	7.6	0.95	0.70	53.7	61.7	7.3	4.9
905	701	274	464	69.4	28.5	35.1	9.5	4.7	0.61	0.66	57.7	60.8	4.7	6.7
Pt914	703	1105	559	16.8	29.1	20.8	11.1	9.8	0.67	0.44	56.6	54.0	16.2	13.0
	705		686			27.5		11.5		0.39		60.7		14.6
916	709	1264	524	-4.3	35.7	25.8	7.2	16.8	0.75	0.74	68.2	47.4	19.6	15.4
1104	904	300	365	21.7	27.7	32.3	4.3	5.2	0.47	0.60	63.3	56.2	2.4	4.6
MODIFIED EASTERN ROUTE														
908	607	758	1033	36.3	40.7	33.6	8.1	7.6	0.95	0.70	53.7	61.7	7.3	4.9
912	608	321	272	-15.3	25.6	17.3	22.1	27.9	0.91	0.83	54.3	58.6	12.1	4.5
915	704	404	529	31.0	35.7	27.6	8.7	13.8	0.80	0.71	59.1	53.0	5.6	3.9
909	706	171	136	-20.5	16.4	16.9	13.5	15.4	0.43	0.48	53.2	52.8	9.5	9.5
Pt914	710	1105	731	16.8	29.1	35.8	11.1	5.6	0.67	0.71	56.6	72.6	16.2	8.1
	807		1031			11.5		11.0		0.29		58.7		11.8
1007	811	1368	587	18.3	34.2	29.5	15.7	8.9	0.99	0.62	65.7	73.8	9.8	1.8
1103	903	213	251	17.9	26.3	25.1	15.5	13.1	0.72	0.62	54.1	60.3	11.8	6.9
1106	906	371	273	-26.7	25.9	28.6	9.7	7.3	0.55	0.56	70.9	60.9	10.3	4.7
1201	1001	317	340	7.3	15.8	23.8	14.8	9.7	0.44	0.50	54.9	53.6	14.0	6.2
1202	1002	522	455	-12.8	43.9	28.8	6.1	6.8	1.00	0.55	42.3	47.2	3.2	6.0

SOURCE Australian Bureau of Statistics

* The 1976 figure has been adjusted for a boundary change in 1981.



One district, CD 608, recorded a significantly higher percentage of persons aged 65 years or more than that recorded for the whole Shire. This large rural district to the east of Bowral had a very high proportion (27.9%) of its population within this mature age bracket. It also indicated a 15.3% decline in population over the 1976-81 intercensal period.

Although Wingecarribee Shire still has some districts where there is a concentration of older residents, and the Shire has recorded above State percentages of population aged 65 years or more at the 1976 and 1981 Censuses, the difference has narrowed as the general population structure has aged and young families have established themselves in the Shire. Table 3.3 shows that the Shire, at the 1981 Census, had above State levels for the 0 to 14 and 65 plus age groups. It also had a higher proportion of its population in these two age groups than the Wollongong and Shoalhaven subregions of Illawarra.

When the total number of persons in the 0 to 14 years and the 65 years and over age groups (i.e. generally the number of dependants) is divided by the total number of persons in the 15 to 64 years age group, the Dependency Ratio of the population is obtained. Dependency Ratios may be used to indicate the size of the two population groups which are generally least likely to drive and potentially most susceptible to traffic induced pollutants. For the New South Wales population, this Ratio has fluctuated from 0.57 in 1971 to 0.62 in 1976 then back to 0.53 by 1981.

In the past the study area has had a higher Dependency Ratio value than the State value. In addition to having been an established area with above State levels of older people, it has also had large numbers of school age young people, a reflection of the number of schools, colleges and homes in the area (see Section 3.2.3). More recently, the growth in the number of young families in certain districts within the Shire has also contributed to the above average level of people in the 0 to 14 age group.

This relative increase in the establishment of new homes within the Shire, together with the restructuring of the workforce which has been occurring (Section 3.2.3), has contributed to the high proportion of residents (56.2%) who have been in their dwelling place for less than five years at the 1981 Census. The Shire population has generally been very mobile.

Table 3.3 also indicates the percentage of dwellings not having a car for personal transport. There is a continuing trend towards increasing car ownership for the Shire population. Each district examined within the Shire registered, in 1981, below State average values of dwellings with no car.

The implications of this demographic analysis for constructing the proposed highway are discussed in Section 10.3.2.

3.2.8 Transportation

Two major transportation corridors pass through the study area: the Sydney-Canberra-Melbourne corridor from north to south, and the Wollongong-Moss Vale corridor from east to west. Linkages are stronger in the directions of Sydney and Canberra, though numerous recreational trips and some community trips take place between the study area and the coast.

The main road system in the north-south corridor consists of the Hume Highway (State Highway No. 2), supplemented by the Moss Vale-Bowral Road (Main Road No. 260) and the Illawarra Highway (Main Road No. 25). For the linkage to the coast, the principal main roads are the Illawarra Highway, and Main Road No. 261 between Moss Vale and Nowra. The railway system in these corridors consists of the Main Southern Railway and the Moss Vale-Port Kembla Railway. These railways connect the three main towns and most of the rural townships. As indicated in Section 3.2.2, the Main Southern Railway was instrumental in the early development of Mittagong, Bowral and Moss Vale. It is the principal long distance rail freight corridor in New South Wales, accounting for 29% of the total State tonne-kilometres in 1975-76 (Commission of Enquiry, 1980a). Moss Vale is the major rail centre, any large shipments of goods to or from Sydney or Wollongong tending

to be directed to this station. This reinforces the picture of Moss Vale as the industrial or agricultural service centre and helps to concentrate road movements associated with rail shipments on this town. Movements to Bowral and Mittagong railway stations are connected more with local retail and smaller industrial and agricultural loads. The principal freight movements by rail do not greatly affect road movement patterns, being constituted of, for example, limestone to the Berrima Cement Works, milk to Sydney and steel from Wollongong towards Canberra and Melbourne. Because of the general location of the railway lines, however, any road traffic proceeding to a railway station again centres on the three major towns.

While the advent of the railway in the mid-nineteenth century virtually replaced travel by slow, horse-drawn drays, carts and waggons, this situation changed dramatically from the 1920s when motor cars and lorries began to be mass produced. From a total of 40,100 vehicle registrations in New South Wales in 1920, this figure rose to 510,400 by 1950 and to over one million by 1960 (Wotherspoon, 1980). Subsequently, the Illawarra transport network has developed primarily for private motor transport. For example, in Wollongong the car ownership rate is 12% higher than in Sydney and there are fewer households without cars. "New living areas throughout the region have been developed with a general, if unspecified, assumption of universal car ownership. However, most major roads were designed for fewer vehicles and slower traffic than they are now forced to carry, and there is congestion on urban roads at peak times" (D.E.P. 1982b).

Although local movements concentrate in the urban corridor between Mittagong and Moss Vale, there is some cross movement along other roads in the area. The majority of this movement also centres on the three towns, resulting in a concentration of traffic in this eastern urban side of the study area. The towns differ somewhat in function. There is a considerable degree of interchange between them, with, for example, shopping trips concentrating on Bowral and trips concerned with industry or rural administration being directed to Moss Vale. There is, accordingly, a fairly diverse pattern of local movements. The number of roads serving these movements tends to be greater in the more densely settled eastern areas.

The pattern of movements along the urban axis and from rural areas into this axis is illustrated by local bus routes. One company follows a route from Mittagong to Berrima via Bowral and Moss Vale, while its school services link Bargo, Braemar, Hilltop and Berrima with the three towns, Robertson with Bowral, and the area around Wombeyan Caves Road with Mittagong. A company established in Bundanoon provides a service linking that centre with Moss Vale.

The dominant local rural movements have been the transport of stock to saleyards and abattoirs at Moss Vale, and bulk milk deliveries to milk factories at Bowral and Moss Vale. Industrial traffic uses diverse routes. There is no particular dominant pattern.

3.3 PLANNING POLICIES

3.3.1 General Planning

The Sydney Region Outline Plan (1968) set Sydney in a central coast context. It saw Sydney, Newcastle and Wollongong as a closely integrated urban complex. An objective of that plan was to improve accessibility between the three cities to foster greater versatility in, and inter-relationship between, the economies of these three areas.

The Outline Plan also identified the Campbelltown, Camden and Appin district as a priority area for urban growth. Continuing development in this growth centre is likely to provide a source of employment for some of the people in the Illawarra Region while also applying greater pressure on the region's road system and recreation resources.

Having regard to these and other issues, the former Planning and Environment Commission prepared a draft regional plan for Illawarra to manage the region's resources. It recognised that planning issues and priorities may differ in each of the three sub regions, namely, the Wollongong Plain, Shoalhaven and the Tablelands. Further, the draft

plan noted that the "Tablelands is attracting industry wanting to capitalise on its location on the north/south corridor and is receiving land speculation pressure as the urban fringe of Sydney moves in a south westerly direction" (P.E.C., 1979).

Following public exhibition of the draft plan and consideration of submissions received, the Regional Planning Committee presented an amended draft plan to the Director of the Department of Environment and Planning early in 1982, for consideration of submission to the Minister for approval as a Draft Regional Environmental Plan. The stated main purpose of this Plan is to provide a framework for co-ordinated action so that State and local government agencies, private agencies and individuals may ensure that:

- the best utilisation of land resources might be achieved;
- a stable and good climate for public and private investment might be established;
- the quality of life, especially in so far as it is affected by land use, might be optimised;
- regional needs and interests might be taken into account in local planning and state planning activities.

3.3.2 Planning Objectives

The Campbelltown area to the north is expanding and pressures for continuing urbanisation in the study area are becoming apparent. While much of the land around Mittagong, Bowral and Moss Vale would be suited to residential and industrial expansion, it is also valued as agricultural land, providing some of the best pasture in the State. The draft Plan indicated possible directions of growth for these three towns. Planning objectives have been stated as being:—

- (a) to encourage residential growth in Mittagong and Bowral in an easterly direction, and at Moss Vale to the east and south-west;
- (b) to contain industrial growth to the corridor west of Moss Vale to Berrima, and to the north-west of Mittagong;
- (c) to preserve viable agricultural land (P.E.C., 1978).

Bowral has been the major shopping centre with the greatest variety of goods and functions, supplementing the other centres. Moss Vale has been the major administrative centre, while Mittagong has catered for highway trade and industry (P.E.C., 1979, p. 72). The Draft Regional Plan saw a need to rationalise the retail and commercial functions of the three towns as they become increasingly interdependent with growth in population. "Bowral should remain the primary retail centre, providing a large range of higher order goods and services. Moss Vale and Mittagong should retain their present role with a general improvement of convenience goods and shopping conditions. Moss Vale should consolidate its business area, while Mittagong could expand moderately" (P.E.C., 1979, p. 73). These planning objectives have been repeated more recently (D.E.P. 1982b).

4. EXISTING MAIN ROAD SYSTEM AND ITS DEFICIENCIES

4.1 TRAFFIC MOVEMENTS

The existing main road system in the area is shown on Figure 8. Traffic between Sydney, Canberra or Melbourne concentrates principally on State Highway No. 2 (the Hume Highway), although some of this inter-city movement occurs on Main Road No. 260, State Highway No. 25 (the Illawarra Highway) and, to a lesser degree, Main Road No. 261 between Sutton Forest and the Princes Highway at Nowra. Traffic volumes on the Hume Highway were recorded in 1978 as being of the order of 9000 vehicles per day, compared with 6500 on Main Road No. 260 and 1000 on Main Road No. 261. The Hume Highway forms part of Australia's National Highway System, linking the two largest cities, Sydney and Melbourne. As such it forms a vital commercial link. It also forms part of the major access to Canberra, the National Capital.

The Illawarra Highway is the principal east-west link, serving industrial and recreation movements between the study area and the coast. It is a vital link for a number of industrial concerns on the Southern Highlands for which Wollongong acts as an important market and/or source of raw materials. Main Road No. 263 acts as part of this link, funnelling traffic from the Mittagong and Bowral areas onto the Illawarra Highway at Robertson.

Main Road No. 260, while acting as a feeder route to the Hume Highway from the three closely related urban centres of Mittagong, Bowral and Moss Vale, also acts as the arterial connection for local traffic. As noted above, it is also used as an alternative route to the Hume Highway.

Although local movements concentrate in the urban axis between Mittagong and Moss Vale, there is some cross movement along other roads in the area. The majority of this traffic also centres on the three towns, resulting in a concentration of local traffic along the urban axis. As stated in Section 3.3.2, the towns differ somewhat in function. Consequently, there is a considerable degree of interchange between them with, for example, shopping trips concentrating on Bowral and trips for industrial or rural administration purposes centring mainly on Moss Vale. This situation gives rise to a fairly diverse pattern of local traffic movements.

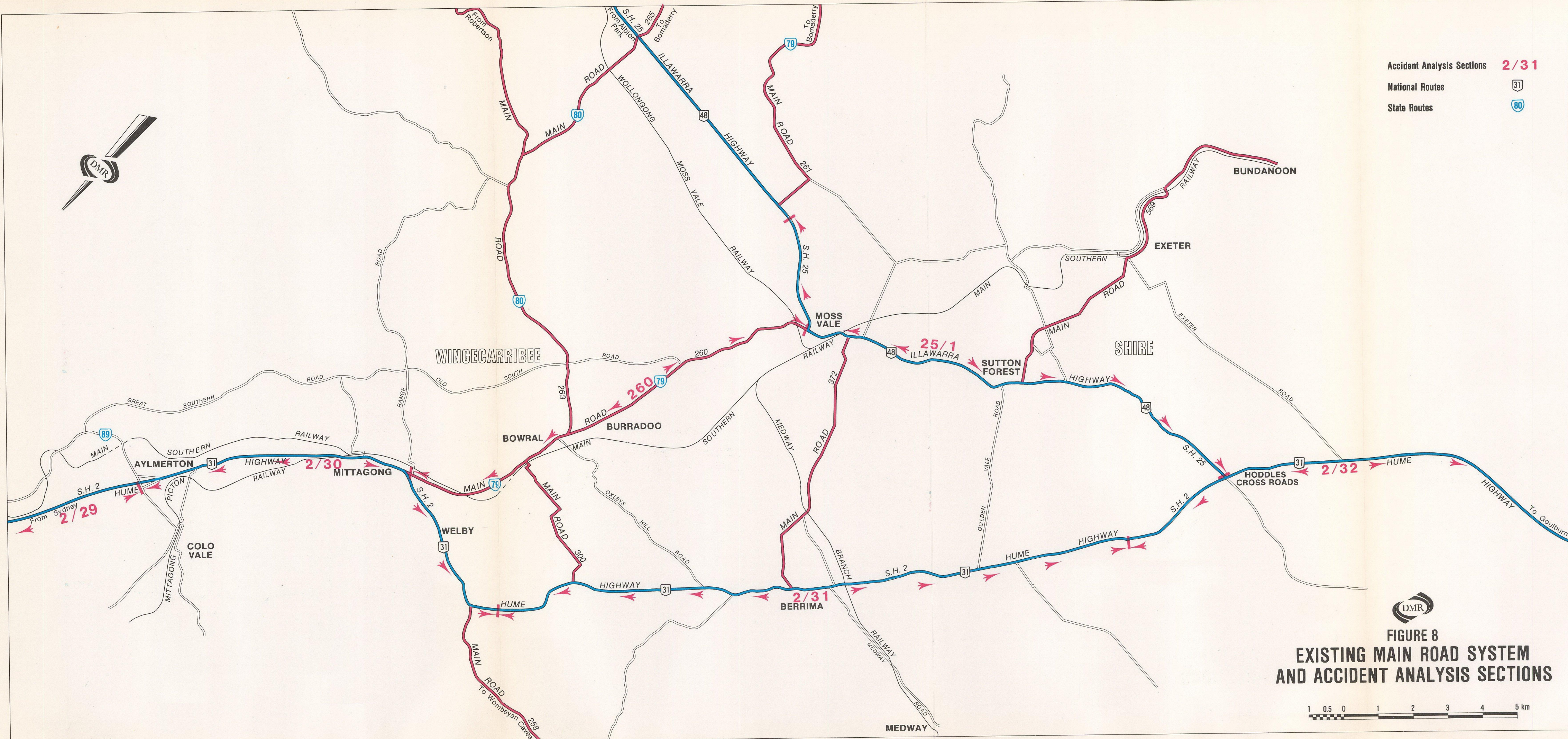
The dominant local rural movements are the transport of stock to saleyards and abattoirs at Moss Vale, and bulk milk deliveries to milk factories at Bowral and Moss Vale. Industrial traffic uses diverse routes with typical movements being limestone from Marulan to the cement works at Berrima, and fertiliser from Port Kembla to Moss Vale. There is no particularly dominant pattern.

4.2 DESIGN STANDARDS

Most of the section of Hume Highway between Aylmerton and Hoddles Cross Roads consists of two sealed lanes. For the 35 kilometre length of road, 71% is two lanes and 22% three lanes (overtaking lane available). There are sections of four lanes through Mittagong and at Bendooley Hill. On the two lane sections, there are five short lengths where the total width of the trafficable pavement is only 6.1 metres, compared with a desirable 7.3 metres width. These lengths of pavement have not been resurfaced since 1966.

A significant feature of the traffic on the Hume Highway is the unusually high proportion of heavy vehicles (33% — DMR, 1980a, p.45). Nearly half the number of heavy vehicles are large interstate trucks. This freight traffic, together with the other long distance traffic, passes through the urban centres of Mittagong and Berrima with the consequent 60 km/h speed zoning, mixing with local traffic movements.

These factors contribute to a low level of traffic service on this National Highway. "Level of service is a qualitative measure of the effect of a number of factors, which include speed and travel time, traffic interruptions, freedom to manoeuvre, safety, driving comfort and convenience, and operating costs" (Highway Research Board, 1965). On a six point scale, ranging from a desirable level of service A to an undesirable level of



service F, sections of the Hume Highway in the study area provide a level of service of only E. The Commonwealth Government's design standards for principal National Highways specify an objective to maintain at least a level of service C, with a desirable level of B or better. National Highways are designed in accordance with the requirements of the National Roads Act, 1974.

4.3 ACCIDENTS

For the purpose of recording accident data the Hume Highway, Illawarra Highway, and Main Road No. 260 (Mittagong-Bowral-Moss Vale Road) are divided into sections, as shown on Figure 8. Section 2/29 covers the Hume Highway (formerly the Yanderra to Aylmerton section of the South Western Freeway) from the Old Hume Highway underpass, South Yanderra to Church Street overbridge, Aylmerton; Section 2/30 runs from the end of Section 2/29 to just south of the junction with Wombeyan Caves Road; Section 2/31 runs from the end of Section 2/30 to 10 kilometres south of Berrima; and Section 2/32 runs from the end of Section 2/31 to just north of Murrumba. Section 25/1 covers the Illawarra Highway from Hoddles Cross Roads to 3.2 kilometres east of Moss Vale. The whole of the Bowral to Moss Vale Road is covered by Section 260.

Table 4.1 lists the accidents which occurred along these sections of road during the five year period from 1st October, 1976 to 30th September, 1981. The accident rate shown is the number of accidents per million vehicle kilometres. This rate permits direct comparison between the different sections of road with their varying conditions. The number and rate of fatalities, injuries and total accidents is given for the freeway standard section between Yanderra and Aylmerton (Section 2/29), for a shorter time period.

The section of road with the highest total accident rate is 2/30, while Section 2/31 has the highest injury and fatality rates. Both of these sections carry the long-distance, inter-city traffic movements and form part of the National Highway network. These high accident rates reflect their sub-standard nature. In contrast, most of Section 2/32 has been built to National Highway standards, with divided carriageways, as has the freeway standard Section 2/29. These latter sections have the lowest injury and total accident rates.

TABLE 4.1: ACCIDENTS FOR PERIOD 01/10/76-30/9/81

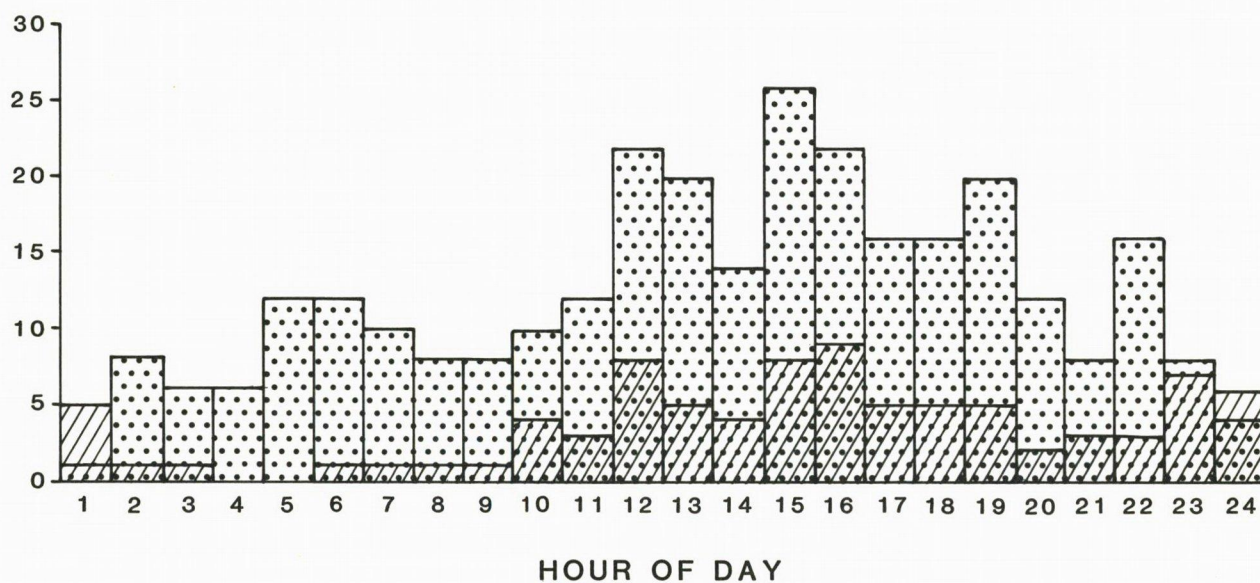
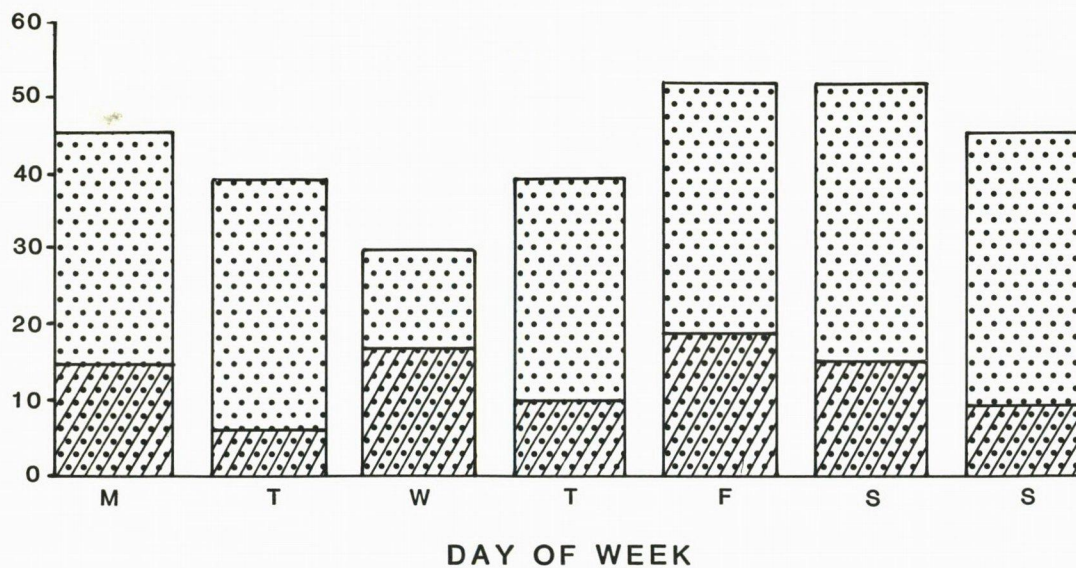
Section	Length (km)	Av. Veh. Kms per day	Fatalities		Injuries		Total Accidents	
			No.	Rate	No.	Rate	No.	Rate
2/29*	12.1	121,750	0	0.000	8	0.144	12	0.216
2/30	12.8	150,150	12	0.044	243	0.886	320	1.168
2/31	18.2	152,150	23	0.082	253	0.911	309	1.112
2/32	17.2	148,950	8	0.029	71	0.261	99	0.364
25/1	16.2	91,550	5	0.029	110	0.658	172	1.029
260	13.17	87,450	2	0.012	66	0.413	89	0.557

*Covers period 1/1/81 to 31/3/82

A recent study of the accidents saved as a consequence of opening the latest section of the South Western Freeway concluded: "When a two-lane highway is replaced by a Freeway, accident savings in the order of 80-85% can be expected" (Kenderes, 1982). More specifically, results show that the provision of the Yanderra to Aylmerton section of the South Western Freeway resulted in a reduction in the all-accident rate of 89%, in the injury rate of 88%, and in the fatality rate of 78%. These are statistically significant reduction rates.

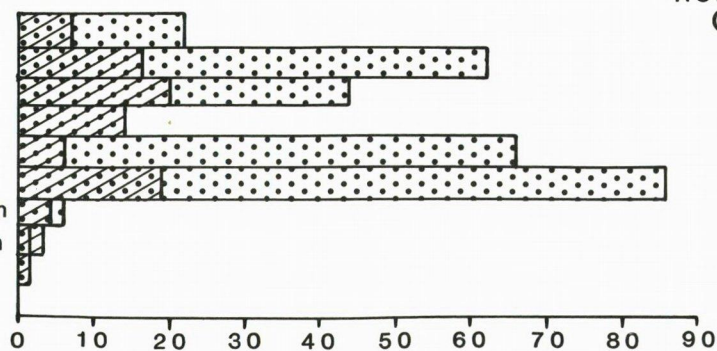
Figure 9 shows the pattern of accidents by day of the week, hour of the day, and collision type for Main Road No. 260 and for Section 31 of the Hume Highway. A mid-week high appears on the generally urban Bowral to Moss Vale Road but is absent from the week pattern of the rural Hume Highway with its Friday to Monday peak. The large number of heavy, inter-city vehicles which travel at night is reflected in the hour-of-day pattern for the Hume Highway, with accidents being recorded in the early hours of the morning. This

urban-rural difference also appears in the collision type pattern. Right angle, nose-to-tail, other vehicle collisions (excluding head-ons), and collisions with an object are the four most significant types on Main Road No. 260, accounting for 78% of the total. There have also been some head-on, rollover, and collisions with a parked vehicle or a pedestrian accidents. For the Hume Highway section, the four most significant collision types, accounting for 85% of the total, are vehicle-object, rollover, right angle, and nose-to-tail. Collisions with an object accounted for 50% of the total.



COLLISION TYPE (Traffic Accident Research Unit)

- 1 Head on
- 2 Right angle
- 3 Nose to tail
- 4 Other veh - veh
- 5 Rollover
- 6 Veh - Object
- 7 Veh - parked veh
- 8 Veh - pedestrian
- 9 Veh - animal
- 10 Other



LEGEND

HUME HIGHWAY
(SECT. 31) 

M.R.260 

FIGURE 9
ACCIDENT PATTERNS

5. ALTERNATIVES

5.1 DO NOTHING

The "Do Nothing" option is not acceptable for several reasons:

- (a) The existing Hume Highway between Aylmerton and Hoddles Cross Roads is below the standard required for the Sydney to Melbourne National Highway. A four lane divided carriageway highway has been specified, the full length being planned for eventual development as an access-controlled road (Commonwealth Bureau of Roads, 1975).
- (b) Congestion and noise from through traffic in Mittagong and Berrima are already cause for concern, and this situation will worsen as the traffic volume increases. The 1978 average daily volume on the Hume Highway at Mittagong was recorded as being in excess of 15,000 vehicles. Heavy vehicles comprise a large percentage of this volume (33%) and many of these vehicles travel at night. Vehicle classification counts taken on the Hume Highway at Marulan, 40km south of Berrima, for the 12 hours between 6.00pm and 6.00am indicate that approximately half of the traffic volume at night is heavy vehicles (DMR, 1980a, p.45). Further, studies have shown that noise levels can peak to over 60 dB(A) inside a motel room 27 metres from the highway with the doors and windows of the room shut (Coneybeare, 1978). Australian Standard 2107 recommends a maximum acceptable level of 35 dB(A) for sleeping areas in motels.
- (c) The "Do Nothing" option will not alleviate the accident toll whereas construction of a freeway standard National Highway can be expected to lower the accident rate significantly.

5.2 IMPROVE EXISTING HIGHWAY

Improving the existing highway is not an acceptable option for providing a National Highway standard road in this situation. The existing Hume Highway passes through the urban centres of Braemar, Mittagong and Berrima with their restrictive 60 km/hr speed zones. Historic Berrima is covered with various Heritage Council Conservation Orders and these would be a constraint to providing four lane, divided carriageway conditions along that section of road. In addition, the alignment of the highway, abutting properties with direct access, and provision of access for adjoining side roads are all factors which preclude developing the existing road to the ultimate freeway standard required for this important and busy National Highway.

5.3 FOUR EXHIBITED ALTERNATIVES

A new route for the Hume Highway which would carry through traffic past the towns of Mittagong and Berrima, would also benefit local traffic and improve conditions for residential and business premises close to the existing highway. After early investigations of deviations to achieve this objective in the Mittagong area, the Department of Main Roads undertook further studies covering the whole Mittagong-Bowral-Moss Vale district and identified four routes for further consideration. These routes, shown on Figure 10, were placed on public exhibition in the three main towns in 1977 when over 2,000 people visited the exhibitions. In addition to verbal comments, 160 written responses were received by the Department.

Of the four routes presented for comment, the one which received most public support and the least criticism was the Western Route. The Central and Modified Central Routes received least support and were clearly unacceptable to the local community. The Eastern Route received moderate support but only after it was modified to reduce adverse property effects. Overall, the Western Route was favoured by 67% of respondents while 16% favoured either the Eastern or Modified Eastern Route.

A detailed analysis of the written response is given in Graphs 1 to 4 (Figure 9A). Graph 1 shows the locational composition of respondents, Graphs 2 and 3 show the preferences of the town and rural respondents, respectively, and Graph 4 shows the composite preferences. A comparison between the Western and Modified Eastern Routes follows.

5.4 WESTERN ROUTE AND MODIFIED EASTERN ROUTE COMPARED

5.4.1 Engineering Considerations

A geological investigation along both routes concluded that there were no known geological hazards which would necessitate changes to either route (Britzga, 1978). Although the Western Route involves heavy earthworks in the Nattai Gorge area, this route provides better quality road construction material than the modified Eastern Route which would require importation of selected subgrade material or chemical stabilisation. Poor subgrade foundations on Wianamatta Shale affects most of the Modified Eastern Route.

Similar standards for the vertical and horizontal alignments can be achieved on both routes. Also there is a need to provide two interchanges on both routes to give adequate access to the towns of the district. Although the modified Eastern Route would be 5% longer, construction cost estimates have indicated that the Western Route would be 8% more expensive. This is because of the additional costs involved in constructing through the rugged terrain immediately west of Mittagong. However, construction of the Western Route could be staged so that National Highway traffic bypassed Berrima and Mittagong. In contrast, the Modified Eastern Route would have to be built south to Sutton Forest before producing benefits for National Highway traffic.

5.4.2 Traffic

Traffic volumes recorded in 1978 for the road system, together with the estimated 1996 traffic volumes under the two options, are shown on Figure 11 for the Western Route and on Figure 12 for the Modified Eastern Route. These traffic volumes assume that the interchanges will be built in the locations shown and that freeway conditions will apply on the Aylmerton to Medway Rivulet section and motorway conditions on the Medway Rivulet to Hoddles Cross Roads section (see Section 7.1).

Since the prime purpose of both options is to cater for the long distance movements of people and goods, the main benefit occurs in the form of greatly reduced traffic volumes on the existing Hume Highway. On other roads the effect of traffic redistribution will be relatively slight, mainly because local movements concentrate in the urban axis between Mittagong and Moss Vale. However, most filtering through traffic should be removed from local roads.

Compared with the "Do Nothing" option, the Modified Eastern Route would result in slightly less traffic on Main Road Nos. 260, 263 and 300, Oxleys Hill Road and on the section of the Illawarra Highway through Moss Vale. However, it places increased traffic on Illawarra Highway east of the Moss Vale interchange and again south of the Sutton Forest interchange, and introduces significantly more traffic onto Range Road because of the proposed half diamond interchange there.

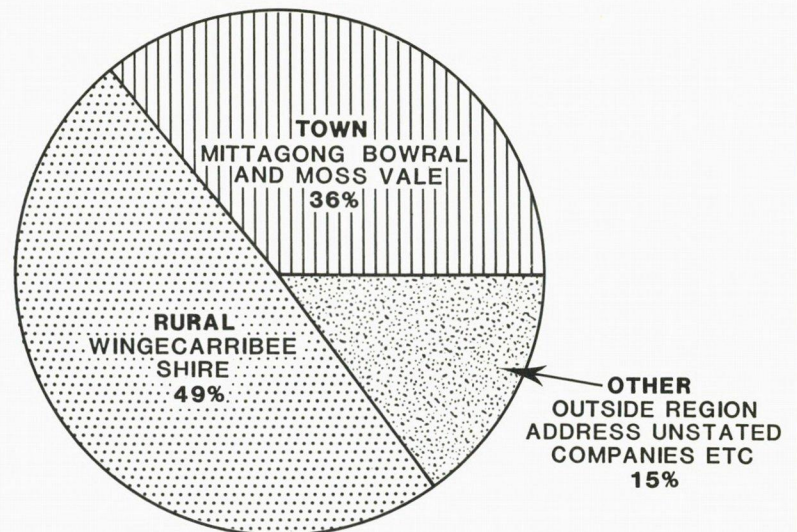
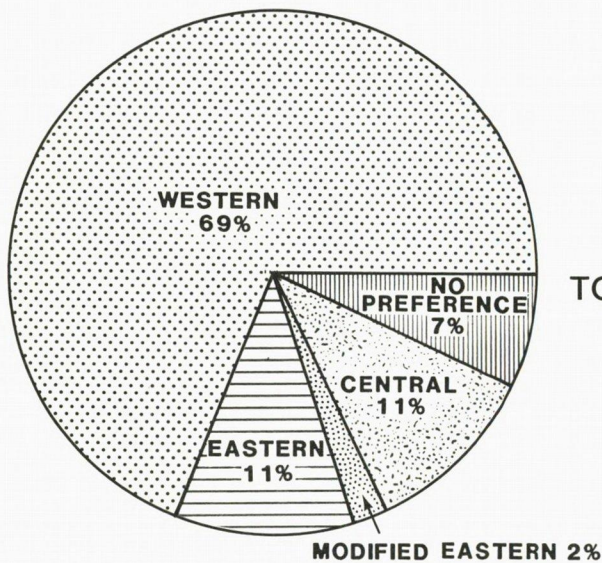
The Western Route does not have such a pronounced traffic reduction effect on the local road network as the Modified Eastern Route when compared with the "Do Nothing" option. Main Road 260 would still have less traffic than in the "Do Nothing" situation, and the Illawarra Highway would also benefit. However, Main Road Nos. 300 and 372, Taylors Avenue and Medway Road will act as feeder routes from Bowral and Moss Vale.

5.4.3 Cost Benefit Analysis Comparison

The two alternative routes were compared in 1978 with the existing Hume Highway facility, using 1976 traffic volumes. On the basis of re-allocating the traffic volumes between the alternative road networks, calculations of savings per car and truck using each alternative were made to determine the gross road user benefits. The gross figures were decreased for a higher total road maintenance cost, then increased for savings from an expected lower accident rate in order to obtain the net road user benefits.

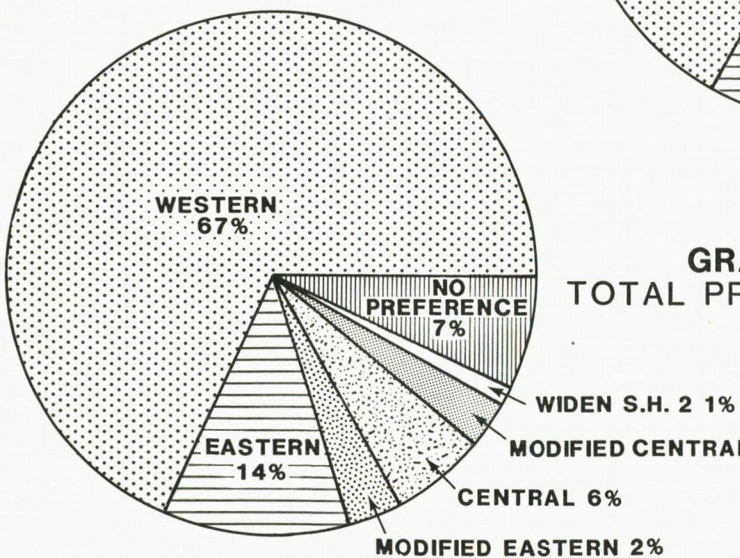
At the time of undertaking the comparison, 1986 was assumed as being the first full year of operation and values were adjusted to that time on the basis of a 5% per annum

**GRAPH 1
COMPOSITION OF
RESPONDENTS**

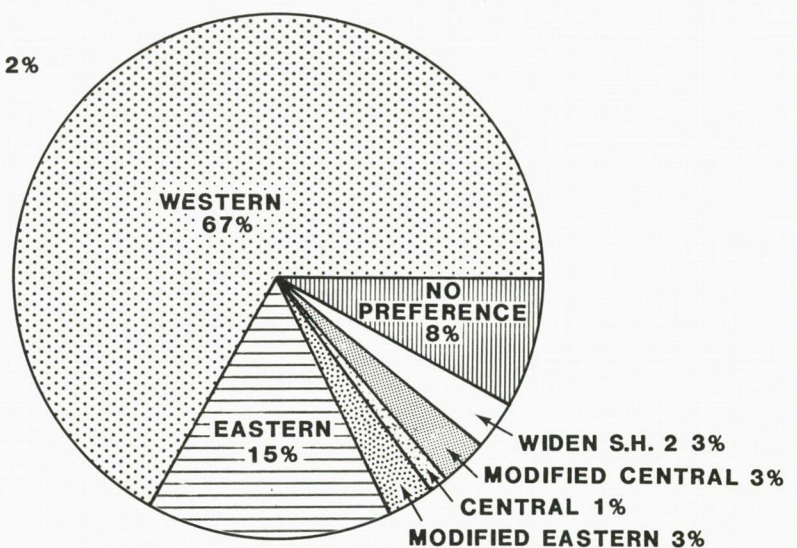


**GRAPH 2
TOWN RESPONDENTS'
PREFERENCES**

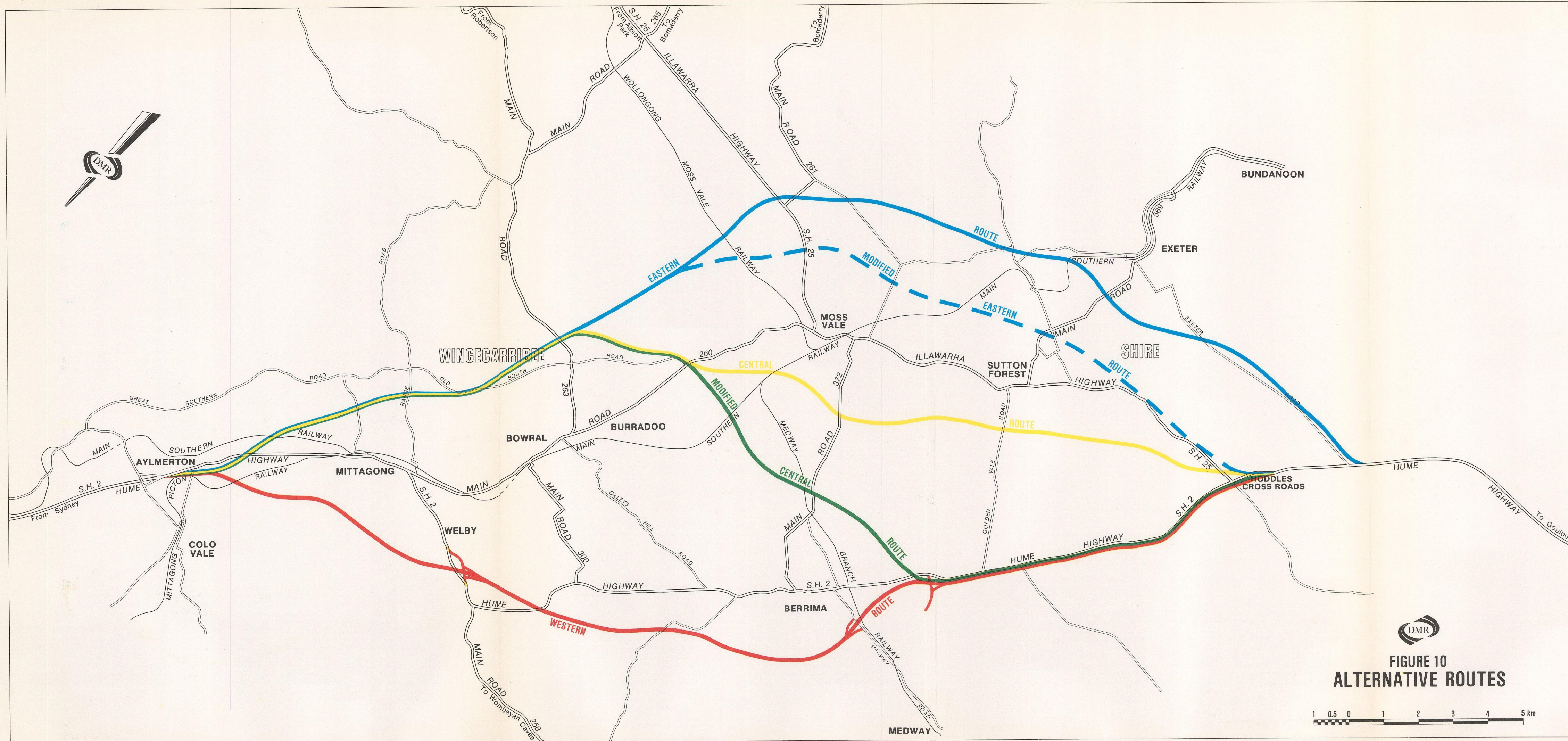
**GRAPH 3
RURAL RESPONDENTS'
PREFERENCES**



**GRAPH 4
TOTAL PREFERENCES**



**FIGURE 9A
RESPONDENTS'
PREFERENCES**



increase in traffic and an annual inflation rate of 7%. The net road user benefits were then summed over the probable life of the road (i.e. the 30 year period from 1986 to 2015), a 10% discount rate was used, and construction costs over a five year construction period were adjusted for common comparison purposes. This data is summarized in Table 5.1. A benefit/cost ratio of 4.0/1 was obtained for the Modified Eastern Route compared with a ratio of 5.3/1 for the Western Route (Table 5.1). A more recent benefit/cost analysis of the Western Route is given in Section 6.4.2.

TABLE 5.1: COMPARATIVE BENEFIT/COST DATA

	ROUTE	
	Modified Eastern	Western
Gross road user benefits	\$2,800,000	\$3,700,000
Additional road maintenance	760,000	720,000
Accident savings	170,000	190,000
Net road user benefits	2,210,000	3,170,000
Sum of benefits (1986-2015)	293,500,000	421,000,000
Construction costs (1981-1985)	73,200,000	78,800,000
BENEFIT/COST RATIO	4.0/1	5.3/1

5.4.4 Natural Environment

Each route passes through land which drains into the Metropolitan Water, Sewerage and Drainage Board's catchments as well as into some local catchments. All of the Western Route and most of the Modified Eastern Route drain into fairly non-restrictive parts of the Board's catchments. A short section of the Modified Eastern Route near Aylmerton drains into a more restrictive catchment. If constructed, this section would require special care to comply with the Board's Act and By-Laws.

With regard to potential watercourse siltation problems, a geological study (Britzga, 1978) has identified two areas on the Western Route which may require special precautions in the Nattai Gorge region. They are, an affected coal mine tailings dump and the crossing of Gibbergunyah Creek.

Soil erosion on each route should be minimal provided adequate erosion control and vegetation regrowth measures are taken.

Ecologically the Modified Eastern Route poses no serious problems since it traverses land which has, for the most part, been cleared for agricultural purposes (see Figure 3). However, this route does affect a proclaimed bird and animal sanctuary and Lancelot Down Wildlife Refuge to the east and south east of Bowral (see Figure 6). In contrast, the Western Route passes through a bushland area in the Nattai Gorge and near Berrima. The area near Berrima is part of a proclaimed bird and animal sanctuary. In the Nattai Gorge, a Crown Reserve for native birds, trees and flora is involved. The Gorge area is periodically burnt by local fire control officers for bush fire hazard reduction purposes.

Fogs occur in the areas traversed by both routes and could adversely affect vehicle speeds at times. Records indicate that the major occurrence of fogs is in the March to June period, between midnight and 7.30 a.m. This time coincides with the lightest traffic flow period. Local opinion suggests that fogs are generally more severe on the eastern rather than the western side of the district.

5.4.5 Human Environment

(a) Agriculture

A report on the alternate routes by the Department of Agriculture (1978) states that the Modified Eastern Route would have the greatest impact on agriculture. This report considers that the Modified Eastern Route would have a devastating effect on dairying

which is carried out on prime agricultural land along much of the route. Individual dairymen would be affected and the Co-operative Factory at Moss Vale could lose some suppliers. By contrast the Western Route passes through generally poor agricultural country with grazing and sheep properties which could largely maintain their viability if severed. Also, the route traverses extensive areas of non-agricultural bushland.

(b) Urban Centres

The Modified Eastern Route would have a much greater impact on residential areas than the Western Route. Figure 6 indicates that it would adjoin the western boundary of Bowral and sever an expansion sector of Moss Vale. It also cuts across potential residential areas east of Mittagong and Bowral. This would make future planning for these areas difficult. With the Western Route, the residential area of Welby is affected on its western boundary.

At present there are some businesses, mainly in Mittagong and Berrima, that cater for passing highway traffic. These businesses are likely to be disadvantaged whichever route is adopted. However, the former Mittagong Shire Council preferred the Western Route because it will allow traffic to use Mittagong as a service centre. At Berrima, local interests also expressed preference for the Western Route, provided access is available to cater for the tourist trade. A Berrima interchange is proposed with this alternative.

Near Mittagong the Modified Eastern Route severs the Renwick Boys Home. It also passes close to Tudor House College near Moss Vale and would increase traffic past Frensham School on the link road between Mittagong and the freeway. Acquisition or relocation of a small public school at Aylmerton is required with the Western Route.

(c) Mineral Resources

Apart from coal measures, no other proven minerals of economic importance would be sterilised by either route. The question of coal resources in the region as they relate to the two routes has been examined by the Joint Coal Board (1978). The conclusion reached was that the Modified Eastern Route was marginally preferable because the coal is at a greater depth, there are no existing collieries, more of the route passes over inferior coal, and with minor exceptions, there is little possibility of future mining proposals.

(d) Heritage Items

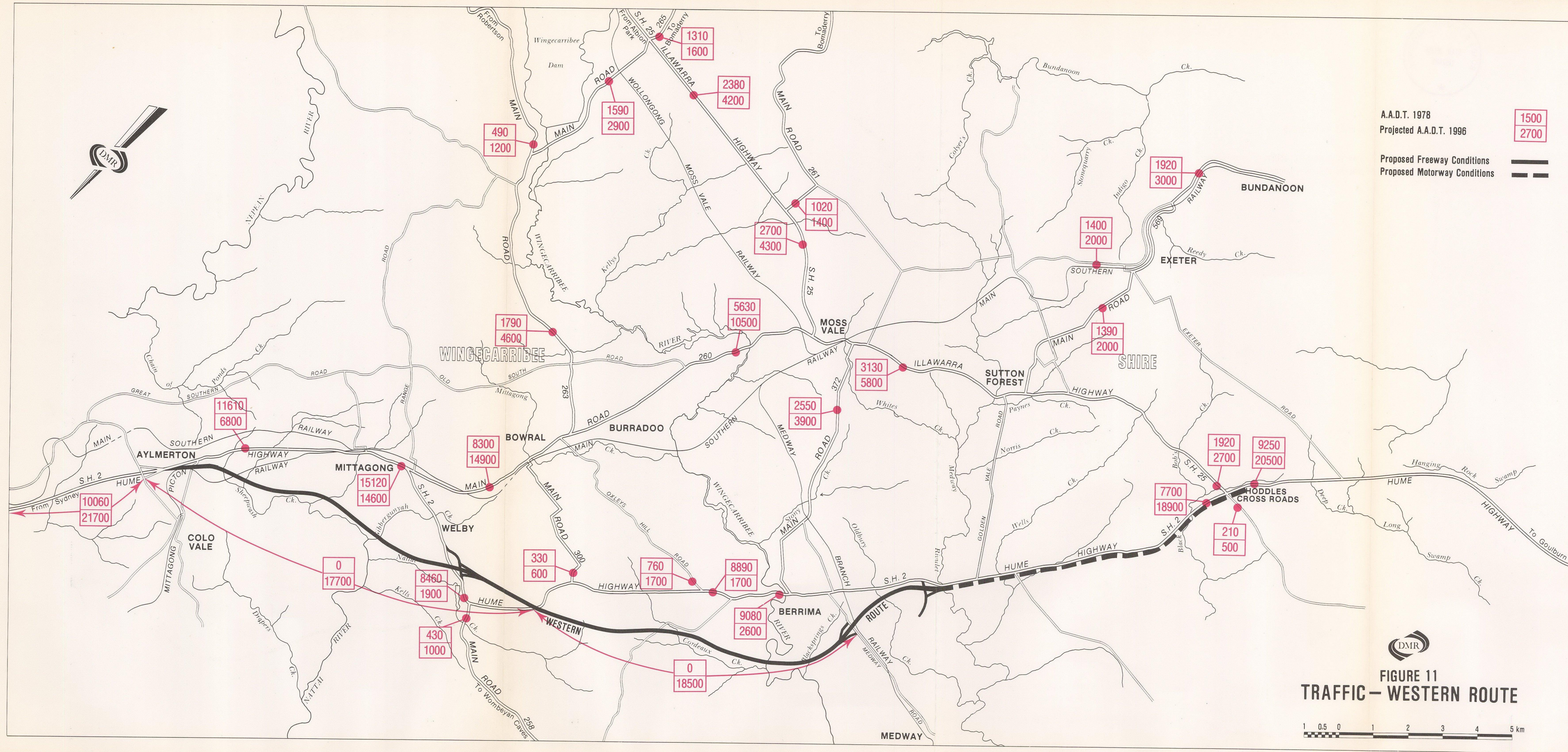
Figure 6 shows Aboriginal relic sites which were shown in the National Parks and Wildlife Service Register at the beginning of 1981, listed buildings and areas of historic interest, and Remembrance Driveway plantations. The National Trust (1977) and Heritage Council (1978) have indicated a preference for the Western Route because of the close proximity of the Modified Eastern Route to such buildings as "Retford Park", "Hillview", "Rotherwood", "Bascobel", "Tudor House", and "Throsby Park". From a heritage perspective, the Sutton Forest-Exeter district is significant because of the landscape created there late last century.

Existing areas set aside for Remembrance Driveway would be excluded from both routes. These areas could still serve a useful passive recreational function in the district.

5.4.6 Planning

The Western Route, lying along the edge of the district and being essentially within an existing and accepted transportation corridor, would not have significant adverse implications for future development in the Shire of Wingecarribee. However, the Modified Eastern Route is a new transportation corridor which would affect existing and proposed urban development (see Figure 6). Constructing a road on this line would involve a complete rethinking of future planning opportunities and constraints by Council and the Department of Environment and Planning. As a consequence, the Western Route is favoured in principle by the Department of Environment and Planning (P.E.C., 1978). This route would have little adverse impact on the planning objectives stated in Section 3.3.2.

In December, 1976, the National Parks and Wildlife Service advised that it had been considering a Berrima nature reserve proposal, and that it also had investigation areas at Bargo, Nattai, and Nepean-Cordeaux. At that time the Western Route had been located to take advantage of a good crossing of the Wingecarribee River and to minimize any



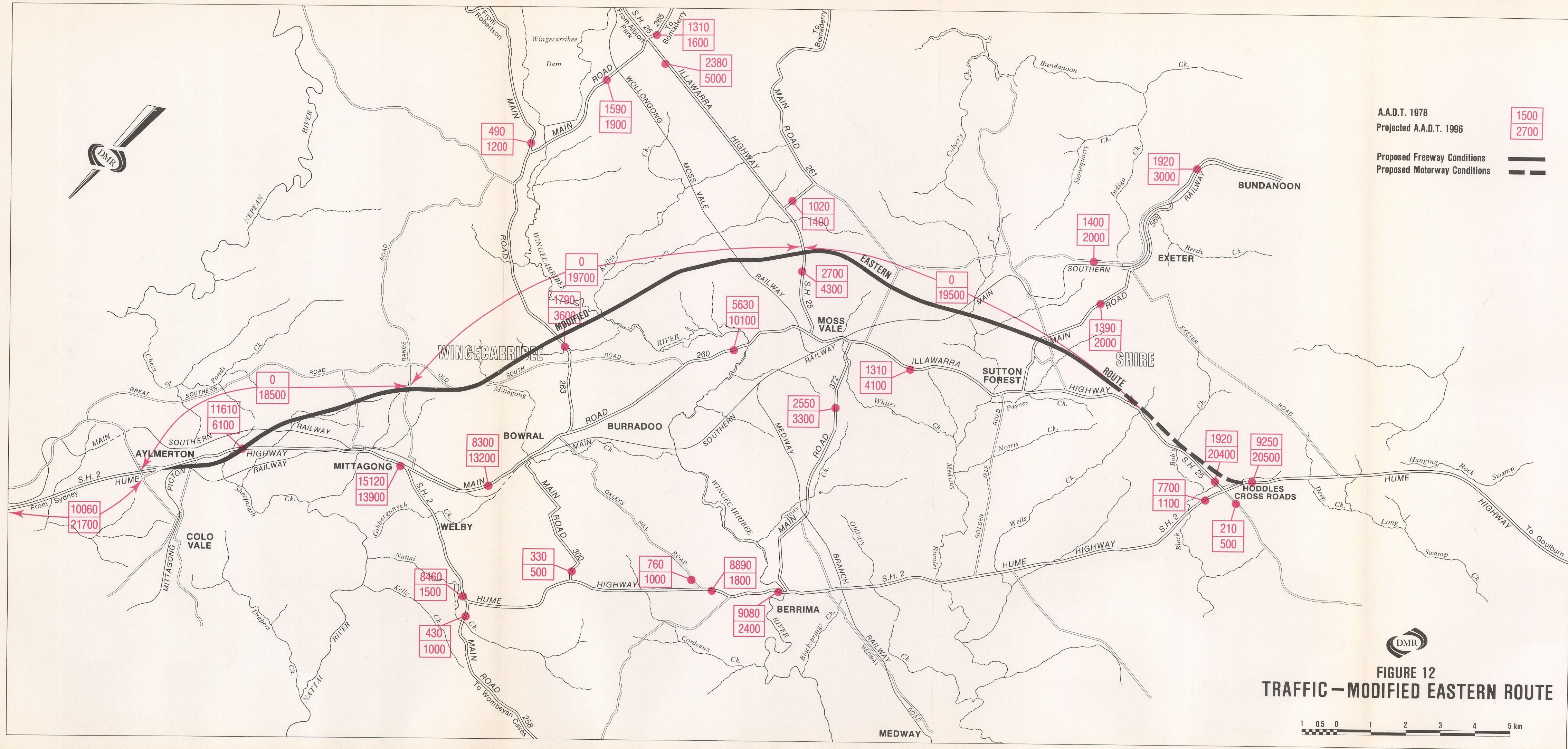
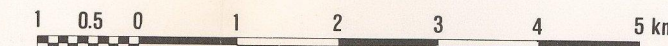


FIGURE 12
TRAFFIC—MODIFIED EASTERN ROUTE



effect on the visual catchment of the Berrima Urban Conservation Area listed in the National Trust Register. While the boundaries of the Berrima nature reserve had not been "rationalized", according to the Service, it appeared that this proposal was in the area of the Western Route.

Advice received from the Service in 1978 indicated that the Western Route was clear of a Nattai National Park proposal and that this route was the most suitable in regard to Aboriginal relics. However, more recent correspondence from the Service (1982a and 1982b) indicates that provisional boundary extensions made to the National Park proposal would cross the Nattai River and the Western Route. If these proposed boundary extensions were to be adopted for the park, provision would need to be made by the Service to exclude a reserve for the highway (see Section 6.6.3).

5.4.7 Landscape Assessment

A landscape assessment report on the two routes concluded that, in so far as visual qualities are concerned, the Western Route would be preferable to the Eastern, both from the users' aspect and that of adjacent towns (Principal Architect, 1978). Much of the Modified Eastern Route traverses terrain of similar appearance and therefore could possibly become tiresome, causing inattentive driving, while the view from adjacent developed areas would be obtrusive, particularly viewed from high elevations.

Establishment of landscape planting would also be more difficult on the Modified Eastern Route because of the exposed conditions, and the quantity of plants would far exceed the requirements of the Western Route to be in keeping with the existing environment.

The diversified terrain of the Western Route was assessed as being much more interesting as far as aesthetic qualities are concerned from the motorists' view, and little of this route will be visible from urban centres.

6. JUSTIFICATION OF PROPOSAL

6.1 INTRODUCTION

Having regard for the shorter length (1.75 km) of the Western Route, its higher economic benefits to the community, the opportunity to build it in stages, the strong support for it by the local community on environmental and social grounds and support by most of the authorities involved, the Department of Main Roads recommended its adoption to the Minister for Roads, and the concurrence of the Commonwealth Minister for Transport was sought. On the 20th February, 1979, the Commonwealth Minister for Transport approved the adoption of the recommended Western Route as the corridor for the Sydney to Melbourne National Highway between Aylmerton and Exeter Road. Since that date steps have been taken to refine the location and undertake detailed geological, archaeological, vegetation and faunal studies.

6.2 HIGHWAY — LAND USE INTERACTION

As indicated in Section 5.4.6, the proposed highway will be within a generally accepted transportation corridor, clear of planned residential and industrial growth areas associated with Mittagong, Bowral and Moss Vale. The Illawarra Regional Planning Report (D.E.P., 1982b) recognises that industry is expanding in the district and states that it "is likely to be further stimulated by continued upgrading of the Hume Highway and the development of the F5, improving linkages with Sydney, Canberra and Melbourne." Taking long distance through traffic out of the built up areas by allowing it to travel on a specially constructed national highway will also assist the planning aim of encouraging Bowral to develop as a strong subregional commercial centre along with the secondary subregional centres of Mittagong and Moss Vale (D.E.P., 1982b).

Maximum efficiency in the use of a national highway is achieved by constructing it to freeway standards, with access to adjoining land uses strictly limited. By limiting access to major interchange points, the free flow of through traffic is maintained without interference to local traffic flows, and local community activities can be undertaken in a less congested and safer environment. This will be of considerable assistance in achieving the general aim of the Illawarra Regional Plan, namely, to maximize the opportunities for the people of the region and the State to meet their individual and community needs.

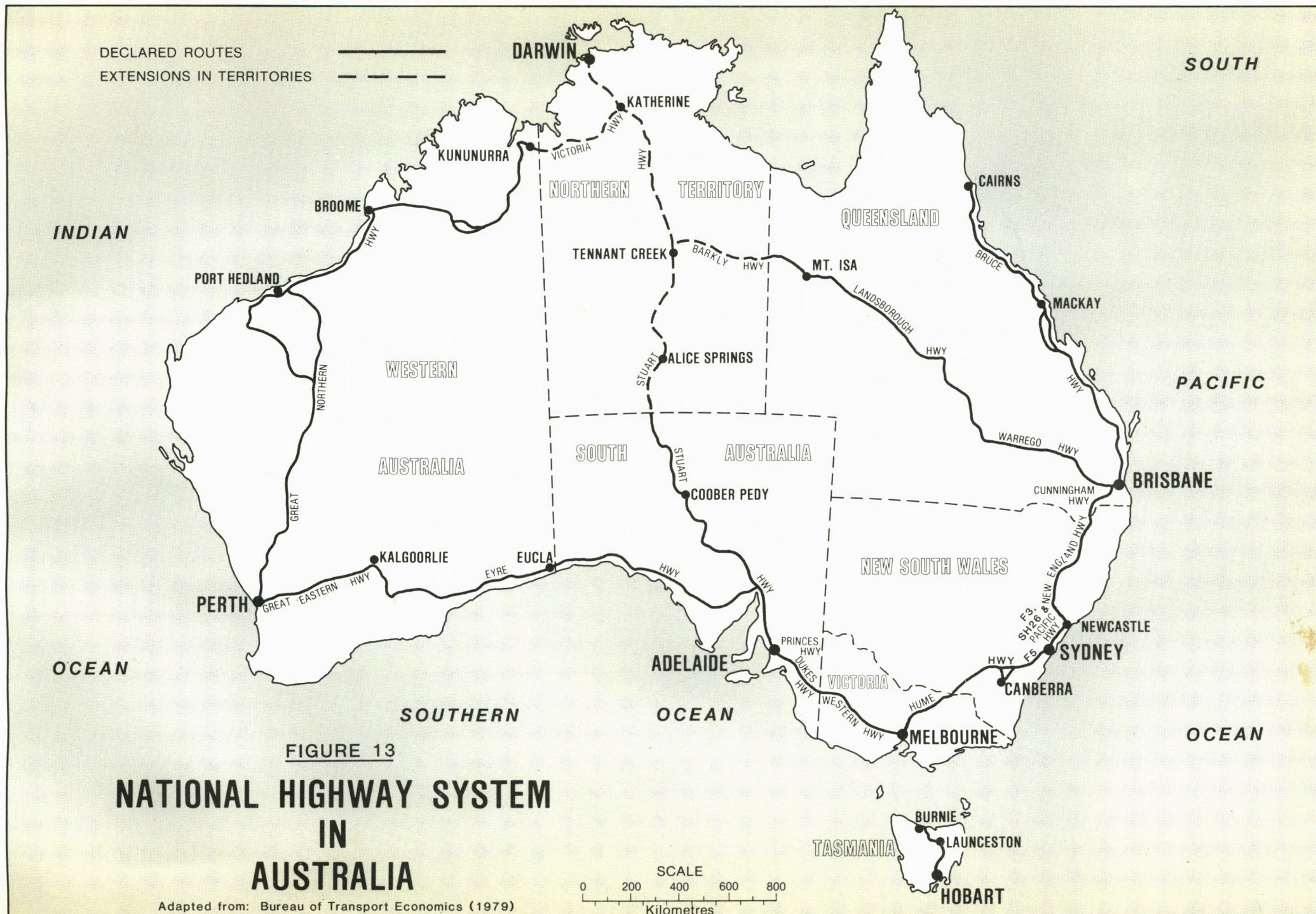
6.3 NATIONAL HIGHWAYS

The former Commonwealth Bureau of Roads in its "Report on Roads in Australia, 1973" recommended that the Australian Government legislate to declare a system of National Highways throughout Australia and to provide grants of financial assistance to the States for the construction and maintenance of the highways. The Commonwealth Government accepted this recommendation, passed the National Roads Act, 1974, and declared a system of National Highways. Grants for the National Highway System have been provided under Commonwealth legislation since then. The National Highway System is shown on Figure 13. The proposed Aylmerton to Hoddles Cross Roads section of the Hume Highway will form part of this System.

In their 1973 Report, the Commonwealth Bureau of Roads indicated the objectives for National Highways in the following terms:

"Whilst the Commonwealth has an interest in all roads some main arterial roads are of more concern to the Commonwealth, because of their importance to Australia as a whole. It is concluded that the roads of most concern, which might be called a National Roads System, are the roads which:

- (a) encourage and contribute, to a major extent, to trade and commerce, overseas and among the States;
- (b) assist industry located in major centres of population to be complementary to industry located in neighbouring major centres;



- (c) reduce, significantly, transport costs of the products of rural and/or secondary industry, between points of production and points of export or consumption;
- (d) provide for long distance movement associated with recreation and tourism; and which
- (e) improve movement between defence production centre, defence supply and storage location, and defence establishments generally."

The proposed section of National Highway will contribute to all of these objectives.

Section 5(i) of the National Roads Act, 1974 enables the Federal Minister for Transport to notify a State on standards "that the Australian Government considers necessary to be observed in connection with the construction or maintenance of national roads". For the National Highway between Sydney and Melbourne, these design standards are contained in Document NH DS1 1976.

6.4 USER BENEFITS

6.4.1 Qualitative Evaluation

Transportation affects the price of goods through both direct and indirect cost contributions. For example, the cost of cartage contributes directly to the price of any item. There is the cost of transporting raw materials to the production site, and also the cost of delivering the finished product to the market. The amount involved in these transport costs depends largely upon the physical characteristics of the particular item. Bulk commodities, such as sand or gravel, may have a transport cost over half the final product price. By comparison, some lighter items with higher unit value, such as business machines or calculators, have low transport costs relative to market price.

Transportation also affects prices in indirect ways, such as by contributing to price stability in local market areas. Long-haul transportation causes markets and prices to be less responsive to purely local supply and demand conditions. In addition, transportation creates value by moving goods to markets at the time they are needed.

A foundation upon which the development of the economy depends is provided by transport. "If no new efficiencies occur in the transportation sector and the transportation system remains unimproved or deteriorates, then the burden of fostering economic growth falls solely upon other production and distributional efficiencies, such as increased labour and capital productivity" (Anon. 1982, p.3).

Long distance freight transport in New South Wales is concentrated in a few corridors. The Hume Highway predominates with 43% of the total tonne-kilometres (see Section 6.5). This National Highway, incorporating the South Western Freeway, has been constructed to divided carriageway standard from the Crossroads south of Liverpool to Aylmerton, five kilometres north of Mittagong. Dual carriageways have also been provided for the twelve kilometres from south of Hoddles Cross Roads to the southern boundary of Wingecarribee Shire. By constructing the linking section between Aylmerton and Hoddles Cross Roads, approximately 111 kilometres of continuous, dual carriageway driving conditions will be available for travellers and freighters. This improved accessibility will mean that the costs involved in travelling the principal corridor linking Sydney, Canberra and Melbourne will be reduced. These reductions in user costs will come from a reduction in travel time, vehicle operating costs, and accident potential.

Individuals, commerce and industry will be able to realize the benefits of the improved travelling conditions. For the individual driver, it will mean more time to spend either on the job or in non-work activities, safer driving conditions, and savings in operating costs. For commerce and industry, it will mean lower transportation costs, quicker delivery of products to customers, and quicker delivery of needed raw materials (see Section 6.5).

6.4.2 Quantitative Evaluation

The cost-benefit study carried out in 1978 and used in Section 5.4.3 is valid in so far as the method used to obtain the benefit/cost ratio was the same for each of the

alternative routes. However, since that time some changes have occurred in the method of economic analysis in the availability of better cost estimates, and in the staging and actual construction of some sections of road.

It is proposed to construct the Aylmerton to Hoddles Cross Roads project in three stages. These are the Aylmerton to Welby section, the Welby to Medway Rivulet section, and the Medway Rivulet to Hoddles Cross Roads section. An economic evaluation has been carried out for each stage and for the total project. The results of the analysis are presented in Table 6.1 and show that:

- (i) each stage of the project has high economic warrant as does the total project;
- (ii) there is no reason to defer the project since each stage has a first year rate of return greater than the discount rate (10%), assuming the timing in Table 6.1.

TABLE 6.1: RESULTS OF COST BENEFIT ANALYSIS

	SECTION			
	Aylmerton to Welby	Welby to Medway Rivulet	Medway Rivulet to Hoddles Cross Roads	Total
Length of existing road (km)	10.5	15.5	9.5	—
Length of proposed road (km)	9.5	15.5	9.5	—
Total construction cost (\$m) ⁽¹⁾	33.3	33.6	18.4	—
First year of construction	1989	1983	1982	—
Year of opening	1994	1988	1987	—
Total benefits in 1st year of operation (\$m)	4.0	3.4	2.0	—
EVALUATION RESULTS⁽²⁾				
Present value of benefits (\$m)	57.5	77.8	53.6	188.9
Present value of costs (\$m)	27.8	28.0	15.4	71.2
Net present value (\$m)	29.7	49.8	38.2	117.7
First year rate of return	14.3	12.1	13.2	N.A.
Benefit cost ratio	2.1	2.8	3.5	2.7

⁽¹⁾ All values are in 1982/83 prices.

⁽²⁾ Values are discounted to 1982 in the evaluation

6.5 ROAD FREIGHT INDUSTRY

New South Wales, by size and position, forms the centre of the Australian land transport arena. It accounts for 35-40% of all Australian road tonne-kilometres (McDonnell, 1982). The Commission of Enquiry into the New South Wales road freight industry found that the importance and role of this industry has not been sufficiently recognised by the community. It concluded that "the N.S.W. freight transport industry, road and rail, should be recognised as a commercial industry among commercial industries, one of the great industries of the State, critical to all other industries" (Commission of Enquiry, 1980, First Report, Vol. 1). In an analysis of historical development, the Commission stated: "Freight transport has been crucially important in the 'annihilation of distance' and the reduction of costs both for industry and consumers which has made possible the flexible and complex society and economy of the State as it is today." In terms of dollars, the freight industries form a major part of the State's economic activity, with an output estimated by the Enquiry "at about \$2,200 million in 1975-76, compared with about \$1,800 million for agriculture (and) about \$1,000 million for mining . . . Good statistics on employment are lacking, but direct employment is estimated at about 60-70,000" (Enquiry, Vol. 1, p.11/1).

An historical pattern of long distance freight transport concentrating in a few corridors in New South Wales still continues. Four highways, the Hume, Pacific, New England and the Great Western, accounted for 81% of total long distance road tonne-kilometres in

TABLE 6.2: FREIGHT MOVEMENTS ON MAJOR NEW SOUTH WALES HIGHWAYS

	1968/9		1970/1		1972/3		1975/6	
	Tonne-kms (mills.)	% of Total	Tonne-kms (mills.)	% of Total	Tonne-kms (mills.)	% of Total	Tonne-kms (mills.)	% of Total
HUME HIGHWAY	1,468.2	37%	1,719.0	42%	2,085.4	44%	2,667.7	43%
PACIFIC HIGHWAY	464.1	12%	583.5	14%	719.3	15%	965.5	16%
NEW ENGLAND HIGHWAY	522.3	13%	515.4	12%	538.4	11%	751.4	12%
GREAT WESTERN/BARRIER HWY.	733.3	18%	473.8	12%	459.3	10%	616.8	10%
NEWELL HIGHWAY	153.2	4%	193.2	5%	231.2	5%	176.9	3%
FEDERAL/MONARO HIGHWAY	53.3	1%	62.7	1%	76.1	2%	104.8	2%
PRINCES HIGHWAY	71.2	2%	65.8	2%	77.4	2%	127.8	2%
STURT HIGHWAY	29.9	1%	28.0	1%	32.0	1%	64.3	1%
MID-WEST HIGHWAY	43.1	1%	37.4	1%	45.6	1%	23.0	0.5%
OLYMPIC HIGHWAY	89.5	2%	76.7	2%	76.1	2%	115.6	2%
TOTAL	3,628.1	91%	3,754.6	92%	4,340.9	93%	5,613.9	91.5%
STATE TOTAL (ROAD)	4,015.3	100%	4,100.7	100%	4,701.9	100%	6,190.9	100%

Source: Commission of Enquiry into the N.S.W. Road Freight Industry, Vol. 1.

1975-76 (see table 6.2). Within this concentrated flow pattern, the Hume Highway dominated with 43% of the total, representing 2,667.7 million tonne-kilometres. For interstate movement alone the pattern is even more marked, with the Hume Highway accounting for 63% of total road interstate tonne-kilometres. Intrastate freight is more diffusely spread on the major highways. Consequently, since the operating costs of road transport are affected by the nature of the roads that are available, it is essential to the overall economy that the road system in general, and the Sydney-Melbourne National Highway in particular, be of the highest quality. A controlled access, dual carriageway road with a high standard of vertical and horizontal alignment is warranted for this main national transportation link.

Having regard to the unusually high proportion of heavy vehicles in the traffic flow (33%), this high standard road is also warranted on safety grounds. The principal conclusion of research on truck accident statistics undertaken for the Enquiry was that "the popular impression that the operations of heavy commercial vehicles, especially articulated trucks, is more dangerous than those of other vehicles is confirmed — they are disproportionately involved in serious accidents" (Enquiry, Vol. 4, p.5/15).

In 1977 articulated trucks represented only 0.6% of the vehicles on the N.S.W. register, but comprised 5.3% of the vehicles involved in fatal crashes, 1.5% of the vehicles involved in injury crashes and 1.4% of vehicles involved in towaway crashes. Even when allowance is made for the numbers of interstate vehicles on N.S.W. roads, the broad conclusion remains. On an exposure basis, when allowance is made for the distance travelled by various types of vehicles, involvement of articulated trucks in *fatal* crashes is over double that to be expected on the basis of numbers registered and distance travelled.

This is consistent with results in other countries, for example, the United Kingdom. Again, statistics for 1977-78 showed that trucks were involved in more than *one-third of all fatal two-vehicle crashes*. Thus trucks, and articulated ones in particular, are involved in relatively more vehicle fatal crashes than cars, especially head-on and rear-end. Safety measures should concentrate not only on protective measures for truck drivers but also on reducing dangers for other road users (McDonnell, 1982, pp.38-39).

Because trucks have greater mass, more rigidity, and a higher structure than a typical car, trucks and their drivers are more frequently unscathed as a result of truck-car accidents. For safety reasons, then, it is most desirable to have a multi-lane, divided carriageway road with a high standard vertical and horizontal alignment. These proposed design features will help to minimize the accident potential by separating vehicles travelling in opposite directions, allow for more uniform speed of individual vehicles in the flow, and permit safe overtaking when required.

6.6 EFFECTS OF THE "NO BUILD" OPTION

6.6.1 Level of Service

As indicated in Section 4.2, the Hume Highway in the study area has a level of service below the standard set by the Commonwealth Government for the Sydney to Melbourne National Highway. For the most part it has just two sealed lanes and there are several short sections where the total width of sealed pavement is only 6.1 metres. There is also a very high proportion of heavy vehicles in the traffic using this main artery linking the eastern states. These factors contribute to the low level of service situation and the high accident rates.

6.6.2 Accidents

An estimate of the potential reduction in accidents can be made between the "No Build" and the "Build Highway" alternatives by using the accident values given in Table 4.1 with the projected traffic volumes. Figure 11 shows these traffic volumes with the western route built. To estimate the potential number of accidents on the new freeway standard highway, the accident rates indicated in Table 4.1 for injuries and total accidents

on Section 2/29 have been used because this covers the length of the Hume Highway which was previously known as the Yanderra to Aylmerton section of the South Western Freeway. However, since the time period for which accident statistics are available is relatively short on this section of road, and no fatal accidents have been recorded, the 1976-1977 averaged fatal accident rate for the more heavily trafficked (500,000 veh. kms per day) Sydney to Newcastle Freeway has been used to calculate potential fatalities on the proposed new highway (D.M.R., 1980, Table 7).

Table 6.3 shows, for the various classes of accidents, the potential annual reductions with the new highway, using the projected 1996 daily traffic volumes. An annual saving of 10 lives and 140 injury accidents, or a reduction of 170 in the total vehicle accidents, is possible if the new section of national highway is built as proposed between Aylmerton and Hoddles Cross Roads.

This is a conservative estimate. A study by the National Roads and Motorists' Association (Searles, 1980) has shown that about four times as many crashes are reported to "comprehensive" insurance companies in Sydney than appear in the official statistics as tow-away and/or casualty crashes. The crashes not appearing in the official statistics are likely to cost as much as comparable crashes which do appear.

TABLE 6.3: ACCIDENT REDUCTION WITH NEW HIGHWAY

Section	1996 Mil. Veh. Kms.	Fatal Accidents	Injury Accidents	Total Accidents
2/30	111.661	5	99	130
2/31	112.931	9	103	126
2/32	119.282	4	31	43
25/1	43.165	1	28	44
260	74.509	1	31	42
Totals without new highway		20	292	385
2/30	36.301	2	32	42
2/31	11.293	1	10	13
2/32	123.677	4	32	45
25/1	25.426	1	17	26
260	61.050	1	25	34
New highway	248.087	1	37	54
Totals with new highway		10	153	214
Net reductions (totals rounded)		10	140	170

For the purpose of gaining some appreciation of the community costs involved, the cost of "serious road accidents" in the State of South Australia during March 1976 to March 1977 has been estimated by Somerville and McLean (1981) to be \$395 million in terms of 1980 dollars. Atkins (1981, p.23) has stated that "the estimated *total* cost of road accidents in Australia was over \$1,590 million in 1978; or equivalent to nearly 2% of Gross Domestic Product in 1977/78". While these cost estimates are substantial, all of the major Australian studies of accident costs have recently been criticized for deficiencies in their economic evaluation. "In each of these studies, the intangible costs are not quantified due to measurement difficulties ..." (Richardson, 1983, p.4). The cost procedures used provide "only an irreducible minimum value" of the social consequences of accidents.

Apart from the potential financial savings to the community which would be lost with the no build option, the possibility of avoiding approximately 10 fatal accidents and 140 injury accidents each year would also be lost. This prospect does not appear to be justified when road accidents are responsible for the loss of more lives below the age of 50 than any other cause in New South Wales. They are also the largest killer of children aged less than 20 years (A.B.S., 1981).

6.6.3 Planning Proposals

As indicated in Section 3.3.1, the study area has attracted industry wanting to capitalise on its location on the State's main north-south transportation corridor, and it has experienced expansion pressures as the urban fringe of Sydney moves in a south westerly direction. Also, planning objectives for the area have been stated as being to:—

- (a) encourage residential growth immediately east of Mittagong and Bowral, and at Moss Vale to the east and south-west.
- (b) contain industrial growth to the corridor west of Moss Vale to Berrima and to the north-west of Mittagong; and
- (c) preserve viable agricultural land (P.E.C., 1978).

Constructing the highway on the proposed western route will assist in the achievement of these objectives and the continued attraction of industry by improving the transportation corridor away from the residential expansion areas. If the highway is not built, the economic growth of, and the related population increase in, the area will be inhibited.

However, recent advice received from the National Parks and Wildlife Service (1982a and 1982b) indicates that they have extended the provisional boundaries for a Nattai National Park proposal across the Nattai River to the outskirts of Willow Vale and Braemar. This extension of the park boundaries would cut across the highway route (see Sections 5.4.6 and 10.3.1).

6.6.4 User Benefits

The "No Build" alternative will involve continuing increases in travelling time, energy consumption, vehicle operating costs and accident rates as traffic volumes continue to increase in this major transportation corridor, compared with reductions which can be effected by the construction of the new highway.

6.6.5 Savings

Some savings would occur with the "No Build" alternative. These include the costs of construction and avoiding any impacts on the flora, fauna, agricultural and private activities in the proposed road reserve. However, as indicated above, these savings are considered to be more than offset by the many advantages which can be gained by building the highway in the proposed location.

7. DETAILS OF PROPOSAL

7.1 DESIGN CONSIDERATIONS

In developing the detailed design for the proposed Aylmerton to Hoddles Cross Roads section of highway, consideration has been given to such factors as volume and type of traffic, the terrain to be traversed, existing facilities and natural resources, effects on the natural and human environments, planning for the area and future needs, standards of adjoining sections of highway, and estimated costs. Having regard to these basic aspects, design specifications to national highway standards were developed for determining the design speed, alignment, maximum grade, minimum sight distance, width and nature of the pavement and formation. Hydrological and detailed geological studies were required to determine bridge and culvert locations and designs, as well as cut and fill batter slopes.

Freeway standard design will apply on the 25 km of new alignment between Aylmerton and Medway Rivulet while motorway standard design will apply between Medway Rivulet and Hoddles Cross Roads (9.6 km). This latter section is contained generally within the existing road boundaries. Under freeway conditions access is limited to grade separated interchanges while under motorway conditions it is limited to intersections and licenced access points.

7.2 DESIGN ELEMENTS

Since the primary function of the highway is to cater for long distance traffic between major population centres, it is being designed to be a safe yet high speed, four lane, dual carriageway road with shoulders for broken down vehicles and control of frontage access from private property. Typical cross sections, in cut and in fill, are shown on Figure 14. For safety reasons, the northbound and southbound traffic streams will be kept apart on separate carriageways with a wide median in between, varying from 20.2 metres wide on the freeway section to a minimum of 10.2 metres wide on the motorway section. The reduced cross section between Medway Rivulet and Hoddles Cross Roads will enable the dual carriageway facility to fit within the existing road reserve, limiting the amount of property acquisition required. Cut batters are to be rounded at the top to present a softer transition line between constructed and existing slopes.

The proposed route of the highway as it bypasses Mittagong and Berrima is shown on Figures 16, 17 and 18. The built up area of Mittagong is bypassed to the north of Mount Alexandra but access is to be provided from a high speed directional interchange at Aylmerton and from a half diamond interchange at Welby. To avoid the historic town of Berrima and its urban conservation area, the route crosses the Wingecarribee River approximately two kilometres to the west before swinging south to join the existing Hume Highway at Medway Rivulet. The Berrima interchange is split into two half diamonds, providing access to the north at Medway Road and to the south from a realigned access road to the Berrima water supply site. (The interchanges at Welby and at Medway Road have been modified, reducing the land acquisition involved. They are shown redesigned on Figures 17 and 18, respectively.)

Although detailed design has not been completed, a 5 km length of the proposed longitudinal section on the Mittagong bypass is shown on Figure 15 for illustrative purposes. The two carriageways have been separated vertically by over seven metres between Mount Alexander Colliery (121 km) and Gibbergunyah Creek (122 km) because of the steep side slope. This reduces the amount of cut and fill required and suits the natural terrain. A maximum grade of 5% is involved. The deepest cut (29 m) for the whole project occurs at 120.3 km, immediately south of the Nattai River.

For the 8.5 km long Mittagong bypass section (Aylmerton to Welby), approximately 1.4 million cubic metres of excavation is required, while for the 16.5 km long Berrima bypass section (Welby to Medway Rivulet), earthworks involve approximately 3.4 million cubic metres of excavation. In comparison, earthworks for the 9.6 km long Medway Rivulet to Hoddles Cross Roads section are very light because the proposed northbound carriageway will, in general, be following a grade similar to that of the existing carriageway and will be within the existing road reserve.

7.3 BRIDGES

Although the detailed design is still proceeding, it is anticipated that nine bridges and one access culvert will be required for the Mittagong bypass section, and twenty-one bridges plus two access culverts will be required for the Berrima bypass section. The longest bridges will be required to carry the dual carriageways over the Nattai River and Gibbergunyah Creek.

For Nattai River, a 220 m long bridge is required for the southbound carriageway and a 244 m long bridge is required for the northbound carriageway. Twin bridges, both 240 m long, are required over Gibbergunyah Creek. In addition to creek crossings, bridges are required to maintain access on the local road system across the proposed road reserve.

7.4 STAGING

It is proposed to construct the 34.6 km length of dual carriageway highway from Aylmerton to Hoddles Cross Roads in stages. First stage construction, the Medway Rivulet to Hoddles Cross Road section, involves constructing a second carriageway within the existing road reserve. The second stage involves construction of dual carriageways for the Berrima bypass section, while the third stage involves similar construction for the Mittagong bypass. Actual timing depends primarily upon programme funding for national highways by the Commonwealth Government. On average, it is expected that there will be approximately 40 people employed in construction for the duration of the project.

7.5 SITE CLEARING

Site clearing will be limited to the minimum necessary for access outside of the area to be occupied by the cuttings and embankments (see Figure 14), plus a small number of stockpile areas for topsoil and base materials. Any remaining timber and shrubs within the highway reserve will be preserved. Although most of the route has previously been cleared of natural bush cover, there is still approximately 55 hectares of clearing required at different locations along the 34.6 km of reserve involved.

It is proposed to dispose of the cleared vegetation by open burning, in liaison with relevant fire authorities. Suitable weather conditions and optimal yet safe burning methods will be selected to ensure full control and to avoid damage beyond the area cleared for construction. The construction site is reasonably isolated from built up areas for most of its length (see Figure 6).

7.6 RESTORATION AND LANDSCAPING

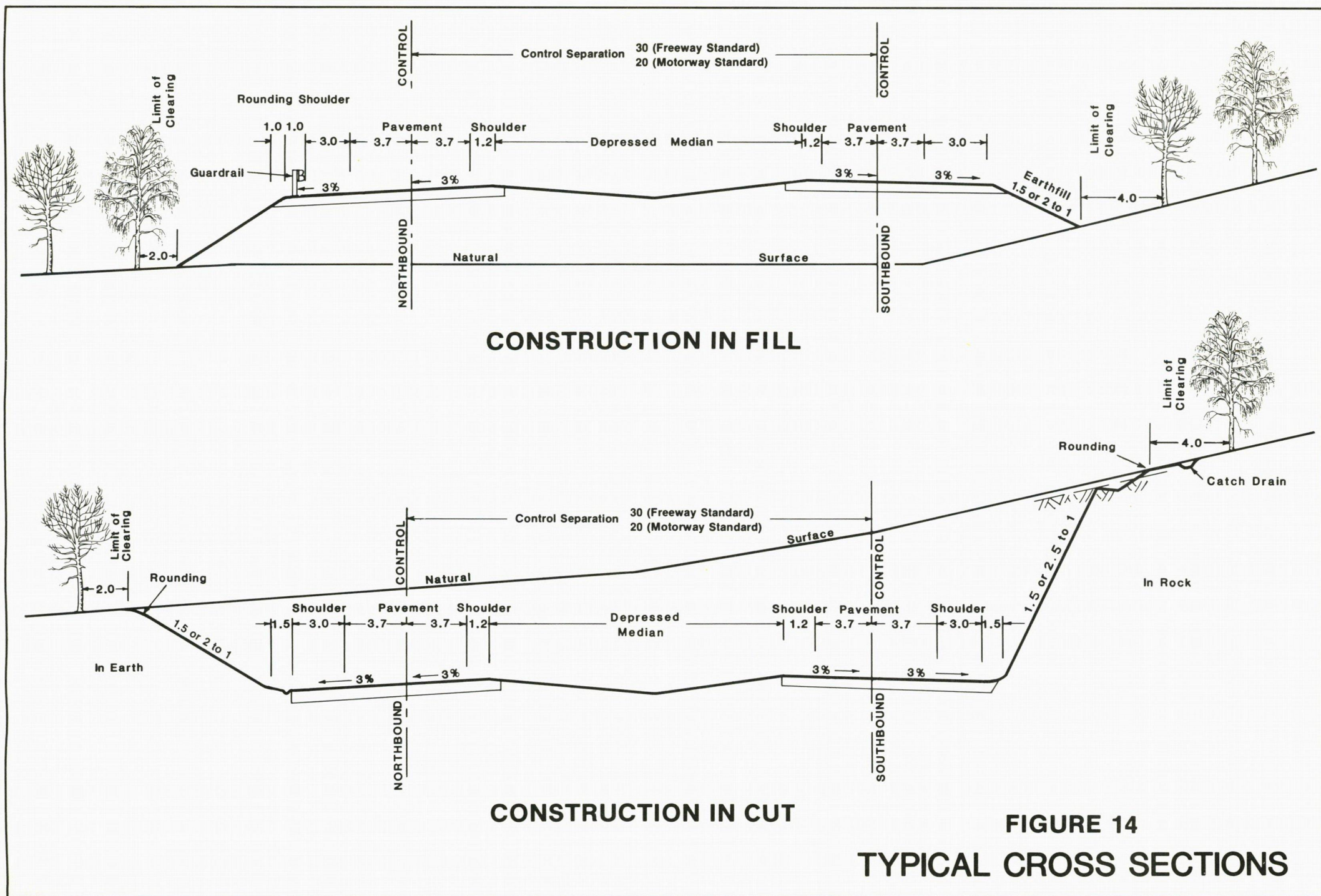
Construction requirements include provision for the works to be kept clean and tidy as they proceed, and to remove regularly from the site rubbish and surplus material arising from the execution of the works. As soon as practicable after completion of the works, all buildings, workshops, temporary works, construction plant and equipment used on the site will be removed.

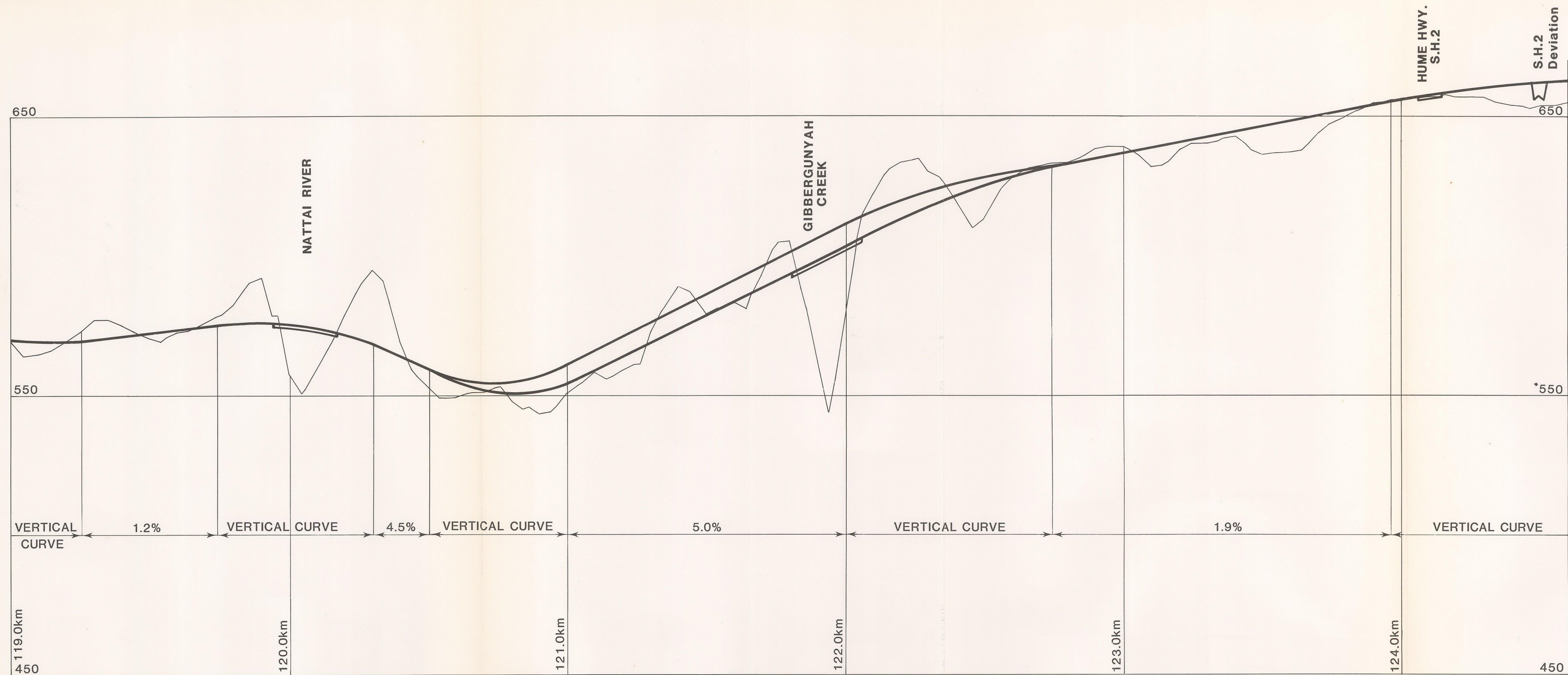
Landscape work will be one of restoration by encouraging regeneration of indigenous species. Section 9.2.8, Landscaping and Revegetation, provides further details of this aspect.

7.7 EXISTING ROADS AND RAILWAYS

In order to maintain access on the existing road and rail network, the following provisions are proposed:

- (1) Hume Highway, Aylmerton — a deviation of the northbound carriageway to pass under the new dual carriageway highway.
- (2) Picton — Mittagong Loop Line — highway underpass.
- (3) Drapers Road — bridge over highway.





SCALES
1:10,000 HORIZONTAL 1:1,000 VERTICAL

FIGURE 15
LONGITUDINAL SECTION

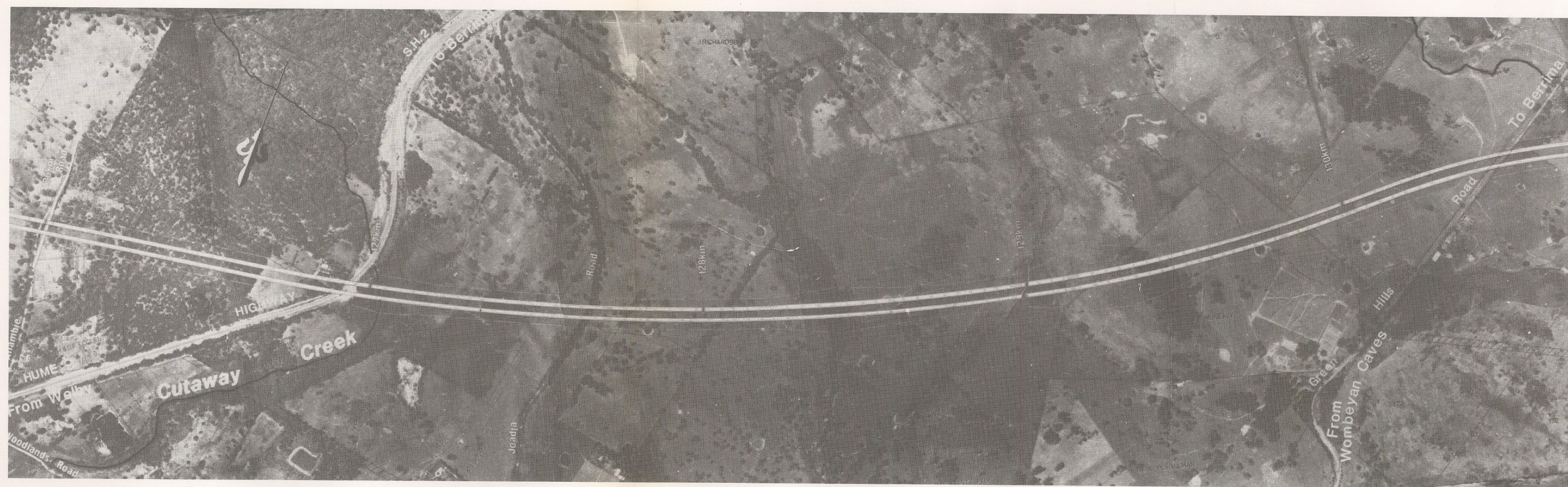
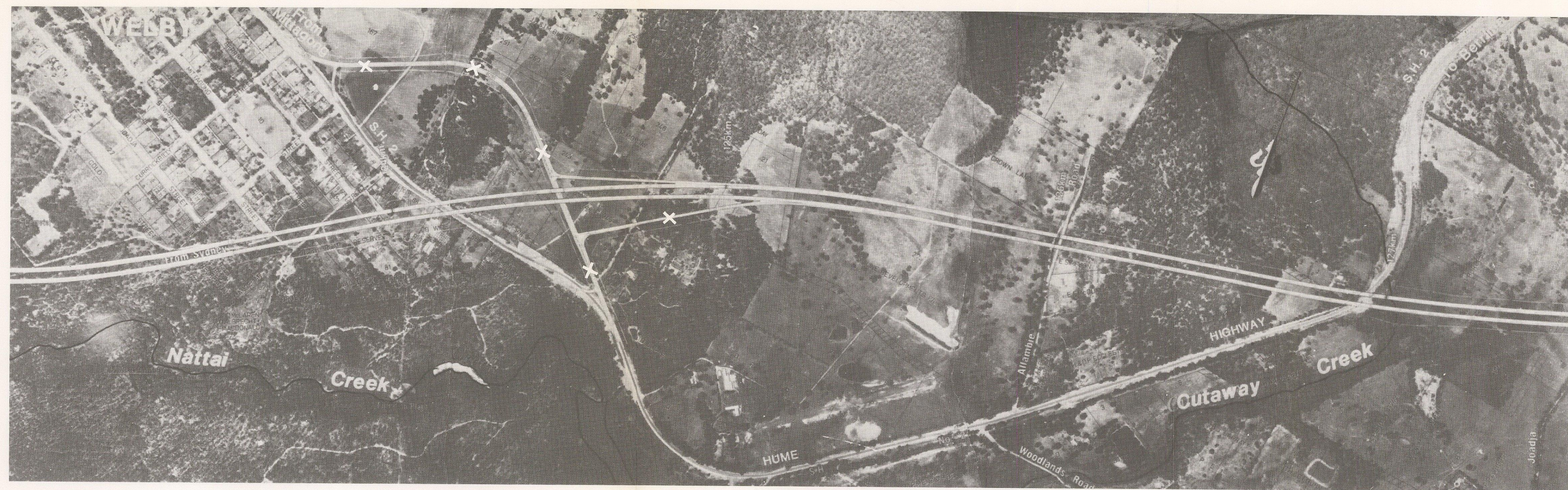


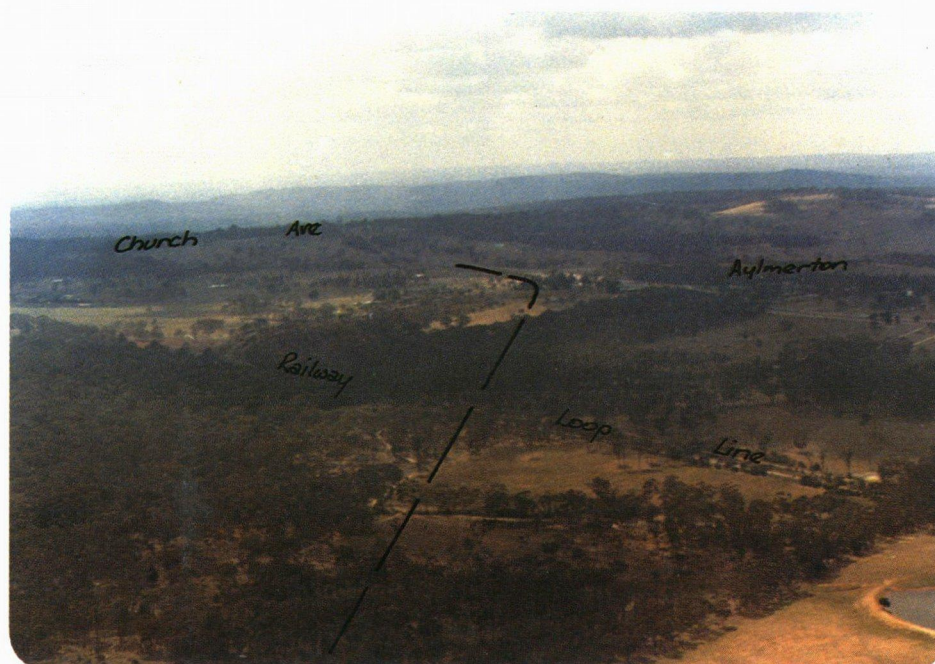
FIGURE 17
WELBY TO GREEN HILLS ROAD



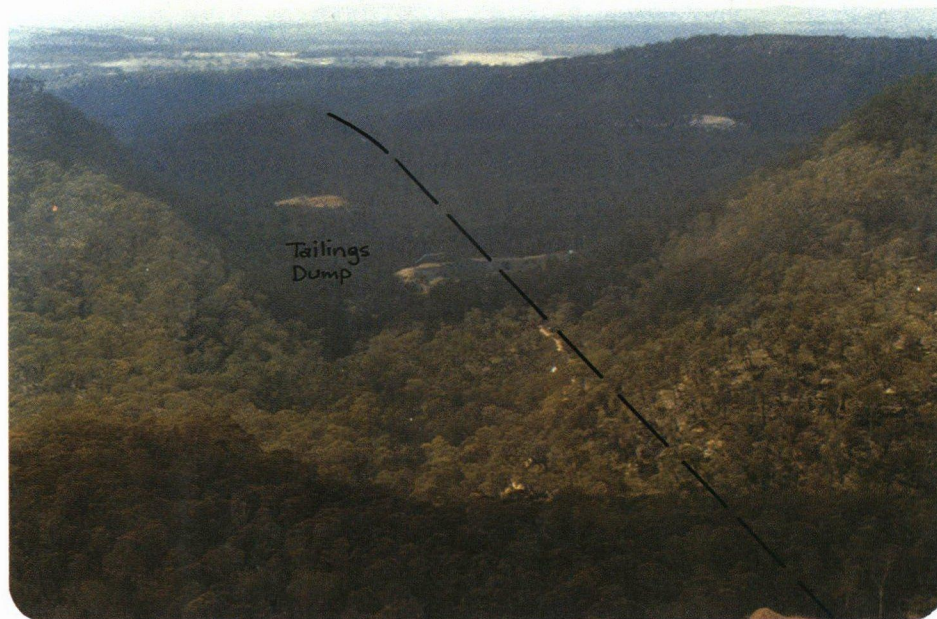
FIGURE 18
GREEN HILLS ROAD TO MEDWAY RIVULET



(3) Looking south from Aylmerton Road
(SECTION 7.2)



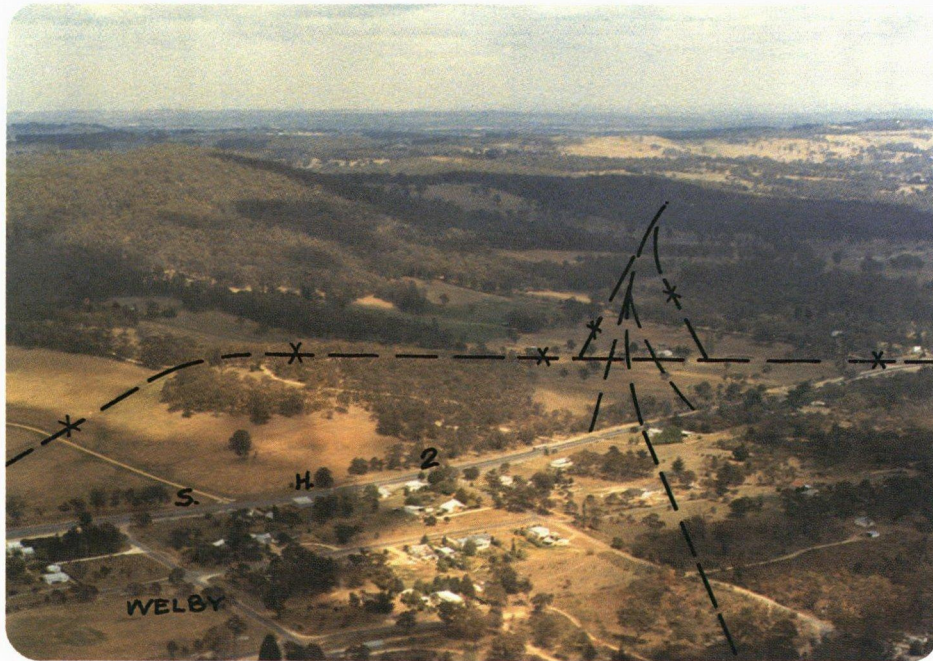
(4) Looking north from Drapers Road
(SECTION 7.2)



(5) Looking north from Gibbergunyah Creek
(SECTION 7.2)



(6) Looking south from Gibbergunyah Creek
(SECTION 7.2)



(7) Looking south from Welby. Interchange redesigned without deviating existing highway
(SECTION 7.2)



(8) Looking south from Joadja Road
(SECTION 7.2)



(9) Looking south from Old Mandemar Road
(SECTION 7.2)



(10) Looking south from Medway Road
(SECTION 7.2)

- (4) Hume Highway, Welby — deviation to pass under the new dual carriageways.
- (5) Allambie Road — underpass.
- (6) Hume Highway, Cutaway Hill — underpass.
- (7) Green Hills Road — underpass.
- (8) Old Mandemar Road — underpass.
- (9) Medway Road — underpass
- (10) Berrima Coal Mining Company's line — underpass.
- (11) Access road to Berrima water supply site — underpass.

8. FEATURES OF THE PROPOSED CORRIDOR

8.1 GEOLOGY

A geological investigation of the proposed route has been undertaken and described in a report by Summerell (1983). This Environmental Impact Statement summarizes the findings of that report.

The distribution of the major rock types is shown on Figure 19. Triassic Hawkesbury Sandstone and Wianamatta Group Shales predominate. Tertiary basalts covered most of the region but erosion has reduced the extent of the basalt to remnant cappings. Regional dips are in the order of 5° but doming, associated with shallow intrusives, has resulted in dips of up to 30° in the Nattai Dome. This doming has also exposed weaker Narrabeen Group and Illawarra Coal Measure rocks in the Nattai Gorge, while deep incision by the Nattai River and Gibbergunyah Creek has produced prominent cliff and talus landforms. The Wingecarribee River has also incised deeply into the sandstone downstream of Berrima, but this is not pronounced along the proposed route. The remaining rivers and creeks along the route are in a late stage of maturity.

The strength of Hawkesbury Sandstone varies from moderately weak to strong, with the bulk of the sandstone being within the moderately strong range. These variations in strength depend upon the degree of weathering, the amounts of authigenic silica and limonite, and upon grain size.

Engineering properties of the Wianamatta Group shales are similar and comments here are limited to the Ashfield Shale. This shale is usually deeply weathered with outcrops being rare. The shales weather and fret rapidly on exposure. Weathered products of the shales are clays and silty clays of medium to high plasticity. The strength of the shales varies considerably, depending on the degree of weathering, but fresh shales and siltstones fall within the moderately strong to strong classes.

Some cuttings in the remnant basalt caps are involved in the proposed route. The more resistant basalt overlies tertiary deposits of sands, silts and clays on Wianamatta Group shales, and undermining of the basalts has resulted in the formation of steep slopes. The basalt varies from highly weathered to fresh, but is highly fractured. While the moderately weathered to fresh basalt should be relatively stable, the weathering pattern is irregular with high to extremely weathered sections occurring above and below the moderately weathered to fresh sections.

8.2 SOILS

A soil survey was carried out in October, 1982 as input to this environmental study and is reported by Summerell (1983). A summary follows. The mapped distribution of soils is shown on Figure 20.

Five of the twenty-one soil units identified by Hamilton (1976) in a reconnaissance survey of the Hawkesbury River catchment occur along the route.

Soil Unit 1: Clay Loam, Brown and Red Structural Soils

These soils are formed on parent material derived from Tertiary volcanics including basalt, basalt breccia and micro syenite. They are usually found on remnant basalt caps on the higher positions in the landscape.

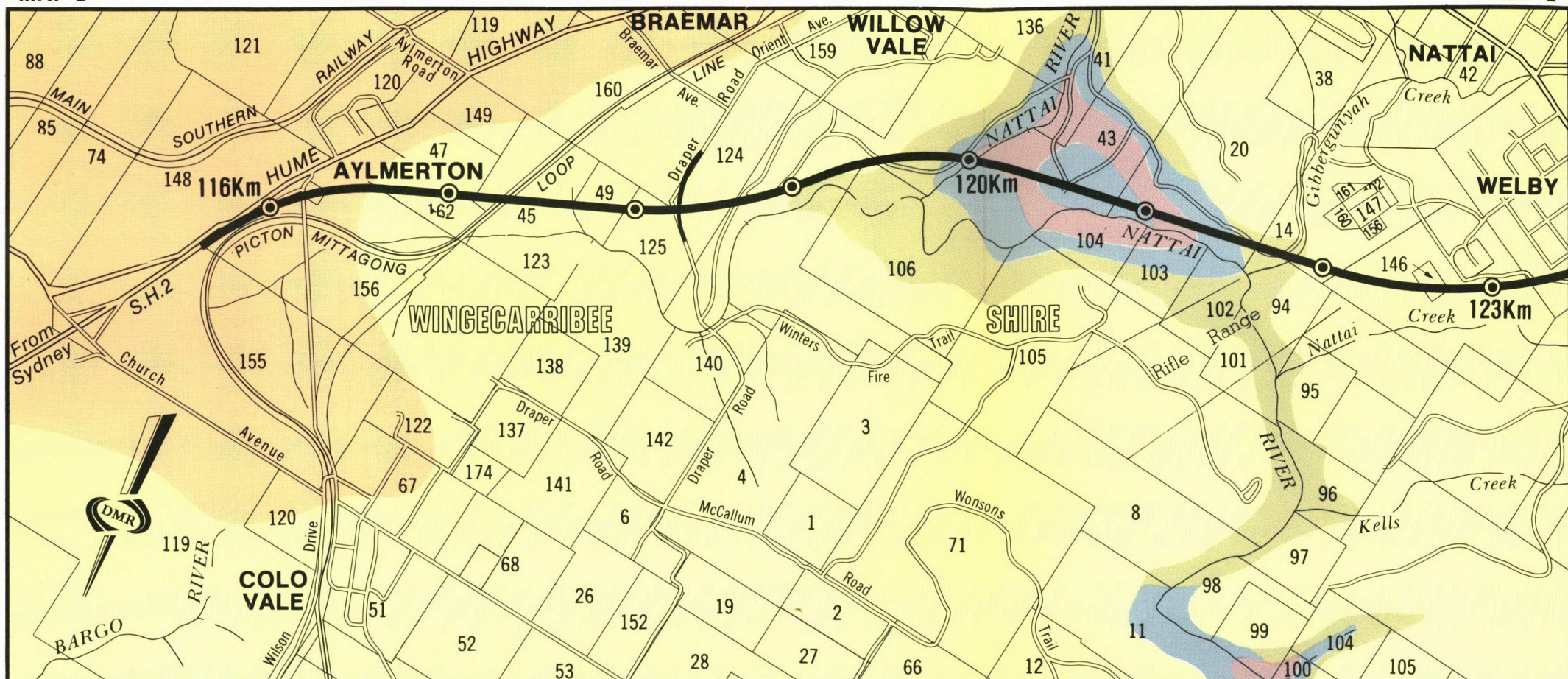
The soils are mainly neutral although those formed on massive micro syenite are slightly acidic. They are well structured, fertile soils but with a moderate to high erodibility with some tunnelling in the B horizon. On steep slopes, usually at the boundaries of basalt caps, these soils have exhibited a tendency towards slumping and landslip.

Soil Unit 2: Clay Loam, Red Gradational Soils

This soil unit occurs on moderate to gently undulating slopes underlain by Ashfield Shales. Invariably they have had a significant colluvial input from the remnant basaltic

MAP 1

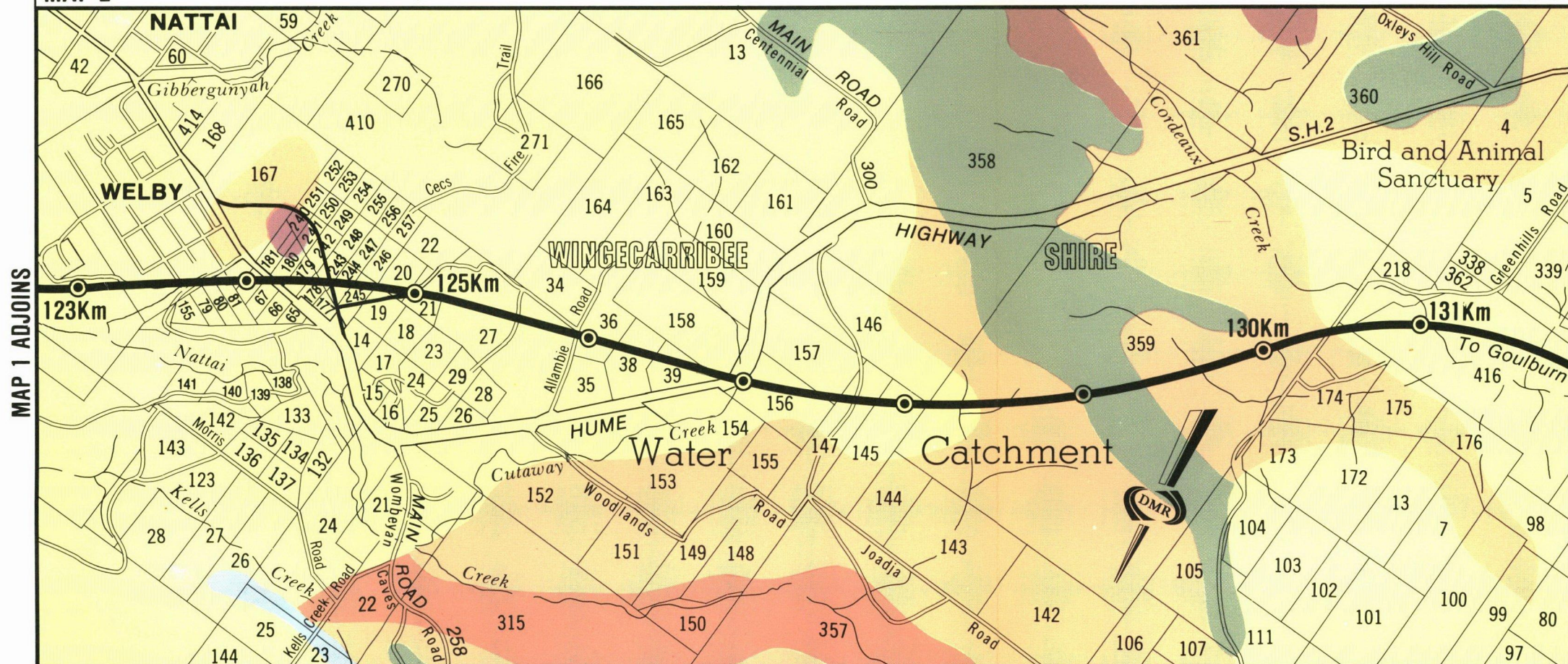
MAP 1



MAP 2 ADJOINS

MAP 2

MAP 2



MAP 1 ADJOINS

MAP 3 ADJOINS

Silt, clay, soil



Weathered, basaltic soil



Alkaline, olivine basalt



Olivine dolerite, gabbro



Syenite, microsyenite



Trachyte



Ashfield Shale



Hawkesbury Sandstone



Narrabeen Group rocks



Illawarra Coal Measures



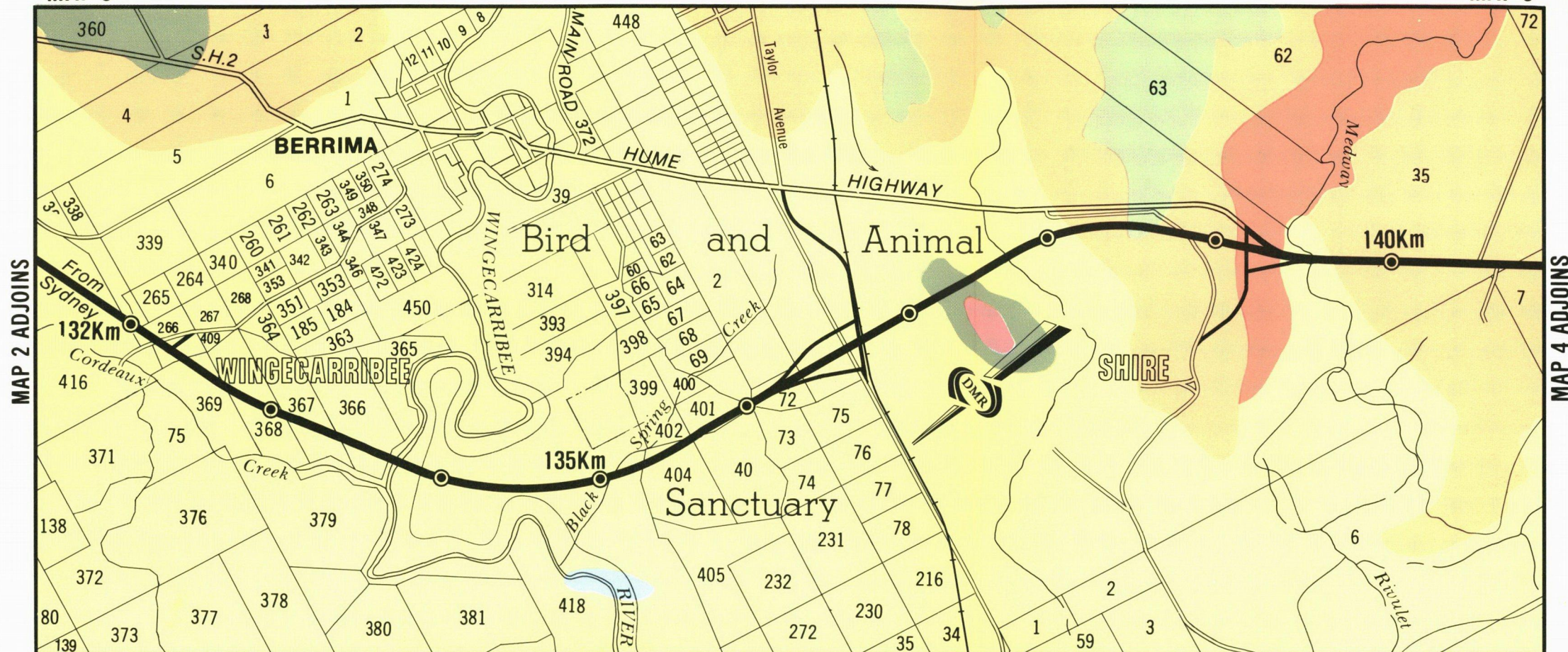
FIGURE 19

GENERAL GEOLOGY

km 0 0.5 1 2 km

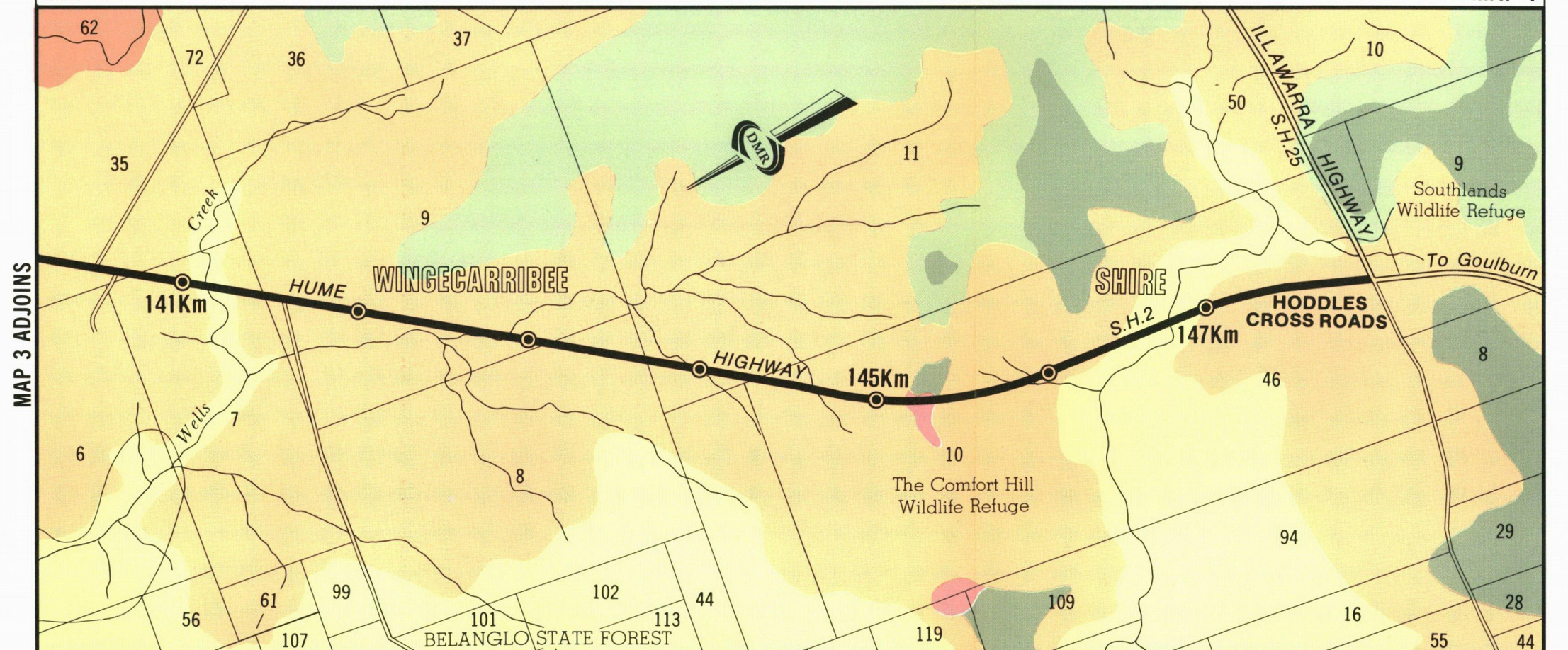
MAP 3

MAP 3



MAP 4

MAP 4



Silt, clay, soil

Alkaline, olivine basalt

Basalt breccia



Olivine dolerite, gabbro

Bringelly Shale

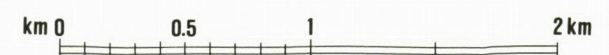
Ashfield Shale



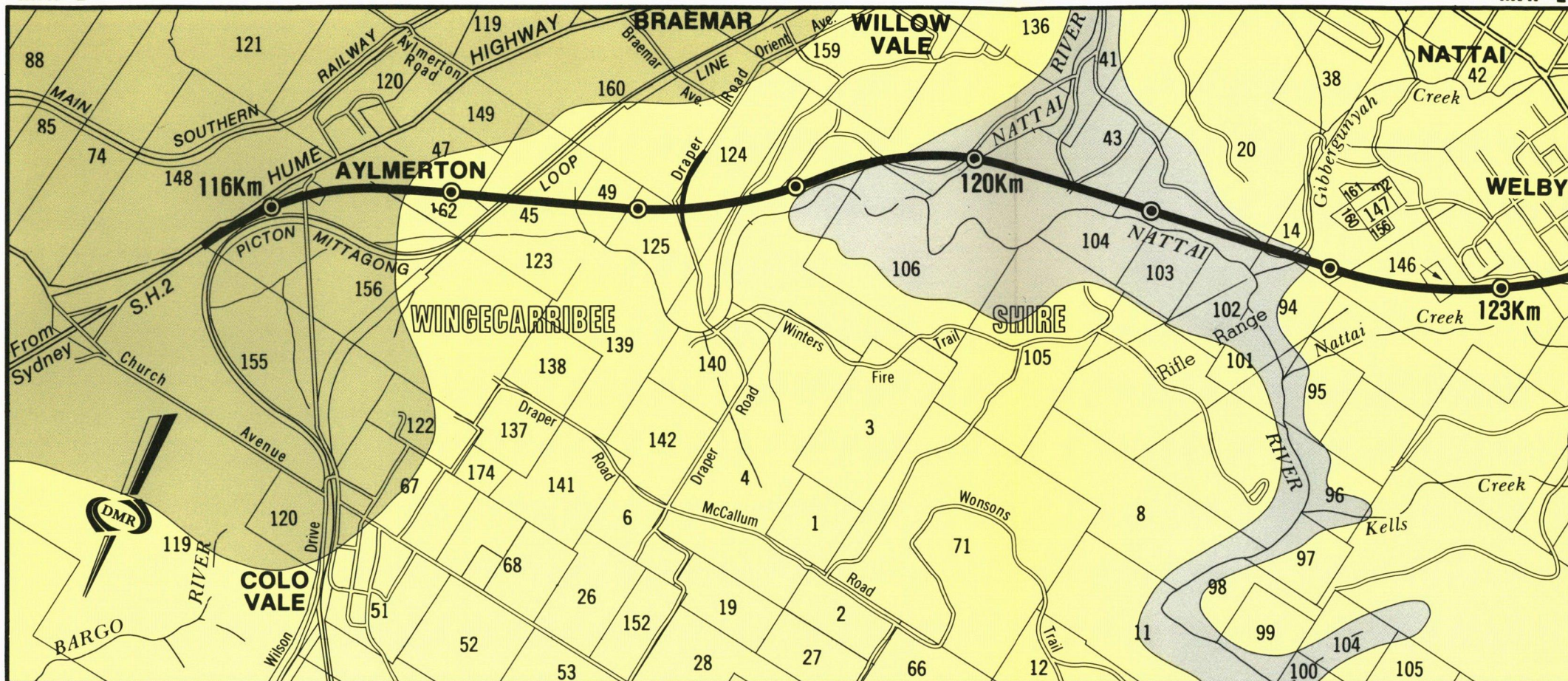
Hawkesbury Sandstone



FIGURE 19
GENERAL GEOLOGY



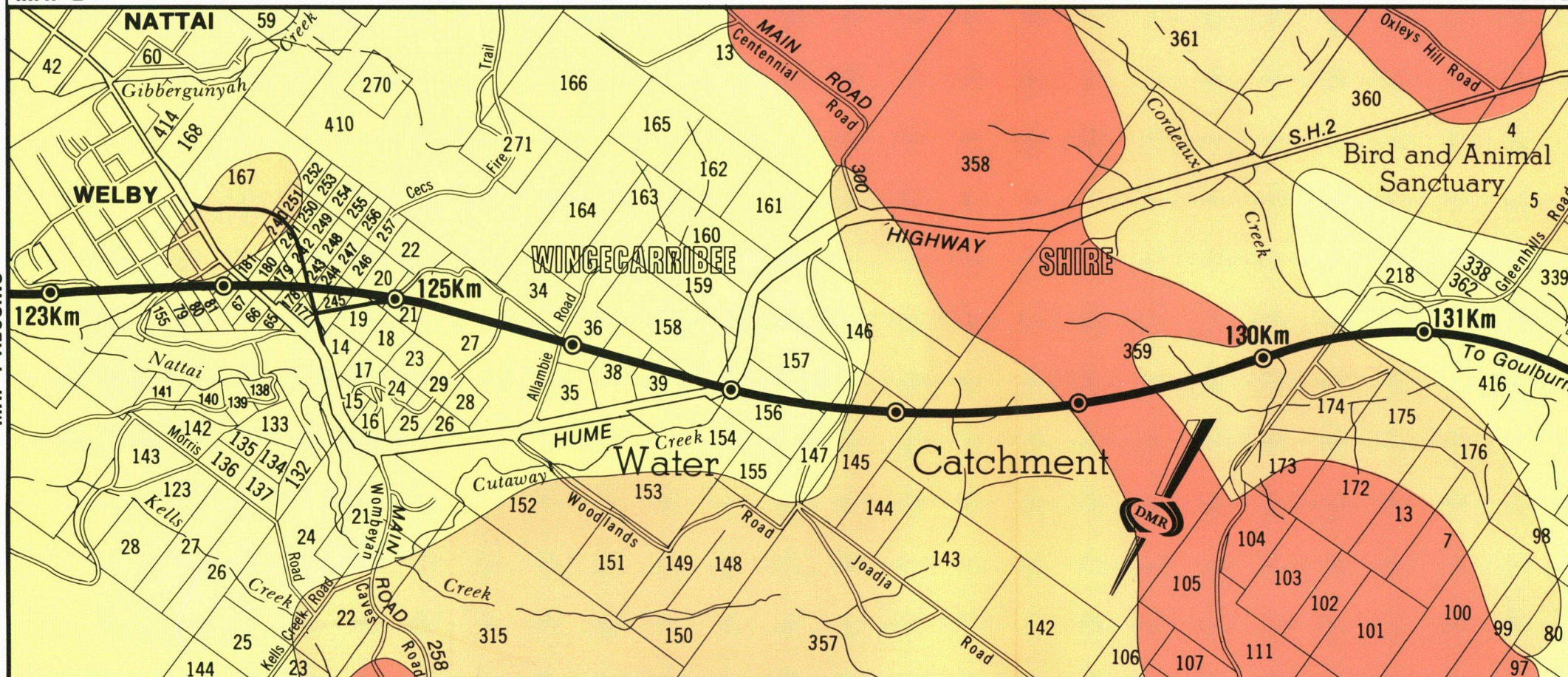
MAP 1



MAP 1

MAP 2 ADJOINS

MAP 2



MAP 2

MAP 1 ADJOINS

MAP 3 ADJOINS

Clay loam, brown and red, structured, friable soils.

Sandy, yellow, leached, gradational soils. (with ironstone gravel)

Sandy loam, leached, gradational soils.

Clay loam, red gradational soils (with ironstone gravel)

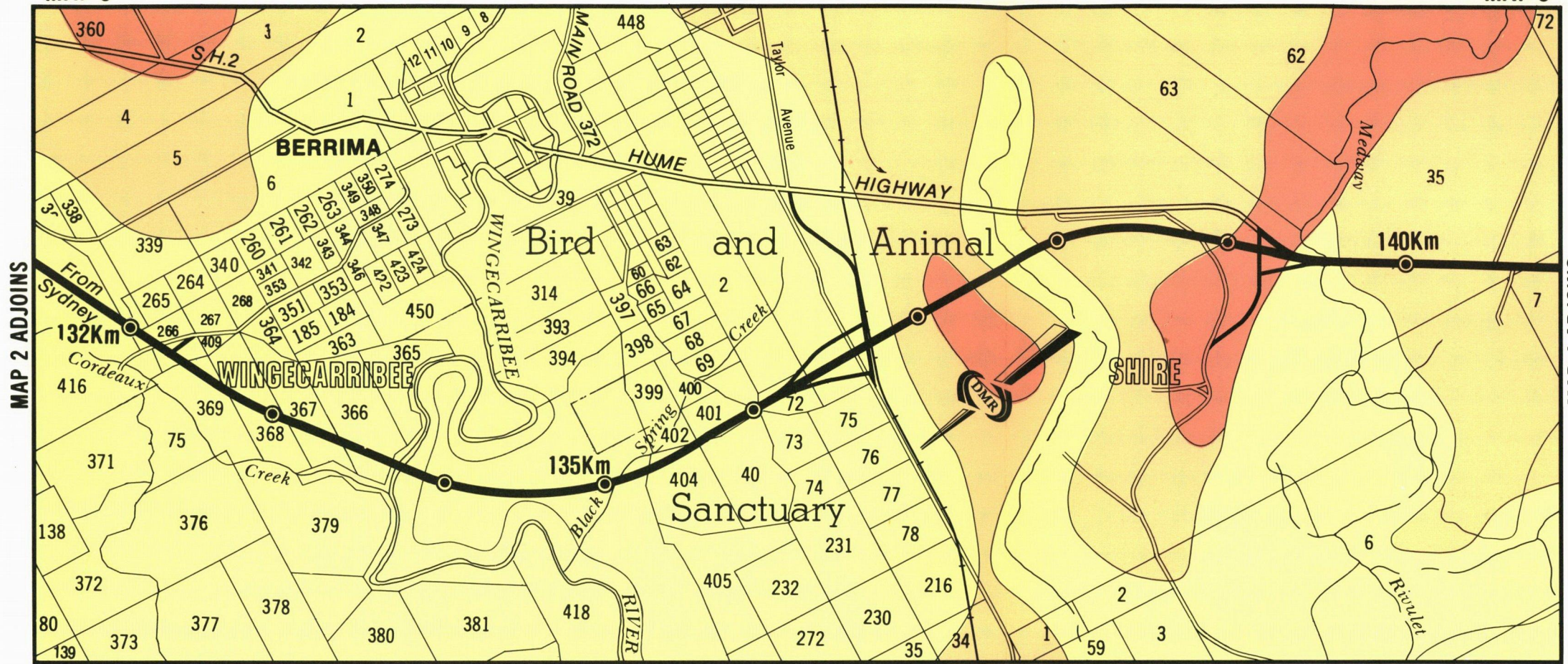
Hardsetting, loamy, red and yellow, texture contrast soils (with ironstone gravel)

FIGURE 20
SOILS



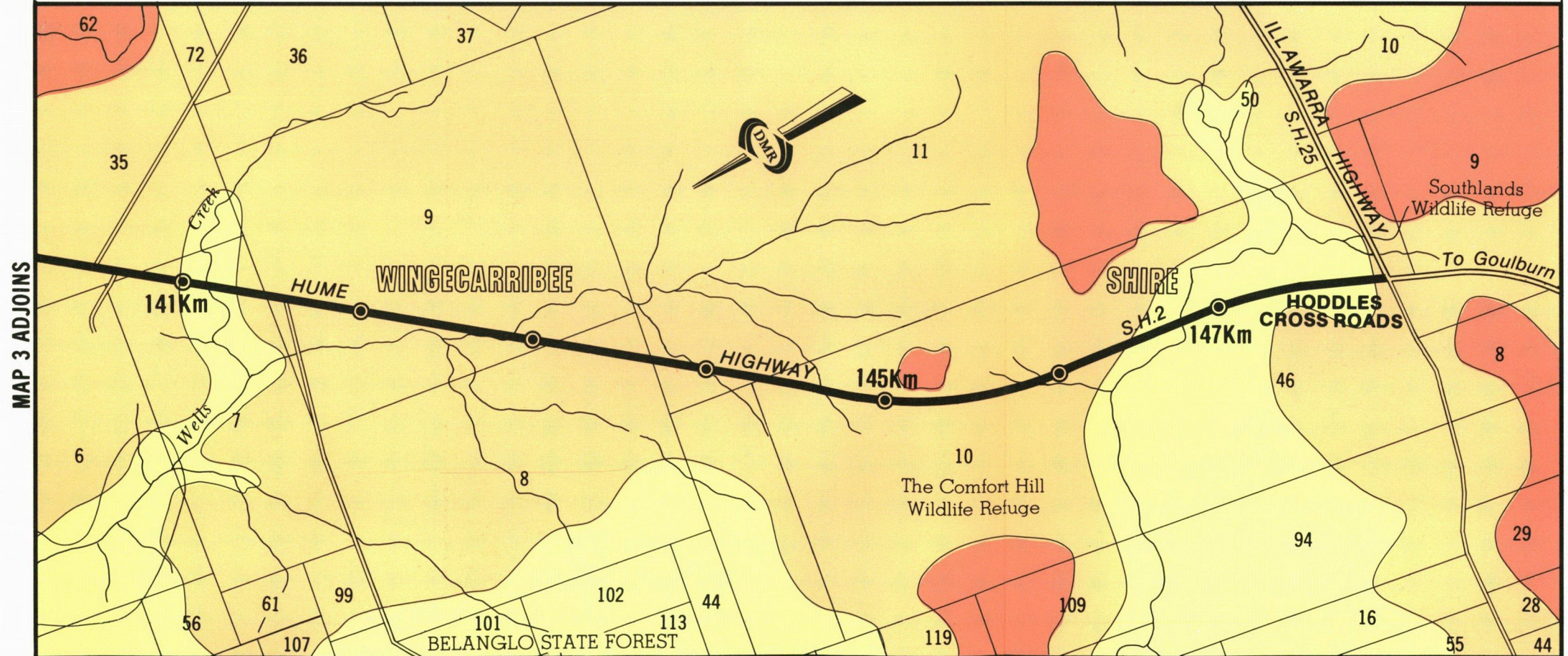
MAP 3

MAP 3



MAP 4

MAP 4



Clay loam, brown and red, structured, friable soils.

Sandy, yellow, leached, gradational soils. (with ironstone gravel)

Clay loam, red gradational soils (with ironstone gravel)

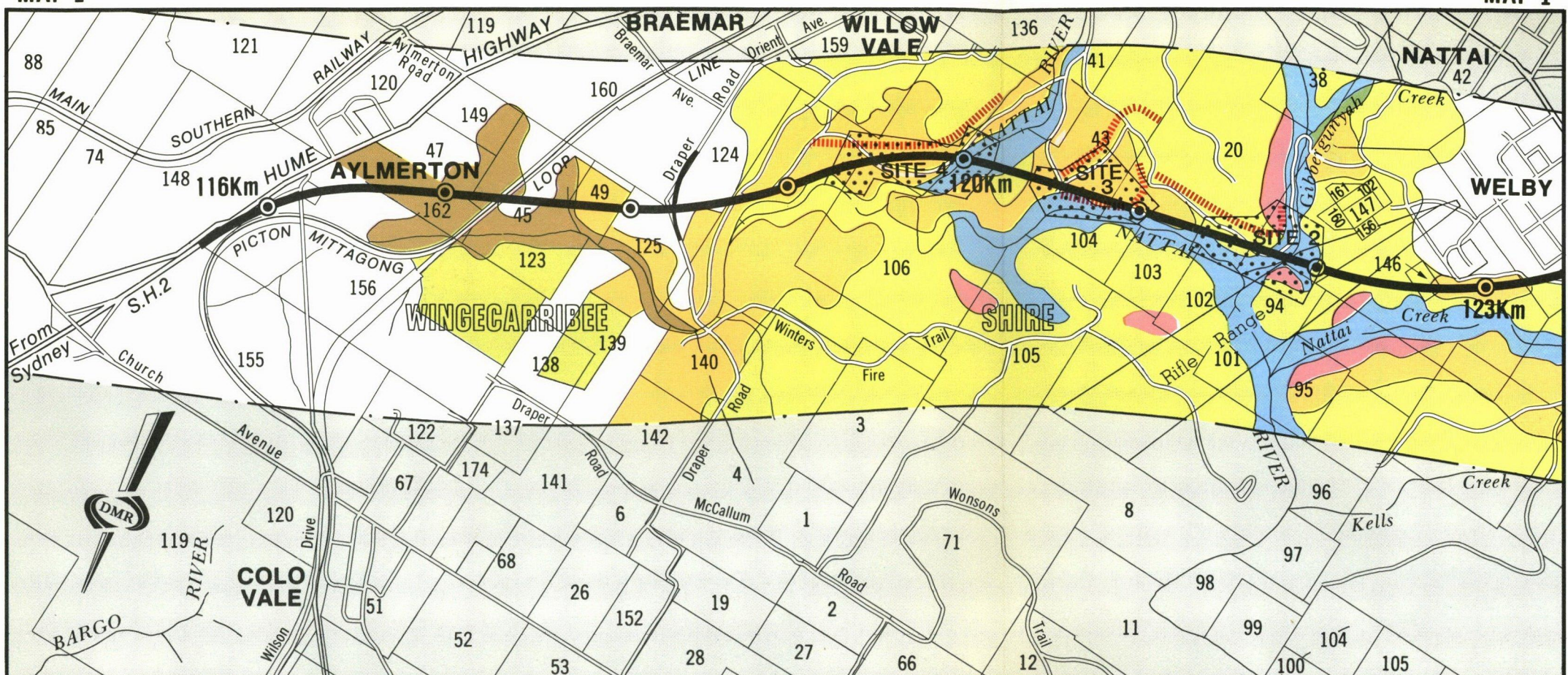


FIGURE 20

SOILS



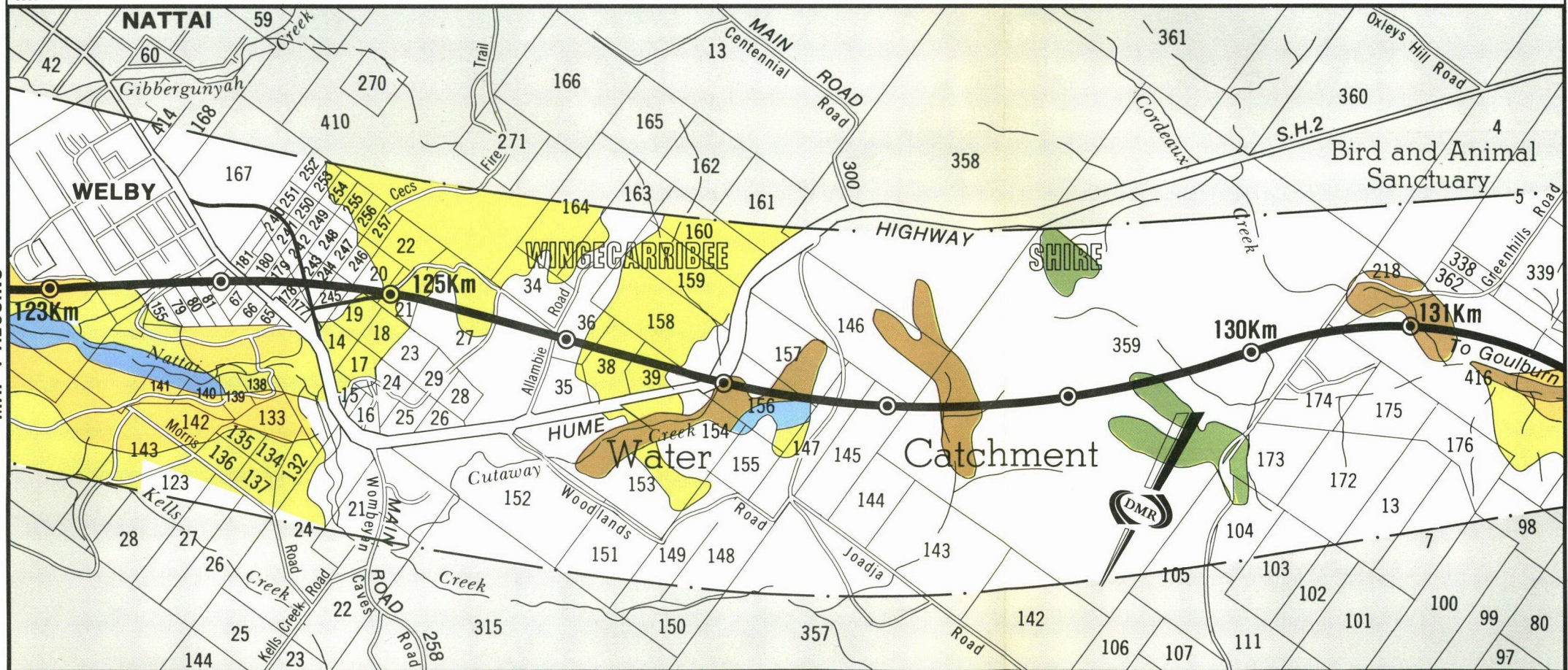
MAP 1



MAP 1

MAP 2 ADJOINS

MAP 2



MAP 2

MAP 1 ADJOINS

MAP 3 ADJOINS

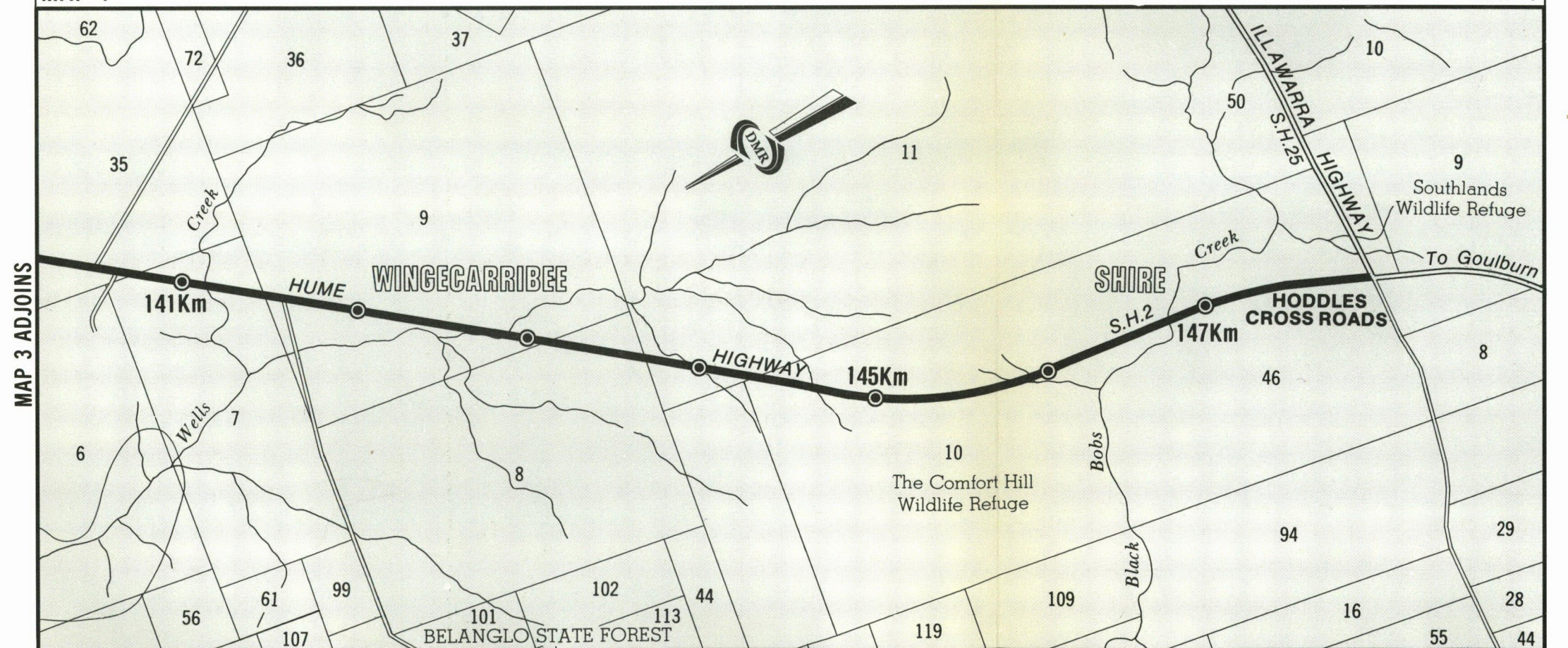
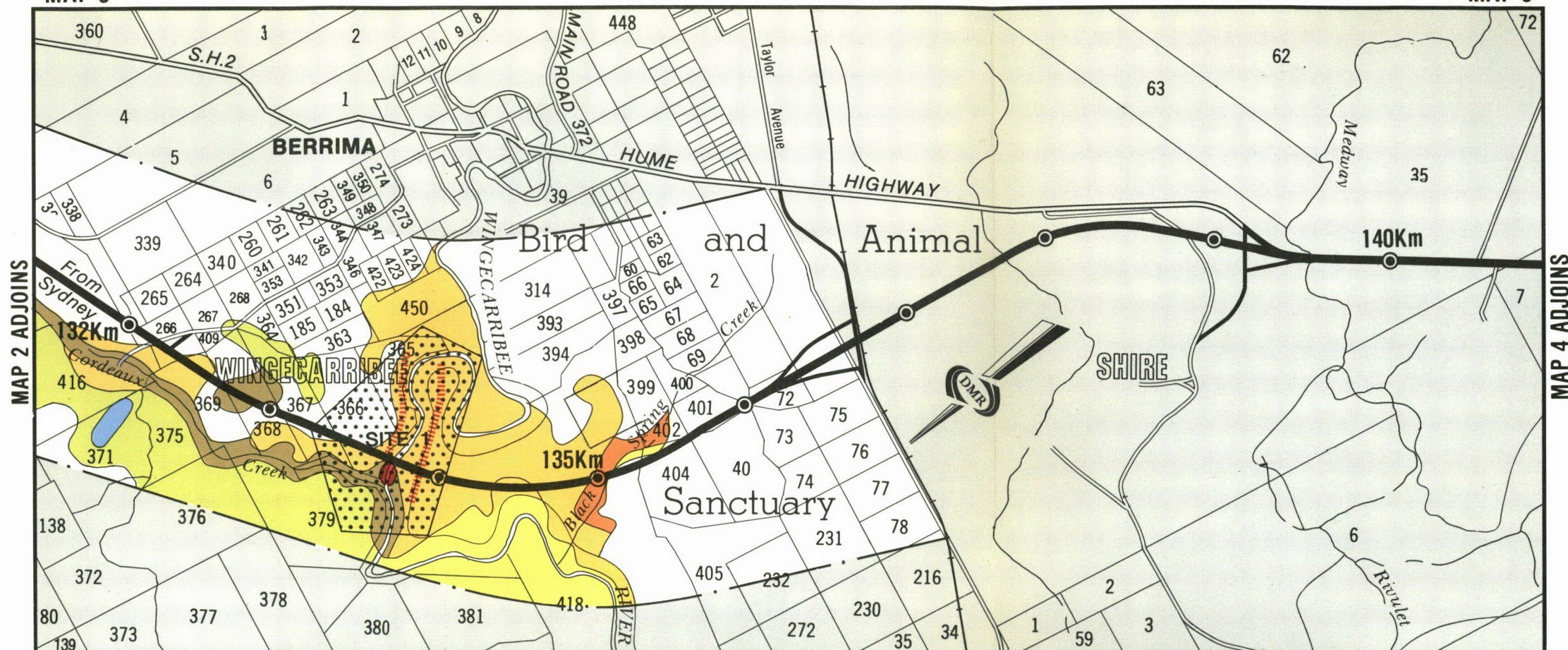
Woodland/Open Forest
Eucalyptus sclerophylla
Woodland
E. piperita & *E. sieberi*
Open Forest/Tall Open Forest
E. viminalla & *E. cypelloarpa*
Open Forest
E. oreades

Low Open Woodland
E. apiculata
Woodland
E. pauciflora & *E. mannifera*
Woodland
E. ovata & *E. amplifolia*
Woodland
E. elata

Cleared Land
Faunal Survey Site
Spotlighting Transects

FIGURE 21
BIOLOGICAL FEATURES

km 0 0.5 1 2 km



Woodland/Open Forest
Eucalyptus sclerophylla

Woodland
E. piperita & *E. sieberi*

Open Forest/Tall Open Forest
E. viminalis & *E. cypellocarpa*

Open Forest
E. oreades

Low Open Woodland
E. apiculata

Woodland
E. pauciflora & *E. mannifera*

Woodland
E. ovata & *E. amplifolia*

Woodland
E. elata

Cleared Land

Faunal Survey Site

Spotlighting Transects

Platypus Habitat

FIGURE 21
BIOLOGICAL FEATURES



cappings. Isolated examples of this unit also occur on ridges and knolls overlying Hawkesbury Sandstone, where the overlying shales and basalts have been removed by erosion. Portions of the unit will occur in the area mapped as Unit 3. The boundary between the two soil types is often ill-defined owing to downslope movement of shale derived material.

These soils have a gradational texture profile ranging from a silty loam to a medium clay B horizon. They are slightly to moderately acid and of moderate fertility. Bands of ironstone gravel up to two metres thick may be found at the top of undulations. These soils have moderate erodibility.

Soil Unit 3: Sandy, Yellow, Leached, Gradational Soils

This soil unit occurs on Hawkesbury Sandstone areas of gentle to moderate relief. It occurs over about half of the study area. The soils are highly acidic and of poor fertility, depending largely on organic matter for the retention of plant nutrients. Rock or ironstone gravel commonly occurs at shallow depths, particularly on slight rises.

The soils generally have a sandy loam texture which grades to a light clay B horizon in some areas. The nature of these soils can vary markedly, depending on topography and variations in parent material. These soils have a moderate erodibility in their natural state. However, owing to their low nutrient status and the poor water holding capacities, it is difficult to re-establish vegetation cover and they are highly susceptible to erosion when disturbed.

Soil Unit 4: Sandy Loam, Yellow, Leached Gradational Soils

This soil unit is restricted to the steep talus slopes of the Nattai River Gorge. The Nattai River has exposed the Narrabeen Group, Illawarra Coal Measures and Tertiary Syenite materials. However, colluvial materials derived from cliff forming Hawkesbury Sandstone is the primary source of parent material.

The soils are immature with little profile development and are highly variable in depth and texture distribution. They are very acid, low in fertility and contain a large proportion of rocks, cobbles and boulders. Owing to the steep slopes, the soils are unstable when disturbed, relying for mechanical strength on the roots of the forest cover.

Soil Unit 5: Hardsetting Loamy Red and Yellow Texture Contrast Soils

This soil unit occurs on gently undulating ridges of the sandstone plateau associated with interbedded Wianamatta Shales. They are generally shallow with a hardsetting A horizon. The B horizon is also hardsetting when exposed.

These soils have a clear boundary between a hardsetting grey A horizon and a pedal clay mottled B horizon. They are acidic and chemically infertile. They are highly dispersive and susceptible to tunnel erosion. The A horizon is highly erodible while the B horizon is moderately erodible.

8.3 VEGETATION

A vegetation survey along the corridor of the proposed line has been undertaken and described in a report by the Royal Botanic Gardens (Cooper, Powrie and Benson 1983). Data collected was used to divide the vegetation into plant communities, groups of species that grow together in response to a particular set of environmental conditions. For mapping purposes, the communities were defined structurally with the dominant tree species. Eight communities were recognised along the corridor and their distribution is shown on Figure 21. Their composition and location has been determined by geology, aspect, soil depth, slope, fire, and drainage. A total of 257 species were recorded.

The remaining natural vegetation is confined mainly to two areas, adjacent to the Nattai River and to the Wingecarribee River. In general, there was more diverse vegetation with taller forest in the Nattai, compared to the Wingecarribee area. This reflects the geology and topography. The Nattai area contains deep gullies with more varied geology

while the Wingecarribee area has undulating topography and is mainly on Hawkesbury Sandstone. Five of the communities recognised are in these two areas while the other three communities are in smaller areas of basalt and shale influence. The plant communities are briefly described below and are summarized in Table 8.1.

Community 1: Woodland/Open Forest (*Eucalyptus sclerophylla*)

Consists of trees to 12m high with variable canopy cover and a well developed shrub layer to one metre. It is a widely distributed community, common near Sheepwash Creek and the Wingecarribee River, on poor sandy soils of low slope on Hawkesbury Sandstone. The main tree species present are *Eucalyptus sclerophylla* and *E. piperita*. This community near the Wingecarribee River has been slightly grazed and has fewer species than the Sheepwash Creek community. It also has a number of different species, including a few exotic ones.

Community 2: Woodland (*Eucalyptus piperita* and *E. sieberi*)

Consists of trees 20-25 m high with a well developed shrub layer. Ground cover tends to be open. It is a widely distributed community in the Nattai River part of the study area, occurring on Hawkesbury Sandstone with variable slope and soil depth. The main tree species present are: *Eucalyptus piperita*, *E. sieberi*, *E. agglomerata*, *E. punctata*, *E. radiata*. In the community there is considerable variation in the structure and composition of the shrub layer. The trees vary in their dominance.

Community 3: Open Forest/Tall Open Forest (*Eucalyptus viminalis* and *E. cypellocarpa*)

This community consists of tall trees up to 32 m high with a dense canopy cover. The shrub layer is diverse, tall (2m), and moderately dense. Ground cover is also moderately dense. It is a common community in the gullies of the Nattai Gorge. Its habitat is sheltered, steep gullies with deep soils on Hawkesbury Sandstone with possible influence from the Narrabeen Group rocks. The main tree species present: *Eucalyptus viminalis*, *E. cypellocarpa*, *E. smithii*, *E. macarthurii* and *E. Fastigata*. Tree dominance varies with soil depth, aspect and slope, and hybrids are common.

Community 4: Open Forest (*Eucalyptus oreades*)

The structure of this community is tall trees with straight boles to 25 m, and a sparse understorey. The shrubs and ground cover are very open. This is an uncommon community in the study area, found only in the Nattai Gorge and restricted to the steep, exposed, rocky slopes with a southerly aspect, on Hawkesbury Sandstone. *Eucalyptus oreades* is dominant and its occurrence represents the southern limit of its range.

Community 5: Low Open Woodland (*Eucalyptus apiculata*)

This is a mallee community about 4 m in height with a tall (2m), even shrub layer. It is restricted in the study area to the "Wallaby Rocks" on exposed bedrock of Hawkesbury Sandstone with very shallow soil. The main tree species present are: *Eucalyptus apiculata*, *E. mannifera*. The former is a rare eucalypt that is limited to a restricted habitat.

Community 6: Woodland (*Eucalyptus pauciflora* and *E. mannifera*)

This community consists of trees 12 m in height, with a heavily grazed understorey. It was found in the study area only at Blacksprings Creek, on shale and sandstone derived alluvium, possibly in a frost hollow. The main tree species present are: *Eucalyptus pauciflora*, *E. mannifera*, *E. aggregata* X *mannifera*, *E. stellulata*. These trees are cold climate species that are unusual in the Mittagong-Berrima area.

Community 7: Woodland (*Eucalyptus ovata* and *E. amplifolia*)

The structure of this community is trees 18 m in height with a moderate canopy cover (25% projected cover), a sparse understorey, and grazed, the surrounding area often cleared. It is a community which is widely distributed in the study area in the upper

reaches of creeks, notably Sheepwash, Nattai, and Cordeaux Creeks. It occurs on shale-derived soils, often alluvium. The main tree species are: *Eucalyptus ovata*, *E. amplifolia*, *E. mannifera*, *E. elata*, *E. globoidea*, *E. radiata*. This community was found to be rarely in an undisturbed state. It is best represented at Aylmerton where it is uncleared but grazed.

Community 8: Woodland (*Eucalyptus elata*)

This is a pure stand of *E. elata* 25 m high, with a spreading habit. No shrub layer is present and the understorey of grasses is heavily grazed. In the study area it is restricted to "Hurdle Ridge" between Greenhills Road and the Hume Highway, on Robertson Basalt. It is heavily grazed and the surrounding area has been cleared. *Eucalyptus elata* is found elsewhere in the region on some areas of alluvium. In an undisturbed state this community may have supported a diverse flora.

TABLE 8.1 SUMMARIZED COMMUNITY DESCRIPTIONS

Community	Main Species	Structure	Geology	Occurrence
1	<i>Eucalyptus schlerophylla</i>	W/OF	HSs	Common in the Nattai River area and the Wingecarribee River where it dominates on sites with low slope.
2	<i>E. piperita</i>	W	HSs	Common in the Nattai River area from ridgetops to lower slopes.
3	<i>E. sieberi</i>			
3	<i>E. viminalis</i>	OF/TOF	HSs	Gullies in the upper Nattai River and tributaries.
4	<i>E. cypellocharpa</i>			
4	<i>E. oreades</i>	OF	HSs	On steep rocky exposed slopes in the Nattai River area.
5	<i>E. apiculata</i>	LOW	HSs	Exposed bedrock of sandstone at "Wallaby Rocks" extending to Medway.
6	<i>E. pauciflora</i>	W	HSs	Blacksprings Creek on shale and sandstone derived alluvium.
7	<i>E. mannifera</i>			
7	<i>E. ovata</i>	W	WS	Widely distributed in the study area in the upper reaches of creeks.
7	<i>E. amplifolia</i>			
8	<i>E. elata</i>	W	Rob. Bas	On basalt at Hurdle Ridge.

Abbreviations:

Structure	
LOW	— Low Open Woodland
W	— Woodland
OF	— Open Forest
TOF	— Tall Open Forest
Geology	
Rob. Bas	— Robertson Basalt
HSs	— Hawkesbury Sandstone
WS	— Wianamatta Group (Ashfield Shale)

8.4 FAUNA

8.4.1 Introduction

Field work for the faunal survey was conducted between mid-August and the end of December, 1982 and is described in a report by Dr Whelan of the University of Wollongong (Whelan, 1983). Following a preliminary search of the entire route, four areas were identified as warranting detailed study because of their possible sensitivity to disturbance. These areas are identified on Figure 21 and are:—

Site 1 — the Wallaby Rocks area, including the site of the proposed bridge over the Wingecarribee River;

Site 2 — 1.5 km along the Nattai River from the proposed bridge over Gibbergunyah Creek to the Mt Alexander colliery

Site 3 — The environs of the proposed bridge over the Nattai River; and

Site 4 — 1 km along Sheepwash Creek northwards from its junction with the Nattai River.

A summary of the survey report follows.

8.4.2 Mammals

In addition to the preliminary search of the entire route, three survey techniques were used to locate and identify the mammals. Each site was searched thoroughly for signs of mammal activity, traps were set and each animal caught was tagged so that recaptures could be distinguished from newly caught animals, and a spotlight search was conducted at each study site.

Eleven mammal species were recorded overall. Of these, nine are native and two are introduced (Table 8.2). In addition, three other introduced species would be expected in the survey area but were not recorded. These are the feral cat, the ship rat and the house mouse. These might be expected in the vicinity of the rubbish tip at Welby and wherever the bush adjoins either farms or houses.

The only species of small mammals trapped, namely, the bush rat and the brown antechinus, are considered to be common and widespread. Nevertheless, these species exhibited distinct habitat preferences.

TABLE 8.2: List of mammals recorded. Data from all survey techniques at each study site.

Common Name	Scientific Name	Site Number			
		1	2	3	4

(a) Native:

Echidna	<i>Tachyglossus aculeatus</i>	a	a	x	x
Platypus	<i>Ornithorhynchus anatinus</i>	x			
Wombat	<i>Vombatus ursinus</i>	x	x	x	x
Swamp Wallaby	<i>Wallabia bicolor</i>	x	x	x	x
Greater Glider	<i>Schoinobates volans</i>	x	x	x	x
Squirrel Glider	<i>Petaurus norfolcensis</i>			x	
Ring-tailed Possum	<i>Pseudocheirus peregrinus</i>	a	x	x	x
Brown Antechinus	<i>Antechinus stuartii</i>	a	x	x	x
Bush Rat	<i>Rattus fuscipes</i>	a	x	x	x

(b) Introduced:—

Feral Dog	<i>Canis familiaris familiaris</i>	a	x	x	a
Fox	<i>Vulpes vulpes</i>	x	x	x	x
Feral Cat	<i>Felis catus</i>	a	a	a	a
Ship Rat	<i>Rattus rattus</i>		a		
House Mouse	<i>Mus musculus</i>		a		

(a) — Animal not recorded but expected to occur at site.

(x) — Animal sighted or signs identified.

The bush rats were caught mostly among the denser vegetation of the creek margins while the antechinus was caught only in the uphill grids, located in more open, drier vegetation.

The capture rates (animals caught per trap night) were lower in this survey than expected. This may be partially due to the openness of the vegetation. However, it is likely that disturbances, such as trailbikes and frequent fires, have caused a reduction in numbers of small mammals. Furthermore, the presence of introduced predators, such as the fox, the feral dog and the feral cat, can cause decimation of populations of native animals.

Most of the larger mammals recorded in the survey are also considered to be both common and widespread. These include the echidna, greater glider, ring-tailed possum, squirrel glider, swamp wallaby and wombat. Nevertheless, local extinctions of even these species can occur as a result of the destruction of their preferred habitats. The spotlighting survey showed that all of these larger mammals are sparsely distributed. In particular, the greater gliders were absent from areas lacking large trees, ring-tailed possums tended to occur near watercourses where shrub vegetation was dense, swamp wallabies also favoured dense vegetation, and the squirrel gliders comprised a single family group nesting in one tree.

One of the most important findings of the survey was the discovery of platypus in the Wingecarribee River near Berrima. Two animals were recorded in the large pool in the river about 100 m downstream from the proposed bridge. Protection of these animals will require special consideration. Particular attention will be paid to sedimentation controls.

8.4.3 Birds

Three survey methods were used to locate and identify birds. Each site was visited and all birds seen and heard were identified, transects were established and counts made of birds seen and heard in five minute intervals every 150 m along the transects (see Figure 21), and birds were trapped in mist nets erected in a variety of vegetation types.

A total of 60 bird species was recorded in the bird survey (Table 8.3). Most of the species are common inhabitants of the Mittagong region. However, several species are of particular interest because of their rarity or because they are not usually seen in this area. These include:— peregrine falcon, origma, red-chested quail, azure kingfisher, double-barred finch, superb lyrebird and pilotbird. Bird life was found to be most abundant and varied in the Gibbergunyah Gorge.

TABLE 8.3: List of bird species found in each study site. Data from all survey techniques grouped together.

Common Name	Site Number			
	1	2	3	4
Red-chested Button-quail		x		
Brush Bronzewing		x		
Masked Lapwing			x	
White-faced Heron	x			
Pacific Heron	x			
Pacific Black Duck	x			
Brown Falcon	x			
Peregrine Falcon		x		
Galah	x			
Sulphur-crested Cockatoo		x	x	x
Yellow-tailed Black Cockatoo		x	x	
Gang-Gang Cockatoo			x	
Crimson Rosella	x	x	x	x
Eastern Rosella				x
Laughing Kookaburra	x	x	x	x
Dollarbird	x			x

Continued next page.

TABLE 8.3 (Continued): List of bird species found in each study site. Data from all survey techniques grouped together.

Common Name	Site Number			
	1	2	3	4
Superb Lyrebird		x	x	x
Welcome Swallow				x
Golden Whistler	x	x	x	x
Rufous Whistler	x	x	x	x
Grey Shrike-thrush	x	x	x	x
Leaden Flycatcher		x		
Fan-tailed Cuckoo			x	x
Shining Bronze Cuckoo	x		x	
Southern Boobook		x	x	x
Tawny Frogmouth		x	x	x
Azure Kingfisher			x	
Sacred Kingfisher	x	x	x	x
Black-faced Cuckoo-shrike		x		
Rose Robin		x	x	x
Eastern Yellow Robin		x	x	x
Rufous Fantail		x	x	x
Grey Fantail	x	x	x	x
Superb Fairy-wren	x			
Variegated Fairy-wren		x	x	x
White-browed Scrub-wren	x	x	x	x
Striated Thornbill	x	x	x	x
Brown Thornbill	x	x	x	x
Buff-rumped Thorn	x			
White-eared Honeyeater	x			
Lewin's Honeyeater		x		
Yellow-faced Honeyeater		x	x	x
White-eared Honeyeater		x	x	
New Holland Honeyeater		x	x	x
Eastern Spinebill		x	x	x
Red Wattlebird				x
White-throated Treecreeper	x	x	x	x
Spotted Pardalote	x	x	x	x
Striated Pardalote	x	x	x	x
Silvereye	x	x	x	x
Common Starling	x			
Pied Currawong	x	x	x	x
Australian Raven		x	x	x
Australian Magpie	x	x	x	x
Eastern Whipbird		x	x	x
Pilotbird		x		
Origma		x		
Varied Sitella		x	x	x
Red-browed Firetail		x	x	x
Double-barred Finch			x	
No. of Species.....	26	41	39	36

8.4.4 Reptiles and Amphibia

The herpetofauna was surveyed in the Nattai River region, covering study sites 2, 3 and 4 of the mammal survey. The following methods were used to locate specimens and to prepare the species list:—

- (a) direct observation of active animals;

- (b) removal of refuges (logs, rocks) when animals were inactive;
- (c) spotlighting to observe nocturnally active animals; and
- (d) identification of frog calls.

Twelve species of reptiles and 5 species of amphibians were recorded in this survey. In addition, reliable records of 5 additional reptile species were obtained from other sources. These results are summarized in Table 8.4

There was a general scarcity of both species and numbers of individuals recorded in this survey. Although the short time available for the study is a contributing factor, it is considered that prolonged disturbance to the area, by both trailbikes and frequent fire, could account for the low numbers. Furthermore, it is known that introduced predators such as foxes and feral cats can severely influence populations of reptiles and amphibia.

Two of the species recorded in the survey are of scientific interest because they represent records of the species at the very edge of their known ranges. These species are *Phyllurus platurus* (Southern Leaf-tailed Gecko) and *Litoria dentata* (Bleating Tree Frog).

**TABLE 8.4: Species of reptiles and amphibia recorded in the Nattai River area
(= mammal study sites 2-4), 23-25 November, 1982.**

Family	Species	No. recorded	Location*
(a) Reptiles:			
Agamidae	<i>Amphibolurus diemensis</i>	5	W,R
	<i>A. muricatus</i>	8	W,F
	<i>Physignathus lesueurii</i>	1	G
Boidae	<i>Morelia spilotes</i>	a	
Elapidae	<i>Notechis scutatus</i>	a	
	<i>Pseudechis porphyriacus</i>	1	G
	<i>Pseudonaja textilis</i>	a	
Gekkonidae	<i>Oedura lesueurii</i>	1b	R
	<i>Phyllurus platurus</i>	1	R
Scincidae	<i>Cryptoblepharus plagiocephalus</i>	8	W,R
	<i>Ctenotus teniolatus</i>	22	W,G,R
	<i>Egernia cunninghami</i>	1	R
	<i>Lampropholis delicata</i>	6	R
	<i>L. guichenoti</i>	6	F
	<i>Leiopisma platynota</i>	3	G
	<i>Sphenomorphus quoyii</i>	6	G
	<i>Tiliqua scincoides</i>	a	
(b) Frogs:			
Hylidae	<i>Litoria citropa</i>		R
	<i>L. lesueurii</i>		G
	<i>L. denata</i>		W
Leptodactylidae	<i>Limnodynastes peronii</i>		G
	<i>Ranidella signifera</i>		G

* = W — Woodland, G — Gully, R — Ridge, F — Farmland.

a = Recorded by other observers not in this survey.

b = Sloughed skin only.

8.5 ABORIGINAL SITES

A brief description of Aboriginal settlement in the tablelands of the Illawarra region has previously been given in this Statement (Section 3.2.1). This section summarizes the

findings of an archaeological survey for Aboriginal sites undertaken in a corridor containing the proposed route (Koettig, 1981).

The survey led to the recording of 24 sites, including grinding grooves, scarred trees, open sites and shelter sites. A breakdown of the type and number of sites located is given below:

Grinding grooves	3
Scarred trees	2
Open sites	10
Open sites with quarry	1
Open sites with scarred trees	2
Shelters with deposit	4
Shelters with deposit and art	2

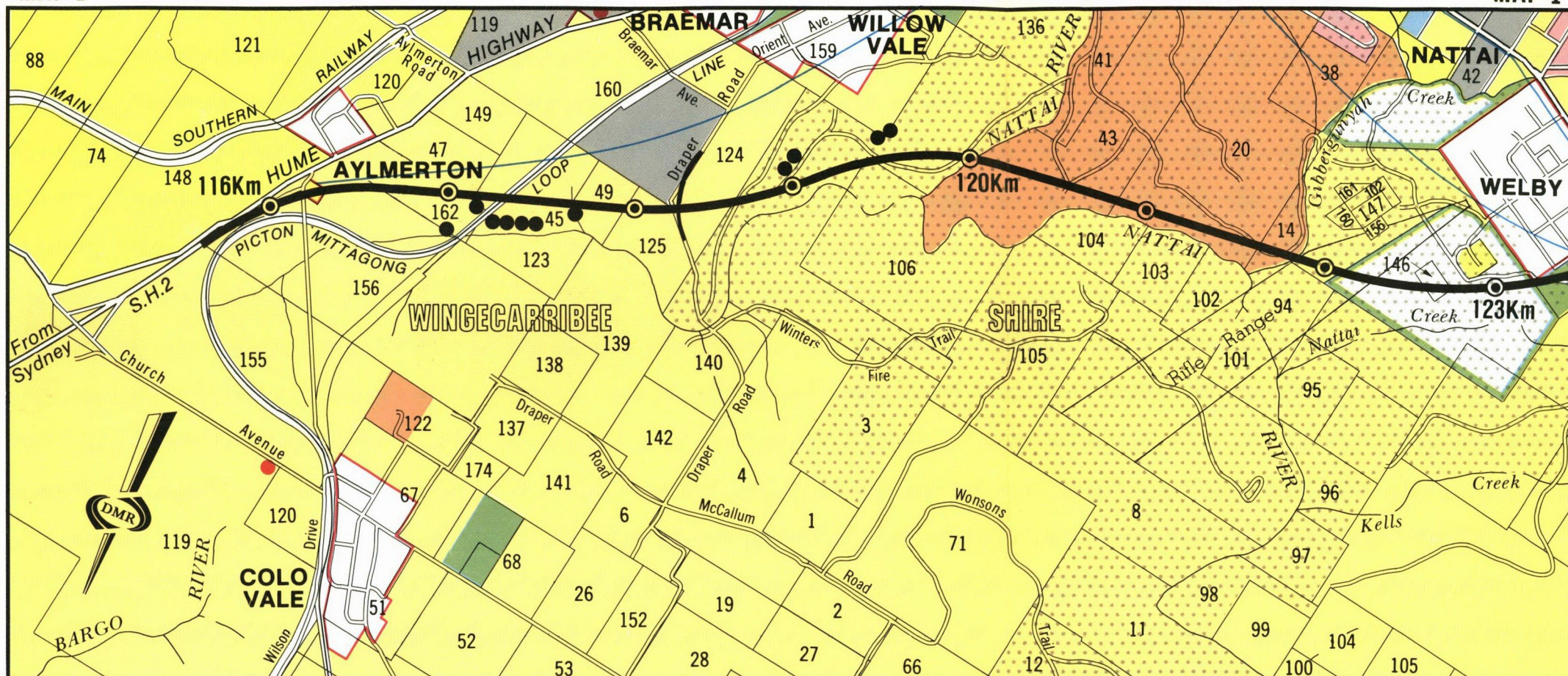
This gives a total of 24 sites over a distance of 34 kms, though the majority (20) of these are located along the northern 20 kms of the route (see figure 22). Except for two, all sites lie within the easement of the proposed road. However, only six of the sites are likely to be physically affected by the project, either partially or completely. (See Section 9.2.10.)

8.6 LAND ZONINGS

Land use in the general study area is described in Section 3.2.4 and shown on Figure 6. Local environment plan zonings along the corridor of the proposed road are shown on Figure 22. These zones are designated in Wingecaribbee Interim Development Order No 2, gazetted 23/2/79, and the Wingecaribbee Local Environmental Plan for the former Mittagong Shire area. Advice received (August 1983) from the Wollongong Regional Office of the Department of Environment and Planning indicated that gazetted of the latter planning instrument was imminent. This local Environmental Plan includes a reservation for the proposed new road, from the proposed interchange at Aylmerton, south to Wingecaribbee River. The predominant adjoining land zones are Rural and Rural Environmental Protection. At Welby the reservation passes through two Open Space zones and adjoins the town. South of the Wingecaribbee River the proposed road passes through Rural Land before rejoining the existing highway reservation at Medway Rivulet.

Map 3 of Figure 22 indicates that the proposed road will pass through the northern extremity of the designated visual catchment area of Berrima. No historic buildings are affected.

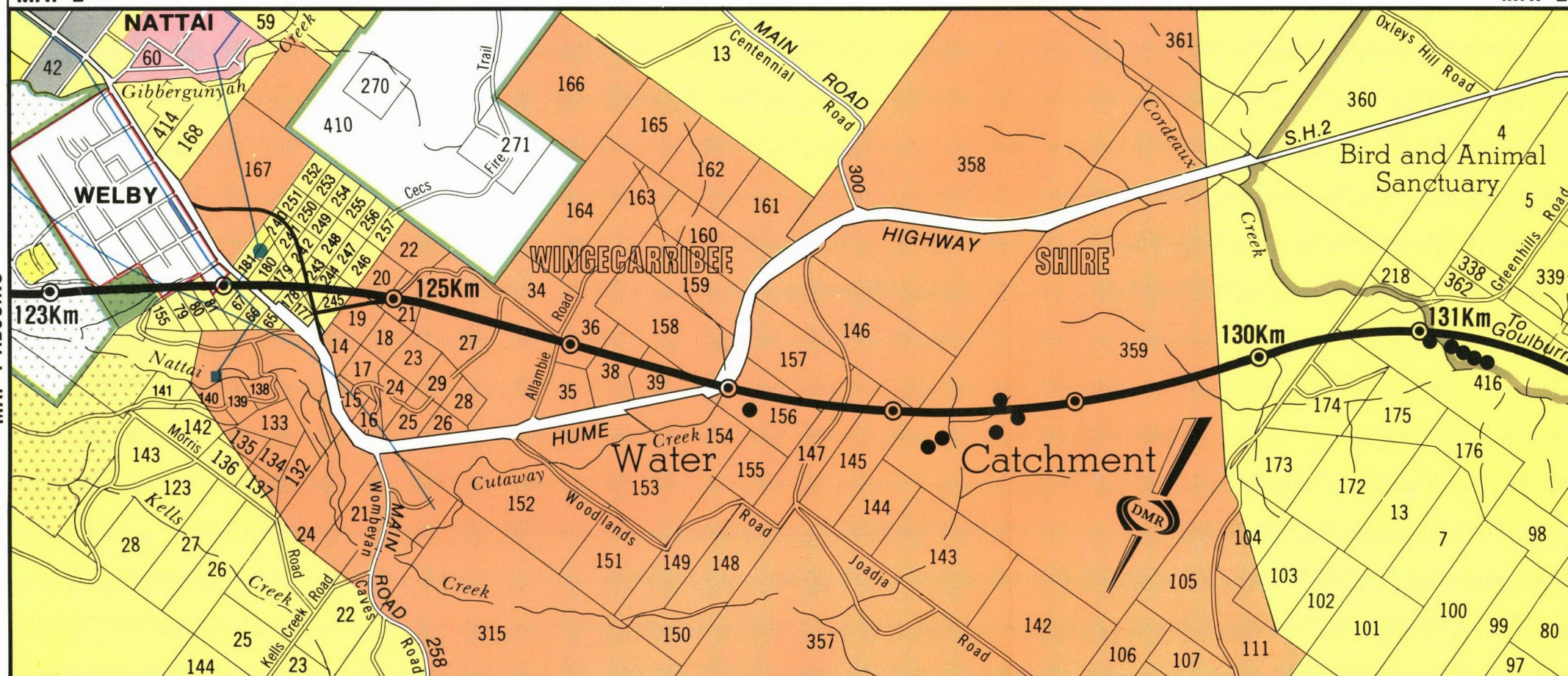
MAP 1



MAP 1

MAP 2 ADJOINS

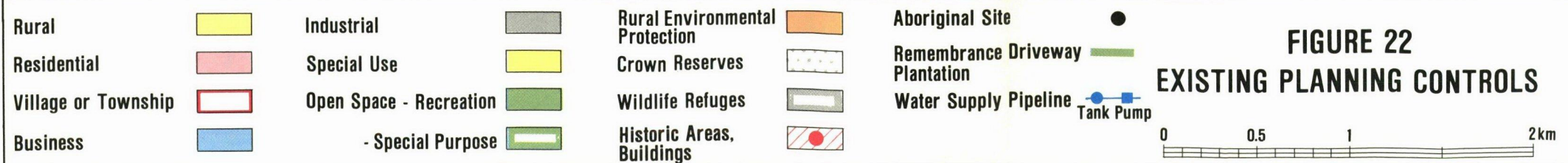
MAP 2

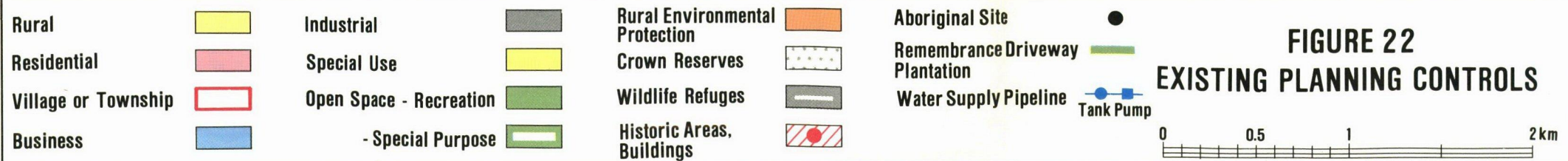
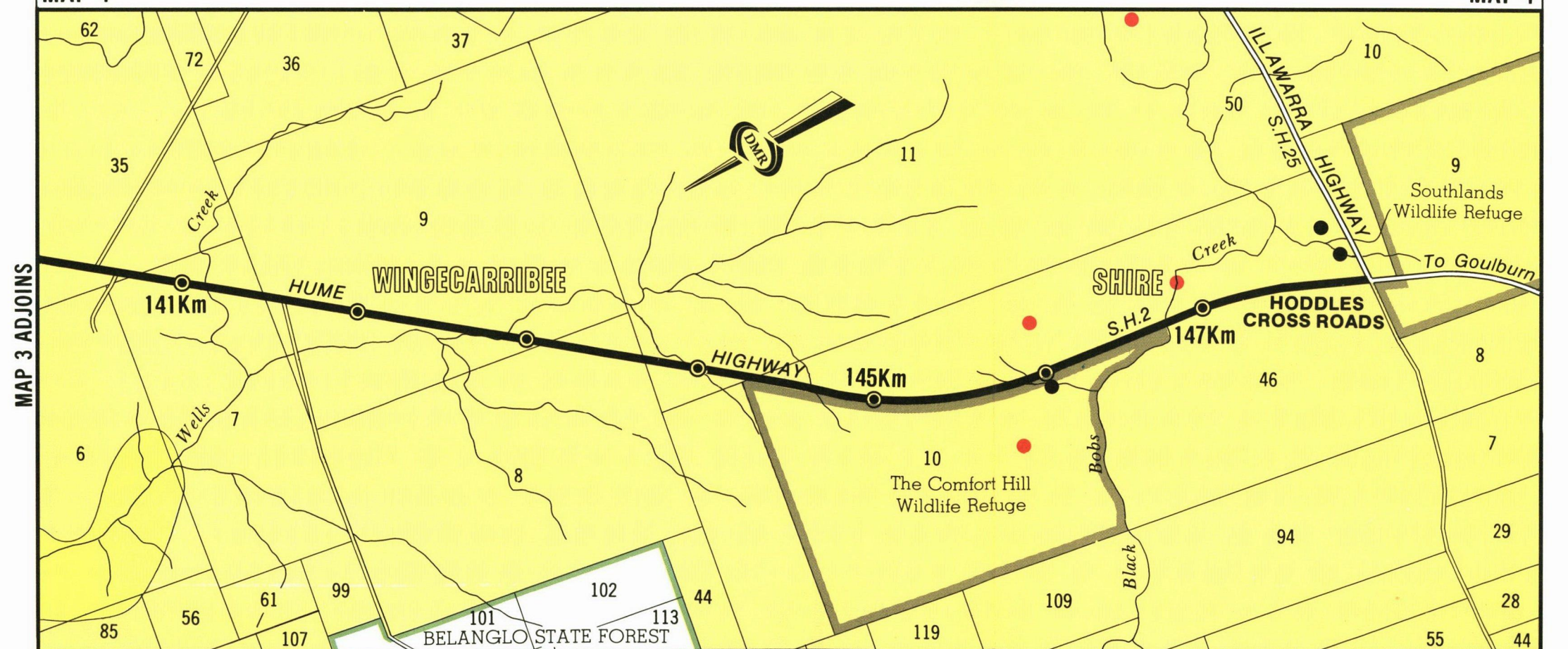
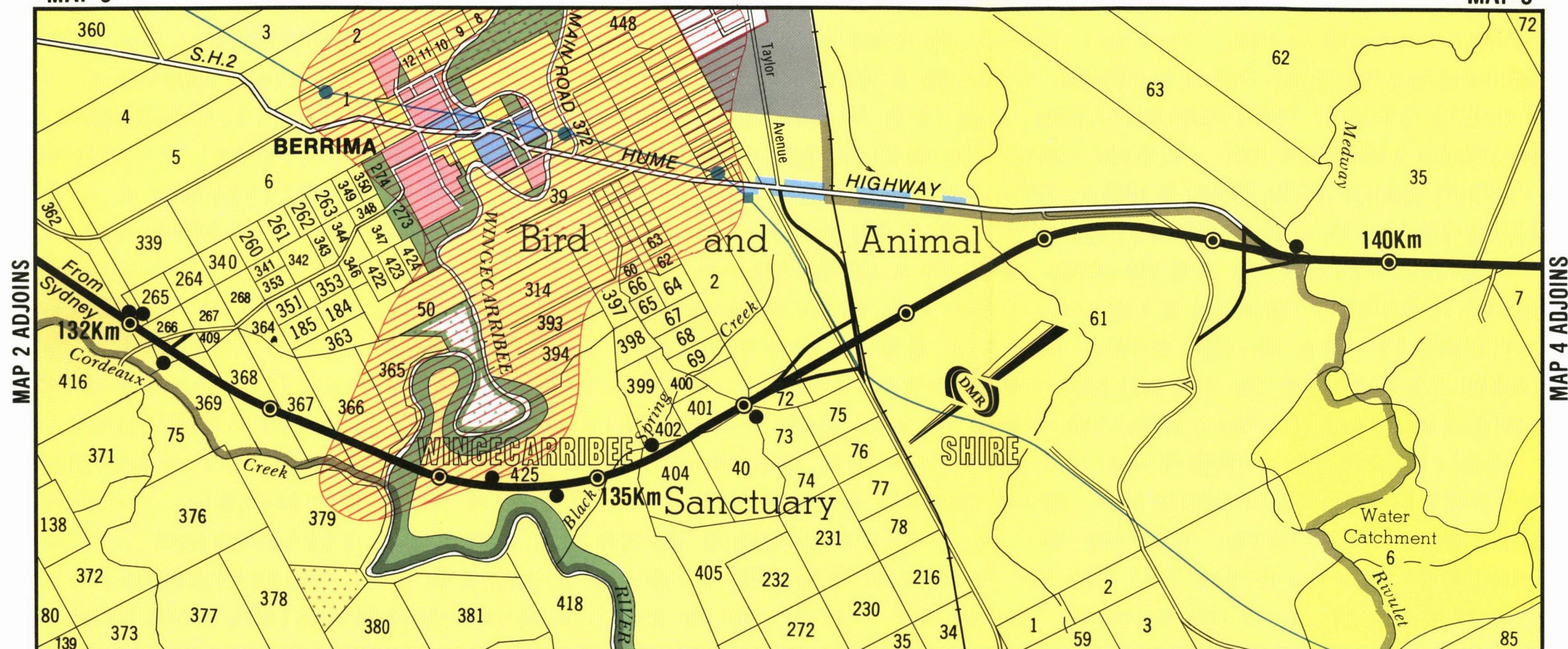


MAP 2

MAP 1 ADJOINS

MAP 3 ADJOINS





9. POTENTIAL ADVERSE IMPACTS AND PROPOSED ENVIRONMENTAL SAFEGUARDS

9.1 PLANNING AND LOCATION

The Department of Main Roads has reviewed the location of the proposed highway in light of geological, engineering, economic, environmental, land use and public representation considerations. Investigations covering the regions between Aylmerton and Exeter Road in the mid 1970s resulted in the selection of four practicable routes (Figure 10), none of which appeared to be clearly superior. Comments were invited on the alternatives from the three Councils involved, interested Government authorities and local parliamentary representatives. This was followed by public displays of the proposal and public meetings at Mittagong, Bowral and Moss Vale during November 1977. Arising out of suggestions at the public meetings, one of the routes, known as the Eastern, was modified to reduce its adverse property effects (see Section 5.3). The results of these public meetings and written responses to the exhibition revealed a clear preference, by both town and rural respondents, for the Western Route. It is on this route that further detailed studies have been undertaken in order to identify any potentially significant adverse impacts and to develop remedial measures.

9.2 CONSTRUCTION STAGE

9.2.1 Geology

The proposed route through the Nattai Gorge section is located on steep side slopes and involves side cuts and fills in Hawkesbury Sandstone. These slopes have a talus cover which will need to be removed and the underlying sandstone will require terracing to ensure stability of the fills. While further detailed site investigations are being undertaken to determine jointing and weathering distribution as an aid to better design, it is proposed to separate the grades of the two carriageways over this section to suit the natural terrain and to reduce the side cut and fill requirements. All areas upslope of the road are also being investigated to locate any potentially unstable rock faces and boulders.

With the exception of the steep cliff-gorge landforms of the Nattai River area, landforms along the proposed route consist of gently undulating slopes of the sandstone plateau with some steeper slopes associated with remnant basaltic caps. Their geology presents no environmental hazards that cannot be controlled using current design and construction methods.

9.2.2 Soils

The soils along the proposed route are generally moderately to highly erodible. The majority of slopes in the area are low to moderate and soil erosion has not been severe. However, in areas of steep slopes in association with basalt caps, some severe gully erosion has occurred. With the exception of the basalt derived soil, the soils of the study area are of low to moderate fertility and when disturbed are susceptible to erosion (Summerell, p. 10). The low fertility soils may require some fertilization to establish a ground cover on disturbed areas, and the use of low angle batters will also assist in this regard while reducing erosion potential. Although limited to the Aylmerton district, the hardsetting loamy red and yellow texture contrast soils will require special attention because they are prone to dispersion. Effective control of runoff during construction and early revegetation of batters will greatly reduce the dispersive and tunnel erosion susceptibility of this soil unit.

9.2.3 Erosion and Sedimentation Control

Erosion control measures will be designed into the project to address the identified potential problem areas and to provide comprehensive erosion control. Certain erosion causing conditions exist only during the construction stage (when the potential for erosion and sedimentation occurring is greatest), but should not be present after the construction operation ends. These conditions will be treated with temporary control measures.

Erosion problems which may last beyond the construction period will be treated with permanent control measures.

Planning for these controls will commence before construction starts and will continue as the work progresses. Since surface conditions vary along the route, the temporary erosion controls will be developed to suit each individual construction site. Examples of some of the proposed measures are given in Figure 23. Careful planning will allow for the most efficient balance between construction needs and erosion control requirements. An example of this planning is the proposal to limit the area of clearing at any one time to a prescribed maximum. This limitation, in association with the intended overall limitation of vegetation destruction within the road reserve (see Section 7.5), will minimize sediment runoff and reduce the cost of erosion controls.

When a construction site is cleared, gently graded contour drains will be formed to divert water and sediment into nearby stable areas. These drains are intended to reduce sediment runoff from the site by diverting much of the flow before it reaches the main outlet channel. By spacing these drains at suitable vertical intervals, the rate and velocity of overland flow will be reduced. This will help to prevent rilling and consequent scouring.

Haul roads, and the other access tracks associated with construction activities, will be planned with special attention to their erosion potential. Where these tracks have steep grades, which could concentrate the flow of water, diversion drains will be constructed at close intervals. In addition, temporary berms and drains can be formed at the end of each work period. The latter works will prevent the scouring of unconsolidated earthworks when the workforce is away from the job.

Sediment which does reach the downstream end of a construction site will be collected in sediment traps or basins. These structures will be either Hay Check Dams or more substantial structures (see Figure 23), depending on the catchment characteristics of a particular site. For each structure, an access track will be constructed to facilitate its maintenance.

The sediment traps and access tracks will be retained after construction ceases until such time as the sediment counts return to the natural levels existing prior to construction. To determine the time when the structures can be safely removed, checks of stream sedimentation will be made during and after the construction stage. Such testing will also provide the data to design adequate structures.

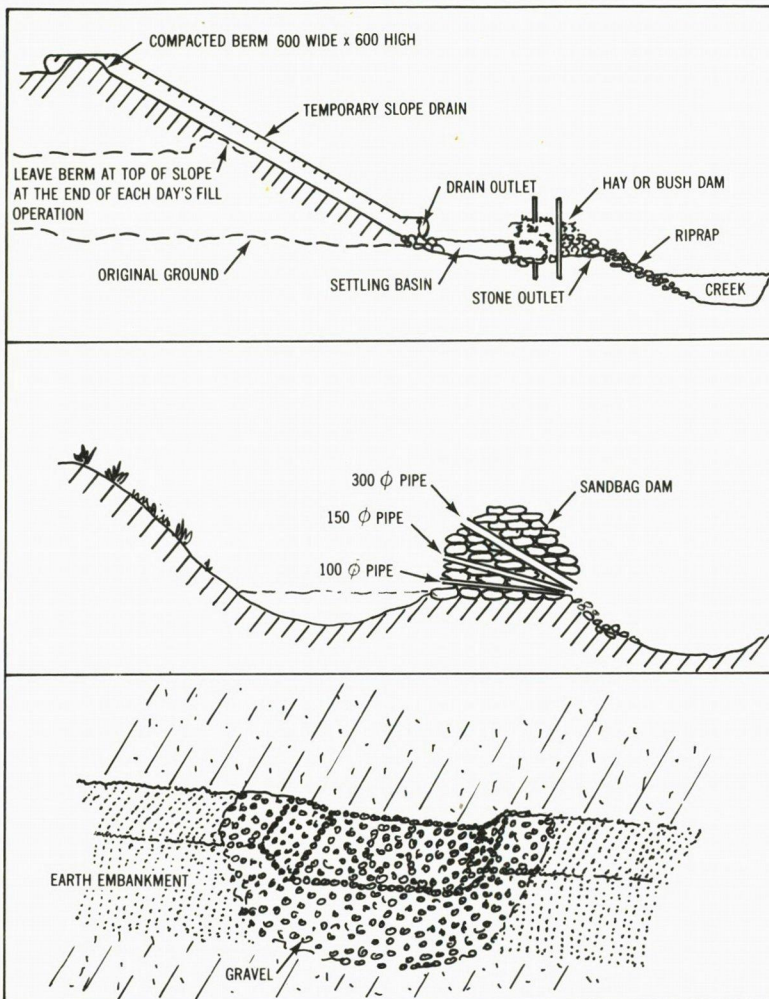
When necessary, temporary culverts or channels will be used to pass natural runoff through a construction site. This procedure will maintain dry conditions on the site. It will also prevent sediment from mixing with the natural flow coming from upstream of the roadworks.

Areas which are cleared well in advance of construction will be seeded to produce a temporary cover-crop of grass. The grasses recommended by the Botanic Gardens are shortlived infertile hybrids such as Japanese Millet. These exotic species have a short life span and are unlikely to spread and invade nearby areas of native bush pending natural revegetation by indigenous species.

As indicated in Section 3.1.4, the southern tablelands can experience some rainfall throughout the year, on average, and also has cool to cold winters. Because of the low evaporation rates, the probability of the soil water storage capacity being exceeded is high in the winter months. Prolonged periods of runoff from catchments can occur during this season (Edwards, p. 63). To help stabilise exposed surface areas, fill batters and the median will be progressively hydroseeded, with a mixture of low profile annuals which can germinate at different seasons, plus indigenous, pioneer, shrub species (see Section 9.2.8). As this cover becomes established, infiltration rates will increase, and this will reduce surface runoff.

While temporary and semi-permanent erosion control measures are aimed at limiting runoff during and immediately after construction, permanent control measures are primarily designed for the stabilization of exposed surfaces and slopes, the disposal of surface runoff with minimum erosional damage, and the minimization of return

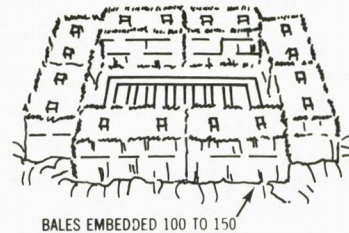
SEDIMENTATION TRAPS



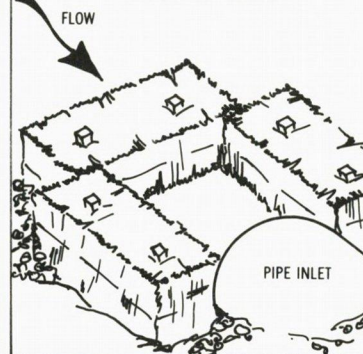
DRAINAGE STRUCTURES

DROP INLET

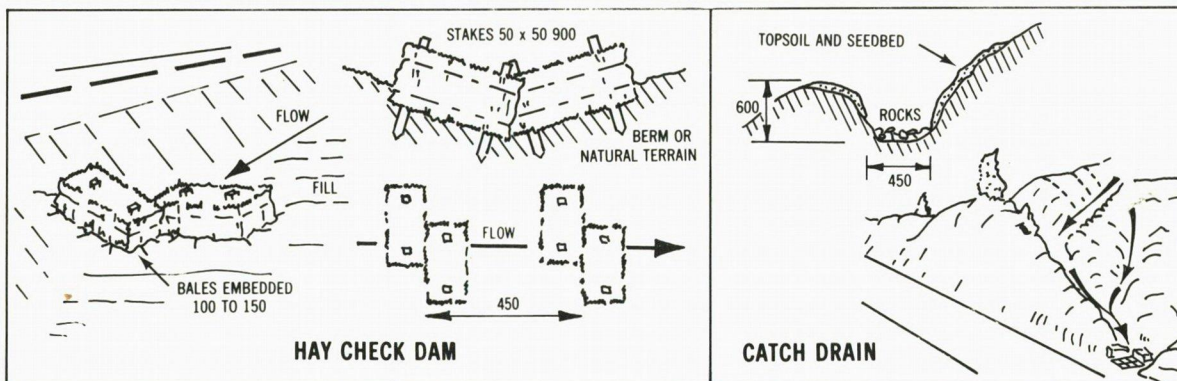
50 x 50 x 900 STAKES



CULVERT INLET



SLOPES



RUNOFF CONTROL STRUCTURES

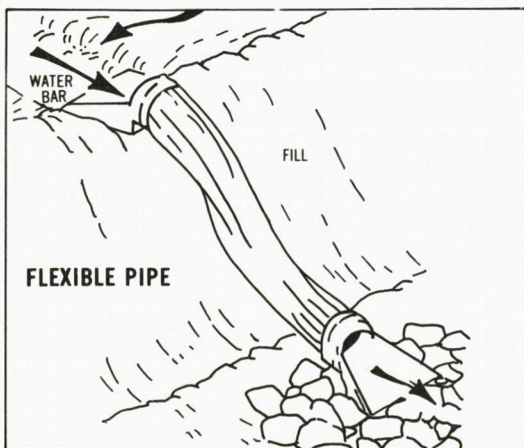


FIGURE 23

TEMPORARY EROSION CONTROL MEASURES

ALL MEASUREMENTS IN MILLIMETRES



(11) Portion of mine tailings dump
(SECTION 9.2.5)



(12) Tailings from Mount Alexander Colliery
(SECTION 9.2.5)

maintenance. They include the establishment of a vegetation cover, and structures such as bridges, culverts, catch drains, median drains, batter drains, and pavement drainage culverts. Energy dissipators will be used, as required, to reduce water velocities and to protect drainage outlets. These dissipators will be necessary in the Nattai Gorge section where the combination of steep slopes, unstable soils, and rapid runoff constitute a severe erosion hazard. Open drains will either be grassed or lined to minimize erosional effects.

Where practicable, catch drains, diversion drains and through drainage culverts will be installed before major clearing and earthworks are undertaken. This will be done to intercept existing natural drainage in order to channel it through the construction area without mixing with sediment from the disturbed ground. The cross drainage system itself will be designed to discharge water with a minimum adverse impact outside the reserve. This will be achieved by keeping discharge rates and sediment loads as close to pre-existing natural conditions as is practicable.

9.2.4 Groundwater

The geological report has referred to springs flowing from the Tertiary sediments which are overlain by basalt caps (Summerell, p. 12). Special drainage facilities will be provided where these springs occur. They will also be provided where seepage of groundwater occurs along the bedding planes within the Hawkesbury Sandstone, where unfavourably dipping joints or bedding planes are exposed in cuttings, and where they occur in sidefills.

9.2.5 Mine Tailings Dump

The disused Mount Alexander Mine tailings dump in the Nattai Gorge will have to be moved prior to road construction in the area. It is estimated that there is approximately 50,000 cubic metres of tailings involved. Tests have been undertaken to determine their composition, and while there is some very poor material involved, an appreciable percentage appears to be suitable for use in road construction as fill or sub-base. It may be possible to bury the unsuitable tailings element in a nearby borrow pit within the road reserve where selected road subgrade material has been located (Summerell, page 13). At present, the tailings are eroding and have caused some sedimentation and ponding of the Nattai River.

9.2.6 Mining Subsidence

Test drilling has been undertaken to determine whether shallow coal seams in the Nattai Gorge have been mined. While this indicated that extraction has not taken place, the existence of old addits, shafts and costeans throughout the area indicates possible limited extraction. However, no hazard from unknown coal workings is considered likely.

In the remainder of the study corridor the coal measures are overlain by Narrabeen Group, Hawkesbury Sandstone and Wianamatta Group rocks. Very little, if any, extraction of coal from under the proposed route has taken place. However, some extraction of coal may be expected in the future. Mining of seams underneath the highway could result in some subsidence hazard, depending on the depth of coal and extent of extraction. Information regarding likely extraction dates and possible ground movements and strains is being collected for use in detailed designs (Summerell, page 13).

9.2.7 Protection of Natural Vegetation

Largely as a result of one and a half centuries of European settlement in the study area, most of the proposed route (73%) has been cleared of its natural vegetation cover. However, there are two substantial remaining areas of natural vegetation in the upper Nattai River gorge and the Wallaby Rocks area of Wingecarribee River (see Figure 21). A report by the Botanic Gardens (Cooper, Powrie and Benson, 1983) discusses the likely impacts of the proposed road on the plant communities involved. The comments which follow summarize the points raised in that report and outline the measures which the Department proposes to take as a safeguard.

Destruction of some vegetation during construction is inevitable, but this will be kept to a minimum, consistent with construction needs (see Section 7.5). Trees and shrubs within the road reserve which are outside the construction area requirements will be preserved. The impact of direct destruction of vegetation will be reduced further by an extensive programme of regeneration and revegetation on the finished earthworks. This revegetation programme is explained in Section 9.2.8.

Clearing for roadworks will directly affect six of the eight plant communities identified. Table 9.1 shows, for each community, the present area, the likely decrease in area and the percentage decrease, based on a cleared width of 80 metres. For the section between Aylmerton and Medway Rivulet where the identified areas of natural vegetation occur, the total width of formation will be approximately 50 metres. An additional 30 metres has been allowed in the 80 metres average width of clearing for cut and fill batters plus the access strips (see Figure 14).

Communities four and five will not be affected. The decrease in area is considered to be tolerable for the six affected communities. By restricting clearing to the necessary minimum required for construction purposes, the areas of plant destruction estimated in the Consultant's report have been halved. Community six, which had been identified as being critically affected with 16% of its small total area required for clearing, will now have only half of a hectare cleared, or 8% of its total area. This community cannot be completely avoided because the proposed route over this section has been determined by a suitable bridge crossing of the Wingecarribee River to the north and an interchange to the south.

TABLE 9.1: ASSESSED LOSS OF NATIVE VEGETATION*

COMMUNITY	PRESENT AREA	DECREASE IN AREA	
	ha	ha	%
1. WOODLAND/OPEN FOREST: <i>Eucalyptus sclerophylla</i>	417	34	8
2. WOODLAND: <i>E. piperita</i> & <i>E. sieberi</i>	780	18	2
3. OPEN FOREST/TALL OPEN FOREST: <i>E. viminalis</i> & <i>E. cypellocarpa</i>	107	2	2
4. OPEN FOREST: <i>E. oreades</i>	18	0	0
5. LOW OPEN WOODLAND: <i>E. apiculata</i>	23	0	0
6. WOODLAND: <i>E. pauciflora</i> & <i>E. mannifera</i>	6	½	8
7. WOODLAND: <i>E. ovata</i> & <i>E. amplifolia</i>	102	9	9
8. WOODLAND: <i>E. elata</i>	18	1	6

* Figures based on information in Cooper, Powrie and Benson, 1983, but assuming minimum clearance of vegetation within road reserve.

Community three, Open Forest/Tall Open Forest, is restricted to the sheltered, steep gullies of the Nattai Gorge. Since the crossings of both the Nattai River and Gibbergunyah Creek will be by bridges, the extent of clearing required for Community three will be reduced to two hectares, or less than 2% of its total area.

Community seven, Woodland, is widely distributed in the study area in the upper reaches of creeks, notably Sheepwash Creek, Nattai Creek, Cutaway Creek and Cordeaux Creek. It was found to be rarely in an undisturbed state. By keeping clearing to essential construction requirements, the extent of direct destruction of this Community will be limited to 9% of the total area identified in the study corridor.

A number of plant species in the study corridor are restricted in distribution. Two species (*Eucalyptus apiculata*, *E. macarthurii*) have been listed as being "vulnerable", while another three (*Eucalyptus oreades*, *E. stellulata*, *E. aggregata*) have widespread distribution but are poorly represented in the area.

Eucalyptus apiculata (Narrow-leaved Mountain Mallee) has been recorded for three localities in the Mittagong-Berrima region. While two localities have only a few trees, the third locality, at Wallaby Rocks, represents a large population of a rare tree. Clearing for the proposed route will not affect this population (Community 5). However, special attention will need to be given to drainage aspects to ensure that existing surface runoff patterns are maintained. Although *Eucalyptus macarthurii* (Paddy's River Box) has been listed as "vulnerable", it is found in a number of localities from Mittagong to Marulan and also at Kanagra Walls. It is common in the Nattai River area and hybridizes with *E. viminalis* (Ribbon Gum) in Community 3.

Eucalyptus oreades (Blue Mountains Ash) has a broad distribution extending to Queensland. Previously the southern known limit of its range was at Lawson in the Blue Mountains. Its presence in the study area extends its range by 80 km. The road reserve at Gibbergunyah Creek narrowly avoids two populations of this species. *Eucalyptus stellulata* (Black Sally) is found from the Northern Tablelands of New South Wales to Victoria. Prior to the survey undertaken for this project, it had been collected once only in the study area, near the Wingecarribee River in 1923. *Eucalyptus aggregata* (Black Gum) also had previously been collected only once in the study area, at Berrima in 1907. The nearest other locations for this species are Wingello and Yerranderie, 60 km to the north-east. It was identified in this present survey as a hybrid and is probably the eastern limit of its range.

Both *Eucalyptus stellulata* and *E. aggregata* occur in the same plant community which is represented at only one locality in the study area, at Black Springs Creek (Community 6). While this community is directly affected by the proposed route, the area involved will be contained to a half hectare.

Unless effectively controlled, sedimentation resulting from the erosion of disturbed surfaces could adversely affect the communities in the Nattai Gorge and in the Wingecarribee River-Wallaby Rocks area. It could also create problems in aquatic communities and encourage the growth of exotic weeds. However, as indicated in Section 9.2.3, the Department will be taking the necessary steps to ensure that erosion and sedimentation are kept at acceptable levels.

The pollution of streams by construction wastes that may be toxic to native species will be avoided by careful planning of the works programme. Safeguards will include briefing field staff in methods for the safe disposal of wastes and keeping the use of any pesticides, herbicides and fertilizers to an essential minimum. Air pollution should not significantly affect the vegetation during construction. Dust will be controlled by frequent watering of exposed surfaces.

9.2.8 Landscaping and Revegetation

As indicated in Section 7.6, landscaping will be essentially a matter of restoration by the regeneration of indigenous species. A prime aim will be to stabilize disturbed areas as quickly as possible, with species which grow naturally in the surrounding areas. This should help to make the highway blend with the local landscape and reduce the susceptibility of bare surfaces to erosion and weed invasion.

In general, the clearing of vegetation will be confined to those areas needed for the earthworks. Other areas of clearing are those required for fencing and stockpiling of topsoil and base materials. Thus it is mainly the cut and fill batters and the median which will need attention. In this process, recognition will be given to the varying revegetation requirements of the sandstone, shale and basalt areas.

Top soil will be recovered when possible and stockpiled for re-use close to the locations from which it is collected. As plant communities are often largely determined by soil conditions and location, this will also assist natural regeneration. The top soil will

retain natural seed and root-stocks. To help prevent sterilisation of seed and to stabilise exposed earth areas, the top soil will be progressively spread as sections of earthworks are completed. Native shrubs will colonize sandstone batters and other cleared sandstone areas with considerable diversity in time (Cooper, Powrie and Benson, page 46). The majority of the undisturbed vegetation along the proposed route is on sandstone.

Since the soils on the shale and basalt areas are not so suitable for natural regeneration, local native species will be planted. Shrubs and understorey vegetation can be collected at the clearing stage, and foliage and seed from felled trees used in remulching with the spread top soil.

In general, the policy will be to plant a temporary cover crop on batters to stabilise the surface while the permanent cover of native plants is being established. For cover crops, only short-lived infertile hybrids will be used. These plants will not invade the bushland. They will be planted using hydroseeding techniques which will enable the grass seeds to be mixed with the seeds of local native plants.

The combination of some year-round rainfall and of relatively low evaporation rates provides adequate moisture, generally, for continuous plant growth. However, while moisture is not a limiting factor, the low winter temperatures restrict temperate plant species growth "almost completely during June, July and August and severely restrict it during May, September and October" (Edwards, p.63). To enable hydroseeding to be undertaken throughout the year as required, a mixture of low profile annuals which germinate at different seasons will be used to establish the initial cover crop. This seed mixture will also include indigenous pioneer shrub species which will establish themselves through the initial cover crop. Use of low profile vegetation as the initial cover will reduce maintenance by avoiding the need to mow, and will also allow natural revegetation to take place.

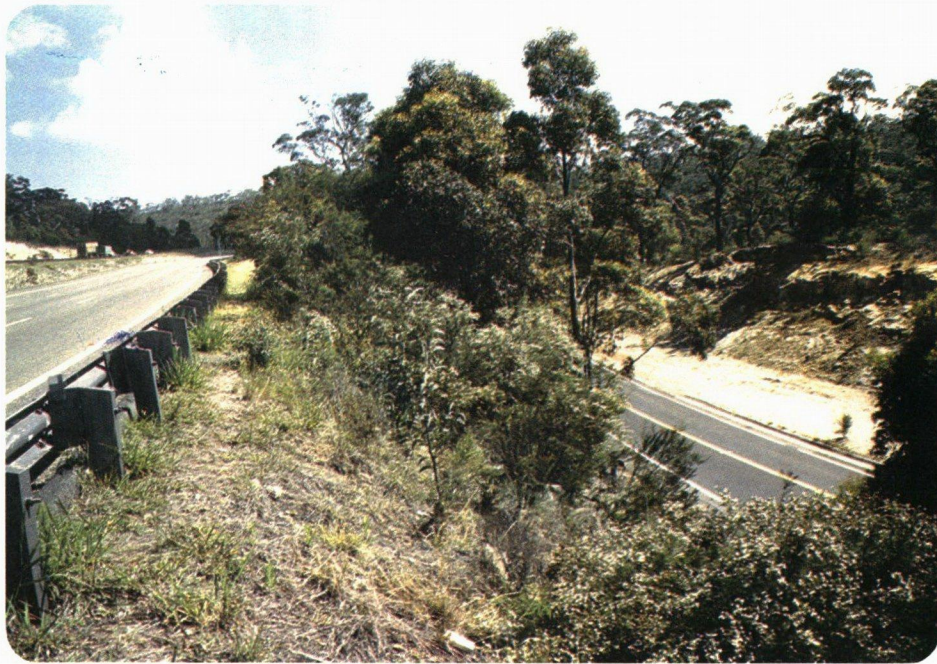
It is considered that adoption of the procedures outlined above will generally maintain the ecological balance of the study corridor, especially through sections containing natural vegetation. The planting procedures will be undertaken with the assistance of the Department's own landscape staff who will consult, where necessary, with the Royal Botanic Gardens and the Soil Conservation Service.

9.2.9 Faunal Safeguards

The mammal survey (Whelan, 1983) revealed the presence of nine species of native mammal and two introduced species. Low trapping frequencies were experienced, suggesting that disturbance by fire, trailbikes and introduced predators is frequent in the region. The Wallaby Rocks area has been grazed, restricting the most suitable habitat for mammals to the river margins. Nevertheless, keeping the clearance of natural vegetation to an essential minimum and encouraging regeneration of native plant species will minimize the loss of natural habitat and help to discourage invasion by fauna alien to the district. It will also lessen the need to use herbicides and fertilisers, and the amount of mown area.

The main concern expressed in the Consultant's report about the effects of the proposed road on mammal populations is the barrier to the movement of fauna. There are two extensive areas of natural vegetation and faunal habitat remaining along the route. They occur from 119 km to 123 km and from 133.5 km to 135 km (see Figures 16-18 and 21). Although the mammal population does not appear to be great, vegetated movement corridors will be maintained at approximately 120 km, 122 km and 134 km with the construction of major bridges, and a bridge sized structure will also be built at 135 km for Black Springs Creek. The preservation of existing faunal movement along the creeks and rivers involved will be assisted by keeping the destruction of vegetation under the bridges to a minimum, consistent with construction needs. Outside the two natural vegetation areas, a total of 19 bridges will be built to carry the highway deviation at various locations between Aylmerton and Medway Rivulet. In addition, existing trees outside the construction strip will be retained and will grow close to the edges of batters, keeping the width of clearing to an essential minimum.

Another matter of particular concern to the Consultant is the protection of the platypus



(13) Regeneration on Sydney-Newcastle Freeway
(SECTION 9.2.8)



(14) Regeneration on sandstone batter
(SECTION 9.2.8)

recorded in the Wingecarribee River, about 100 m down stream from the proposed bridge crossing. Although these animals are known to range large distances in search of food, they are sensitive to disturbance and siltation effects. To protect these animals, the banks of the river near the breeding burrow will be left undisturbed, and special care will be taken to prevent construction sediment runoff entering the river.

Most of the bird species recorded are common inhabitants of the Mittagong region. However, several species are of particular interest because of their rarity generally, or to the area (see Section 8.4.3). The most significant is the peregrine falcon, a rare and endangered species worldwide. While the proposed highway "is unlikely to put populations of any of these species at risk" (Whelan, page 8), special attention will be given to keeping disturbance and clearing to a minimum in the Gibbergunyah Creek area where rare species were recorded.

9.2.10 Archaeological Relics

Prior to the survey undertaken by the Department's Archaeological Consultant, very few Aboriginal relic sites were known to exist within the Mittagong-Moss Vale area and information about them was scant (Koettig, p.45). From the information collected during the survey it is possible to make some predictive statements about what types of sites are likely to occur and where they are likely to occur.

Contrary to expectations, open sites proved to be the most prevalent type. Nearly all of the 13 open sites located occurred on the Wianamatta Shales or where the shales and Hawkesbury Sandstone meet. It appears that evidence of Aboriginal occupation may be found almost anywhere that a level area is located near a watercourse. The open sites range from small areas with a limited assortment of visible material, to very extensive areas that have a considerable range of tool types and raw materials present. Two of the largest sites also had scarred trees in association.

Six shelter sites were recorded within the study corridor. These are confined to the Hawkesbury Sandstone sections. All shelters encountered proved to be Aboriginal sites. More shelter sites are likely to occur in the Nattai Gorge area beyond the proposed easement. Two of the six shelter sites are, in fact, more like open sites adjacent to a sandstone wall. They have minimal shelter.

Grinding groove sites were not numerous. The three recorded during the survey are on sandstone outcrops within a predominantly shale area.

The absence of carved trees and the low number of scarred trees (2) may reflect European clearing. Those areas where the scarred trees were recorded are generally more vegetated.

Of the 24 sites located and recorded during the survey, two were just beyond the boundaries of the proposed road reserve. Because the reserve is wider than the actual width required for the constructed highway, most of the remaining 22 sites are not directly affected. The erection of protective barriers around the sites not directly affected and the issue of appropriate instructions to the construction organisation is considered sufficient safeguard to ensure that these sites will not be damaged.

Although final design has not been completed, it appears that three sites could be wholly affected and three partly. One of the three completely affected sites is a scarred tree. The Department is investigating the possibility of placing the scarred trunk in a local museum. An application for consent to remove the tree, and to destroy an affected open site and shelter, will be made to the appropriate authority following salvage work. As design proceeds, ways of minimizing the impact of the three partly affected sites will be investigated.

9.2.11 Heritage Items

No items listed by the Heritage Council, the Australian Heritage Commission, or the National Trust will be affected by the proposal. However, as indicated in Section 3.2.2, stone piers reconstructed from the original David Lennox designed "Three Legs o' Man"

Bridge are situated within the highway reserve. The existing Hume Highway bridge at Medway Rivulet was built in 1975 upstream from these piers. Another bridge is required to carry the proposed second carriageway. This bridge will be built downstream from the piers. The alignment of the second carriageway has been designed to preserve the old "Three Legs o'Man" piers.

9.2.12 Local Access and Services

Provision will be made to maintain access on the local road network and to properties in the vicinity of the proposed road (see Section 7.7). In addition to crossing provisions, vehicle access to and from the new highway will be provided at five locations. Partial interchanges will be constructed with a deviation of the Hume Highway at Welby, with Medway Road and with a reconstructed section of the access road to the Berrima water supply site. Vehicle access will also be available from the Hoddles Cross Roads and the Aylmerton interchanges. Special provisions will be provided to maintain access between severed areas of several affected properties.

In the Nattai Gorge area the proposed route traverses bush fire hazard country which is served by a number of fire trails. Several trails will need to be cut. With some re-siting of the trails, connection can be re-established under the Nattai River and Gibbergunyah Creek bridges. Access across the highway reserve will be maintained on the existing road system. This will assist bush fire and other emergency services.

Arrangements will be made to re-establish or adjust, where necessary, public utilities and services affected by constructing the highway.

9.2.13 Fire

Precautions will be taken to minimize the risk of fire both in depots and on the works. During construction, these precautions will include ensuring the provision of fire fighting equipment, instruction of staff as to the appropriate action to be taken, and close liaison with the relevant fire control authorities.

Construction of the highway will have the beneficial effect of denying access for trail-bikes to the Nattai Gorge area, and providing a barrier between the bushland to the west of the Nattai River and the settled areas surrounding Mittagong. This should allow better management of fires in this area and reduce fire frequency (Whelan, p.9).

9.2.14 Noise

The daytime noise levels in the immediate vicinity of the highway will be affected during the construction period. Overall noise levels and frequency content will vary at different phases of the work. The highest noise levels will arise during the earthmoving phase when material is excavated at a cut area, transported some distance along a haul road within the site, and placed in a fill area. All construction activities would normally be confined to day-light hours.

Although generated noise will be a potential source of inconvenience to people near the reserve during construction, there are few houses adjacent to the proposed reserve, and construction will be of relatively short-term duration. Nevertheless, noise levels are being calculated and measures for reducing them will be considered, if found to be necessary (see Section 9.3.3).

9.2.15 Rifle Range

The proposed route of the highway passes through the rifle range at Welby. This range, operated by the Bowral Mittagong Rifle Club, is used throughout the year in "round robin" team shooting events between five clubs of the Illawarra District Rifle Clubs' Association. Because of its size, the range cannot be avoided. To meet the safety standards established for Australian rifle clubs by the Department of Defence, 914 metres (1,000 yds) are required for the range proper and an additional 1,828 metres (2,000 yds) are required for a safety area behind the range.

Under the general acquisition procedures of the Department of Main Roads, it is the responsibility of the Club to select a replacement range site and arrange for its development. This is being undertaken. The Department will pay appropriate compensation.

9.3 OPERATION STAGE

9.3.1 Spillages of Materials in Transit

In the event of a spill becoming known to the Department before the Police or Fire Brigade are at the site, normal practice would include identifying the spilt material, and if categorised as 'dangerous' (i.e. toxic or highly flammable), referring the matter to those agencies for action until the site is declared safe for clean-up operations to be commenced by the Department. (Vehicles transporting dangerous cargos are required by law to have the appropriate substance identification placards attached.)

The Police Department is able to call on the services of the Fire Brigade on any main road in New South Wales to combat the effects of a spill. The role of the Department of Main Roads is then to clean the pavement and restore it to a traffickable condition after the site has been decontaminated or declared safe.

Materials spilt in transit which are not toxic and/or highly flammable may be cleaned up by the Department without the aid of the Police or Fire Brigade. Depending largely on the magnitude and location of the spill, the following procedure will generally be adopted in those situations:—

- (a) Confine the spilt material, prevent it from flowing into the drainage system and prevent traffic from transferring it to other areas.
- (b) Recover the spilt material for disposal, where practicable.
- (c) Clean and restore the pavement.

The normal procedure for cleaning a road involves the use of sand and stock pavement cleaner. Emergency telephones will be provided at intervals along the highway. This will assist the quick reporting of any spillage.

9.3.2 Vehicle Emissions

Changes planned for the near future to legislation in Australia are expected to reduce or eliminate possible adverse effects associated with lead deposition from vehicles. At a meeting of the Australian Transport Advisory Council in February, 1981, Australian Commonwealth and State Transport Ministers resolved that 91.5 octane, lead-free petrol will be introduced from 1st July, 1985 and that vehicles made after 1st January, 1986 should be designed to run on lead-free petrol. Since construction of the Mittagong and Berrima bypass sections will not be completed before these dates, lead will pose a declining potential hazard to humans or animals near the route.

Due to the high standard of alignment and the flat grades proposed for the highway, the amount of vehicle emissions to the atmosphere will be minimal. Freedom from stop-start conditions by grade separations, controlled access and adequate traffic capacity will also contribute to a reduction in the amount of vehicle emissions.

9.3.3 Noise

The corridor through which the proposed highway is routed is generally sparsely populated. For the 25 km of new alignment between Aylmerton and Medway Rivulet, there will be only 16 houses within 100 m of the highway carriageways. Most of these (12) are at Welby (see Figure 17). This low number of houses indicates that traffic generated noise will not be a widespread problem.

Although the number of houses likely to be affected is relatively low, noise levels are being calculated. Measures for reducing traffic noise will be considered, using the British CRTN method of calculation (Dept of Env., 1975) and local criteria currently being developed.

These adverse effects should be seen in light of a beneficial reduction in noise levels for approximately 120 houses facing the existing Hume Highway between Aylmerton and Medway Rivulet, due to reduced traffic volumes, particularly the heavy vehicle component.

9.3.4 Hydrology

Possible adverse impacts are:

- (a) Increased runoff volumes. Converting a section of the existing permeable ground cover to an impermeable road surface will reduce infiltration and result in increased runoff. Where necessary, runoff from the roadway may be dispersed to stable locations along the route. This will avoid channelling runoff directly into existing creeks and minimize changes in stream flow;
- (b) Increased runoff velocities. Concrete-lined drainage systems facilitate rapid removal of water from the roadway but may, without adequate controls, cause scouring of natural watercourses. Any consequent sedimentation could be detrimental to vegetation and aquatic fauna of creeks crossed. The velocity of runoff will be restricted by the construction of energy dissipators and/or detention basins at drainage outlets where required. Similarly, bridges over creeks will be provided with waterway areas sufficient to limit flow velocities to a satisfactory rate.

9.3.5 Weeds

Weeds are, generally, plant species that need high nutrient levels and can quickly take advantage of suitably disturbed areas. Undisturbed sandstone areas are not susceptible to weed invasion because of their low soil nutrient levels. Disturbance to the vegetation by the introduction of silt and nutrients could lead to weed invasion. In the study area this has already happened in the Nattai River, Gibbergunyah Creek and Wingecarribee River. The Wingecarribee River has a well established weed problem with large willows being common. Gibbergunyah Creek has a serious weed problem with dense areas of blackberry and other weeds common along the banks (Cooper, Powrie and Benson, page 34).

These problems have resulted from agricultural land in their catchments providing a source of weeds, sediment and nutrients from fertilizers. Gibbergunyah Creek also has a rubbish tip as a major source of weeds. The Nattai River has the least serious weed problem of the three streams as it has more uncleared and ungrazed land in its catchment. Sediment from the coal tailings dump has partially blocked the Nattai River causing ponding and change in channel direction, but the tailings appear to be low in nutrients.

Section 9.2.8 indicates that the prime aim in landscaping will be to stabilize disturbed areas as quickly as possible with species which grow naturally in the surrounding areas. This should reduce siltation and weed invasion potential. The proposed erosion controls (see Section 9.2.3) will also subdue weed growth potential by reducing sedimentation effects and by maintaining existing conditions downstream of the earthworks.

9.3.6 Wildlife Mortality

It was considered by the Faunal Consultant that one of the major direct impacts of a new highway on the mammal fauna would be the depletion of populations due to deaths on the road. A survey was therefore conducted to estimate the number of animals killed on an existing section of freeway, namely, the section in use from Aylmerton northwards to the Wilton exit (approximately 26 km).

On seven dates, October 5, 19, 25 and November 2, 8, 16 and 23, a search was made for animals recently killed by cars. Each search entailed two observers spotting animals from a car driven slowly along the road verge. The searches were conducted early in the morning so as to locate animals before they were either removed from the road or were mutilated beyond recognition. Each animal was tagged with flagging tape to ensure that it was not recounted on a subsequent date.



(15) Weeds in Gibbergunyah Creek
(SECTION 9.3.5)



(16) Weeds in Nattai River. Eroded material from colliery tailings has caused ponding.
(SECTION 9.3.5)

For the seven survey dates, a total of 21 animal species was recorded along the 26 kilometres of freeway. Fifteen were birds (9 magpies), four were mammals, and the remaining two were red-bellied black snakes. One of the mammals found was a feral cat. The others were wallabies and a kangaroo.

The relatively low number of mammals recorded in this road-kill survey indicates a measure of success in fencing the road reserve boundaries to deter animals from crossing the carriageways and thereby risking collision with moving vehicles (Whelan, 1983, p.7). Both boundaries of the new road reserve will be fenced.

10. INTERACTION WITH THE ENVIRONMENT

10.1 THE PHYSICAL ENVIRONMENT

10.1.1 Introduction

Three earlier sections of this Statement have referred to the physical environment. In Section 3.1, the physical environment of the study region is described, in Section 8 a more detailed description of the proposed corridor is given, and in Section 9 there is a discussion of potential impacts and safeguards proposed to protect the physical environment. Following is a discussion of the likely impacts of the finished highway on the physical environment, taking into account the proposed safeguards.

10.1.2 Soils, Rocks and Subsidence

(a) Soils

The major impact resulting from the nature of the soils is the potential for erosion. This impact should be kept to an acceptable level by the erosion control measures which are proposed (Section 9.2.3). As a result of the controls, sedimentation rates beyond the reserve should remain at or near to existing levels.

The soils along the route vary from the low fertility units associated with Hawkesbury Sandstone to the fertile soils derived from Tertiary volcanics (Section 8.2). Generally, it is intended to revegetate the disturbed areas with indigenous plants. These plants vary according to the naturally occurring soils and should, therefore, facilitate rapid regrowth of a satisfactory ground cover.

(b) Rocks

The interactions between the highway and the rock formation present no environmental hazards that cannot be controlled using current design and construction methods. The main challenge for road construction occurs in the Nattai Gorge where doming associated with the syenite intrusion has resulted in higher dips than normal in the Sydney Basin sediments and an altered jointing system. Detailed site investigation is being undertaken for all cuttings in the area to determine jointing and weathering distribution as an aid in batter design. The steep talus slopes are also being investigated to determine the distribution of the talus and any areas of seepage. When these problem areas are identified the cuts and fills will be designed to achieve stable conditions for each individual batter. Outside of the Nattai Gorge, the properties of Hawkesbury Sandstone and Wianamatta Shales relevant to road construction are well known and should present few environmental problems.

(c) Subsidence

Mining subsidence is a potential hazard and likely areas of extraction and potential ground movement are being investigated. A report on the shallow coal seams in the Nattai Gorge area indicates that extraction has not taken place and that no hazard from unknown coal workings is considered likely. Along the remainder of the route the coal measures are overlain by Narrabeen Group, Hawkesbury Sandstone and Wianamatta Group rocks. Very little extraction of this coal has occurred. Since mining of these coal seams underneath the route could result in some subsidence hazard, information on the depth of coal, likely extraction dates and possible ground movements is being collected for consideration in the final design and for discussion with the relevant authorities.

10.1.3 Water

The flow of creeks and watercourses will be maintained by the provision of bridges, drainage culverts and other necessary drainage provisions. The bridges and culverts will safeguard against upstream flooding. Where necessary, increased flood peaks downstream will be mitigated by restricting drainage runoff velocities with energy dissipators and/or detention basins. Adverse impacts on the water quality of creeks

downstream from the works will be minimized by the proposed erosion and sedimentation control measures.

10.1.4 Air

In general, vehicle emissions to the air disperse rapidly, the rate of dispersion being dependent upon certain meteorological parameters. The prevailing winds through autumn, winter and spring, are westerlies, morning and afternoon. In summer, north-easterly winds prevail. Calm periods occur most frequently during the winter months, for just over 20% of the time on average. Since winds help prevent the formation of stable atmospheric conditions which restrict dispersion of emissions, the potential for concentration of emissions from vehicles using the new highway is low for all periods except winter.

However, the air quality situation for the urban areas should be improved because much of the through traffic travelling on the existing Hume Highway alignment will be transferred to the free flow, bypass route. Further, rainfall data shows a fairly even distribution of rain days throughout the year, with rain occurring on more than a third of all days (Table 3.1). Rain days help wash pollution from the air.

As discussed in Section 9.3.2, planned changes to legislation in Australia are expected to reduce possible adverse effects associated with lead deposition from road vehicles by the time construction is completed.

10.1.5 Hazards

Procedures for dealing with the accidental spillage of dangerous goods on the road have been discussed in Section 9.3.1. These procedures should be adequate to prevent serious adverse impacts on the surrounding environment.

The incidence of restricted visibility due to fog or mists is mainly limited to the March-June period, between midnight and 7.30 a.m. when traffic flows are at a minimum. This indicates that the incidence of low visibility fogs may not warrant special design features, but this is being checked.

Adequate road access across the proposed road reserve will be provided to allow local Bushfire Brigades and other emergency agencies to maintain their service to the area (see Section 9.2.11). The width of the proposed clearing within the reserve for the dual carriage highway will act as a significant fire break in the event of an intense fire occurring in heavily vegetated areas.

10.2 THE BIOLOGICAL ENVIRONMENT

10.2.1 Flora

The highway will traverse a region which has been extensively cleared of its natural vegetation. Seventy-three percent of the proposed route has been cleared. Adverse impacts on the remaining native vegetation include some direct destruction and fragmentation. Other potential impacts, such as sedimentation and air pollution, are not likely to be significant as adequate measures will be taken to control these effects. So far as fire is concerned, measures will be taken to minimize the risk of outbreaks during construction, and the highway will act as a fire break and will allow quick access to fires occurring in the area.

The main biological impact will be direct destruction of vegetation. The total area proposed to be cleared is estimated to be 64.5 hectares. However, much of the cleared area will be allowed to regenerate with indigenous species upon completion of construction. Areas where natural regeneration is likely to be slow, and where excessive erosion could occur, will be revegetated initially with fast growing annual grasses. Generally, this revegetation will be followed by a permanent growth of plants which are in keeping with the surrounding area. This procedure will reduce the impact resulting from the initial loss of vegetation.

Three plant species identified in the survey by the Royal Botanic Gardens are listed as being "vulnerable" to extinction. Only one of the three species, *Eucalyptus macarthurii*, will be affected by the project. However, it is common in the Nattai River area, and this river will be bridged.

10.2.2 Fauna

Construction of the 34.6 kilometres of highway will result in the loss of approximately 65 hectares of bushland which provides native fauna habitats. However, these habitats are not in their natural, pristine condition. They have suffered from proximity to one and a half centuries of European settlement and have been disturbed by grazing, mining, trailbike and other human activities. Feral and domestic animals have also taken their toll of native fauna. Research indicates that the slaughter of wildlife even by well fed domestic cats is extremely high (Rose 1976).

Nevertheless, the amount of clearing will be confined to a minimum, consistent with construction requirements. Encouraging the regrowth of indigenous plant species will also help to ameliorate the initial decrease in habitat area. Further, the Faunal Consultant has stated that "construction of the proposed freeway will have the beneficial effects of denying access by trailbikes to the Nattai River area and of providing a barrier between the bushland and the settled areas surrounding Mittagong" (Whelan, p.9). This barrier will prevent direct access by trailbikes and domestic animals to the proposed Nattai National Park, allowing better management and control of the park along its Mittagong boundary (see Sections 6.6.3 and 10.3.1).

The other impacts identified and recommendations made in the Faunal Consultant's report have been discussed in Sections 9.2.9 and 9.3.6. As indicated in those Sections, the Department proposes to implement suitable measures to reduce the adverse impacts to acceptable levels.

10.3 THE HUMAN ENVIRONMENT

10.3.1 Planning and Land Use

Sections 3.2.4 and 3.2.5 describe the existing land use and the statutory zonings, while Sections 3.3 and 5.4.6 discuss the planning policies for general land use in the southern tablelands district. The detailed land use zonings within the study corridor are discussed in Section 8.6.

Outside of the Nattai Gorge area, the land within the study corridor is all privately owned except for small pockets of Crown land. Through the vegetated Nattai Gorge section (118.5 km to 123 km), the land is predominantly in Crown title. Most of the land which will adjoin the proposed highway is rural, having a non-urban 1(a) and 1(b) zoning or a rural environmental protection zoning. Other land use zonings affected to a limited extent are open space-recreation, open space-special purpose, and the township of Welby. The Wingecarribee Local Environmental Plan for the former Mittagong Shire area makes provision for a road reservation from Aylmerton to Wingecarribee River. South from Wingecarribee River the road reserve will cross non-urban 1(a) land before joining the existing Hume Highway reserve at Medway Rivulet. Local government planning, therefore, is proceeding on the basis of a Mittagong-Berrima bypass being built on the proposed alignment for this National Highway.

At the State level, the proposal complies with the planning objectives established by the Department of Environment and Planning for the sub-region, and Ministerial approval to gazetting the Local Environmental Plan incorporating the new road reserve is pending. However, as indicated in Sections 5.4.6 and 6.6.3, provisional boundary extensions made by the National Parks and Wildlife Service to a Nattai National Park proposal would extend across the road reserve to the outskirts of Willow Vale and Braemar. From studies undertaken in this area south-east of Nattai River, there is evidence that it has suffered biologically from human activities and that construction of the highway would create an effective barrier to further encroachments on the natural environment north-west of the road reserve (see Sections 9.2.9, 9.2.12 and 10.2.2).

10.3.2 Social

Most of the land required for road construction purposes is in private ownership and would be purchased by negotiation and mutual agreement with the owner, based on current market value of equivalent properties unaffected by road proposals. Where mutual agreement cannot be reached, acquisition by resumption may be required. Negotiations with the relevant authority are entered into where public lands are involved. Because the area for the proposed road reserve is generally sparsely populated and care has been taken to avoid buildings where possible, it is anticipated that only ten houses will need either to be demolished or moved to enable construction of the full 34.6 kilometres of highway. Total acquisition of the public school at Aylmerton is required. However, the school is on the Mittagong bypass section which is planned for the third stage (see Section 7.4).

The population within the study area has generally been residentially mobile. At the 1981 Census, 56.2% of the Wingecarribee Shire population were recorded as having changed their place of residence since the 1976 Census. Along with certain other western nations, Australia has a high percentage of home movers. In 1970 the percentage of people moving in five years was 46.6 in Canada, 47.0 in the United States, and 51.4 in Australia (Finsterbusch, 1980, page 45). More recent internal migration surveys in Australia have shown that about 16% of all persons aged 15 and over change their residence within a twelve-month period (Aust. Bureau of Statistics, 1982, page 96). For Wingecarribee Shire, 22.3% of the total population changed their residence in the 1980/81 financial year.

People change their place of residence for a variety of reasons. Voluntary household relocation may result from adjustment to housing, neighbourhood or accessibility factors, or be induced by employment or life cycle factors. Involuntary or forced moves are necessitated by events beyond the control of the household, such as eviction or displacement by institutional intervention (Clark and Onaka, 1983). There is no sharp line, however, between voluntary and involuntary moving. For example, some moves motivated by health considerations, or sudden loss of employment, could be classified as being forced. Further, moves which are classified as voluntary may not be voluntary for all members of the household.

Household moving, whether voluntary or involuntary, has been classified as being a stressful life event (Holmes and Rahe, 1967; Finsterbusch, 1980). Construction of the highway will involve the relocation of some households. Such moving requires different types of adjustments and places different types of demand on all members of the families involved. In a population accustomed to moving, research indicates that "involuntary movers are not noticeably more adversely affected by moving than are voluntary movers" (Finsterbusch, p.67). However, each case involved will be given individual consideration.

An analysis of data from the 1976 and 1981 Censuses indicates that the Wingecarribee Shire population grew at more than twice the State rate for the intercensal period. While growth in the Illawarra Region as a whole slowed considerably during this period, Wingecarribee Shire continued to grow strongly. However, since no significant economic developments are foreseen for the Illawarra Region at present (Population Projection Group, 1982, p.25), it is likely that the population growth of Wingecarribee Shire will also slow down in the short term. After 1986 the growth rate of the Illawarra population is projected to return to its higher (early 1970's) growth rate (*Ibid*). The improved accessibility provided by the proposed highway, together with the improved shopping environment in Mittagong with the removal of through traffic, will help to encourage growth in Wingecarribee Shire. This growth is likely to come from residential expansion and from industry capitalising on the improved accessibility to markets connected by the Hume Highway, Australia's principal freight transport corridor (see Section 6.5).

Of the three sub-regional sectors of the Illawarra Region, the Tablelands, or Wingecarribee Shire, had the highest percentage of its population under the age of 15 at the 1981 Census (27.4% compared with 25.6% for the Region and 24.5% for the State). Although the Shoalhaven sub-region had a slightly higher percentage of its population in the 65 years and over age group (12.8%), Wingecarribee Shire had the highest proportion in these combined dependant age groups (39.0% compared with 34.8% for the Region

and 34.6% for the State). By removing the heavy through traffic flow from the built up areas of Mittagong and Berrima and, to a lesser extent, from Bowral and Moss Vale, the area will be safer for these two age groups. Both groups are potentially the most susceptible to air pollutants and to pedestrian accidents.

About 16 houses lie within 100 metres of the proposed highway shoulder and may experience some noise increase. Most of these residences are at Welby. Consideration is being given to help reduce any adverse effects on the houses involved (see Section 9.3.3).

As discussed in Section 9.2.11, provision will be made to maintain access, where practicable, on the local street system and to properties in the vicinity of the proposed highway. This will avoid community severance and the need for any changes in the local social network patterns.

On average, it is expected that there will be approximately 40 people employed in construction for the duration of the project. Very few, if any, would require temporary accommodation. The construction workers would travel in each day to work and return home at night. Consequently, there should be no additional demands made upon such local community services as education, housing and recreation. There is a potential demand involved for medical services, as well as a need for water, sewer and electricity services. No workforce related social changes are anticipated.

10.3.3 Economics

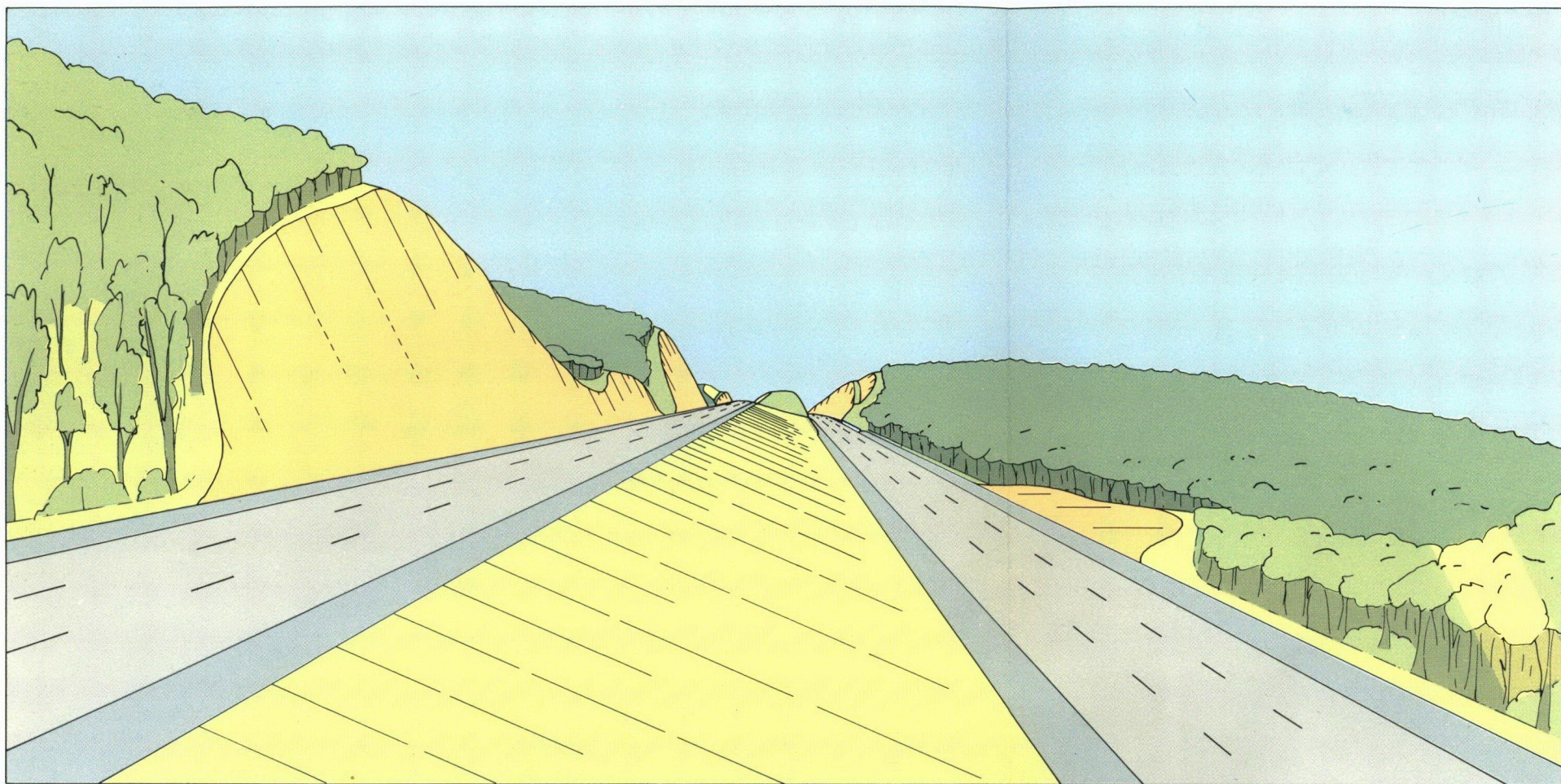
As discussed in Section 6.5, New South Wales dominates the Australian land transport arena, accounting for 35-40% of all Australian road tonne-kilometres. The freight industries form a major part of the State's economic activity, with an output estimated at about \$2,200 million in 1975-76, compared with about \$1,800 million for agriculture and about \$1,000 million for mining.

Long distance freight transport is concentrated in a few corridors within New South Wales, namely, the Hume, Pacific, New England and the Great Western Highway. Within this concentrated flow pattern, the Hume Highway dominates with over 40% of the total long distance freight haulage. For interstate movement alone the pattern is even more marked, with the Hume Highway accounting for 63% of total road interstate tonne-kilometres.

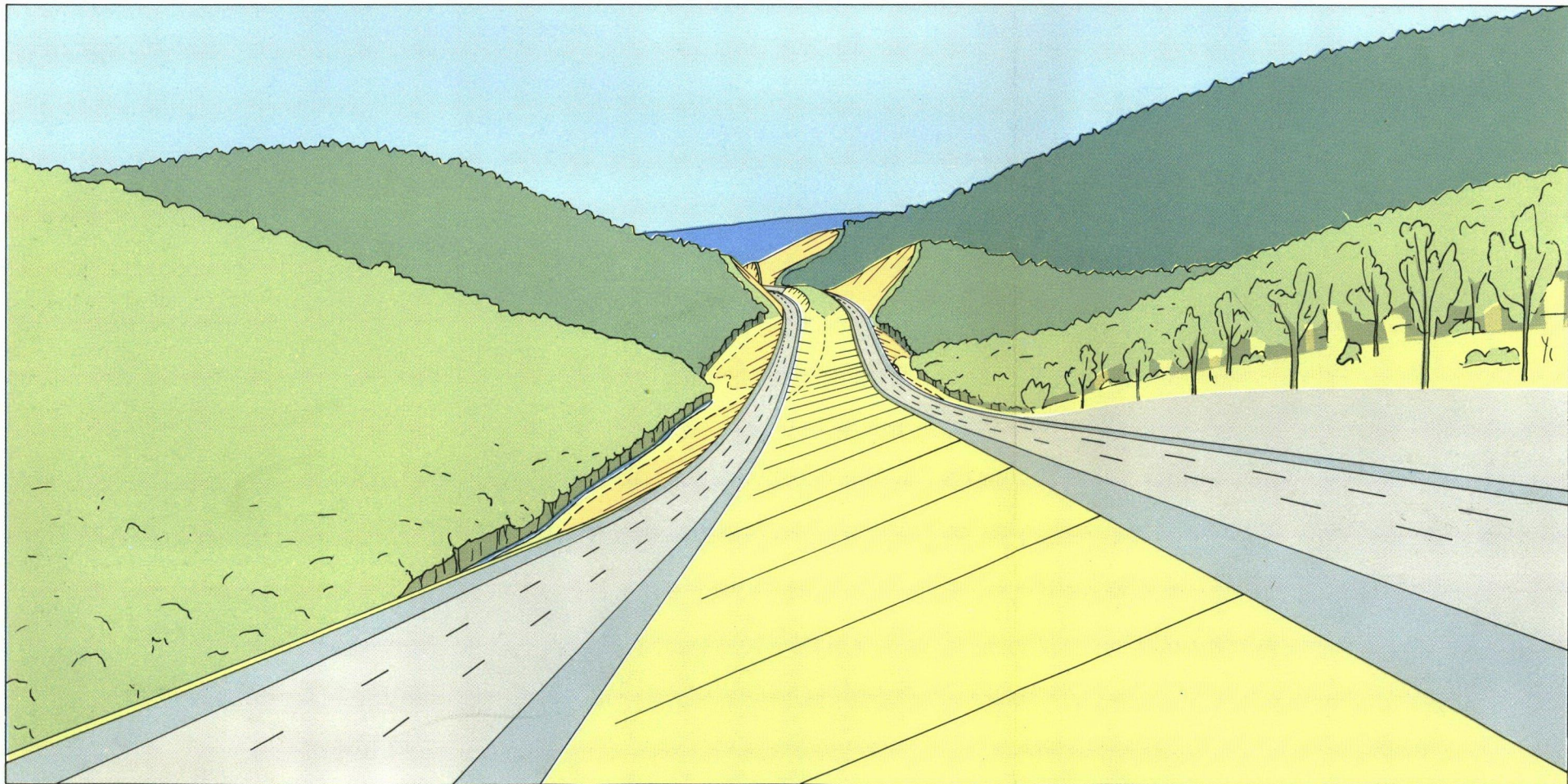
Since the operating costs of road transport can be directly affected by the nature of the roads that are available (Section 6.4.1), it is essential to the overall economy of both Australia and New South Wales that the road system in general, and the Sydney-Melbourne National Highway in particular, be in good condition. Constructing the proposed 34.6 kilometres of dual carriageway highway from Aylmerton to Hoddles Cross Roads, bypassing the congested built up areas of Mittagong and Berrima, will link adjoining sections and provide approximately 111 kilometres of continuous, dual carriageway driving conditions from just south of Liverpool to the southern boundary of Wingecarribee Shire. This will reduce the travel costs involved by reducing the travel time, vehicle operating costs, and the accident potential.

Individuals, commerce and industry will be able to gain direct benefits from this improved accessibility between Sydney, Canberra and Melbourne. In New South Wales, where it has been reported that 60% of all freight by weight and 95% of all foodstuffs are consigned by road (Rochfort, 1982), the community will benefit collectively through lower transportation costs and quicker delivery of products. There will also be savings in energy consumption as a result of the one kilometre reduction in travel distance, the flatter grades, and the improved, free-flowing operating conditions (see Section 11).

There will also be community cost reductions resulting from a reduction in road accidents. While addressing the Transport Industries Advisory Council recently, the Acting Director of the Federal Office of Road Safety stated: "It is acknowledged that the provision of better roads has an important . . . role to play in promoting road safety. In respect of national roads, for which the Commonwealth has assumed full financial responsibility, the overall objective is to ensure safe, reliable and efficient carriage of traffic



LOOKING SOUTH AT APPROX. 121 Km



LOOKING NORTH AT APPROX. 121 Km

FIGURE 24
HIGHWAY PERSPECTIVES

between main centres. Notified design standards associated with national roads enhance road safety" (Upton, 1982, p.17). Section 6.6.2 has indicated that an annual reduction of ten fatal accidents and 140 injury accidents is possible if the new section of national highway is built as proposed. Although road accidents accounted for only 3.2% of all deaths in New South Wales in 1981 (A.B.S., 1981, p.18), it has been estimated that "traffic accidents are the second most costly condition leading to death, surpassed only by cancer. Furthermore, this estimate does not take into account property damage" (Haight, 1983, p.1).

Another economic benefit of the proposal during the construction period will be the impetus generated for local business activity. The principal stimuli for this activity will depend on the distributive effects of construction workforce incomes. Positive benefits can be anticipated for food stores and take-away food outlets in the towns of the area. Service and associated businesses should also benefit. A related benefit of this work will be the provision of increased employment opportunity within the local community. "In this regard, the '2.6 multiplier effect' of roadworks should not be overlooked, in that, for every additional 10 persons employed on roadworks, a further 16 job opportunities are created in the community" (Whelan, 1982).

On the debit side, there are certain businesses in Mittagong and Berrima that cater for passing traffic. These businesses are likely to experience some reduction in trade from this source, due to decreased traffic volumes through the towns. The businesses most likely to be affected this way are fast-food outlets, petrol stations and motels. However, these towns will be sign-posted at the appropriate highway exit, and removing through traffic from them will improve the shopping environment for local customers and encourage the holiday and tourist trade of the area. Also, since the private motor vehicle continues to be the dominant form of transport used for tourism and the trend has been towards more short-haul, short-duration trips, improving road access to and through the district will assist the tourism industry.

10.3.4 Cultural and Historical Sites

Twenty-two Aboriginal relic sites have been located within the proposed road reserve. However, because the road reserve is wider than the actual width of the road itself, at the preliminary design stage it appears that only three sites will be wholly affected and three partly (see Section 9.2.10).

No items listed by the National Trust, the Heritage Council of New South Wales, or the Australian Heritage Commission are affected by the proposal.

10.3.5 Visual Aspects

The highway, on its proposed alignment, will be visible from only two residential areas. It will pass through the north western outskirts of Welby, at ground level to slightly above ground level. Some screen planting may be required at this location. Also, although it will pass approximately one kilometre to the north-west of Berrima, the highway will be just within the visual catchment area of Berrima (see Figure 6). However, it will not be visible because of the existing dense tree cover adjoining the Wingecarribee River (see Figure 18).

From the users' point of view, the route has considerable scenic value. The terrain traversed varies from the rugged gorge country of the Nattai River area, with dense native bush cover, to open grazing land, cleared of most indigenous growth. This varied landscape experience will provide visual contrast and will be an aid in reducing driver boredom and fatigue.

The vertical alignments of the northbound and southbound carriageways have been separated by over seven metres through the Nattai Gorge to suit the steep terrain (see Section 7.2). This will allow closer integration of the highway with the natural environment. Figure 24 shows two computer based highway perspectives at Mount Alexander Colliery, looking south towards Gibbergunyah Creek bridge and looking north towards the Nattai River bridge. The visual effect of vertically separating the carriageways can clearly be seen in this Figure. Cut batters are shown in both drawings as they would appear before the regeneration of native plants.

11. ENERGY STATEMENT

11.1 ENERGY NEEDED TO ESTABLISH PROJECT

Over the eight-year construction period planned for the full Aylmerton to Hoddles Cross Road section of National Highway, it is estimated that construction equipment will use the following amounts and types of fuel to complete the project.

Diesel fuel oil (distillate)	28,000,000 litres
Petrol	850,000 litres
or the equivalent of 1,110,000 gigajoules of energy.	

Once established, only periodic maintenance will be required for continued operation.

No account has been taken of the relative energy contents of the pavement materials expected to be used. While there are differences in energy contents per tonne of the basic and prepared materials, the design differences and the choice of materials eventually used in the pavement are generally based on economic and durability factors. These factors take no major account of the energy content comparisons in arriving at the eventual pavement type chosen.

Similarly, in accepting that construction of bridges is the most practical and environmentally sensitive option for crossing the Nattai and Wingecarribee Rivers and Gibbergunyah Creek, no attempt has been made to estimate the "energy content" of these major structures.

As indicated in Section 8.1, some cuttings in remnant basalt caps are involved. While the strength of the Hawkesbury Sandstone varies, most of this rock along the proposed route is within the moderately strong range. The degree of resistance of these materials to excavation, by major heavy plant items or in combination with explosives, may have a marked effect on the quantity of petroleum fuels used on the work. The quantity of energy equivalent estimated above has been based on the use of conventional heavy earthworking plant. However, improvements in fuel efficiency and decreasing weight of the vehicle fleet, which may be expected over the projected eight-year construction period, are likely to show reduced fuel dependency.

11.2 ENERGY SAVINGS

The new route for the highway will be one kilometre shorter than the 26 kilometres travel distance via the existing Hume Highway, between the Church Avenue interchange at Aylmerton and Medway Rivulet. Following opening of the new section to traffic, the amount of energy used during construction will be offset by savings in fuel consumption due to flatter grades, improved operating conditions, and the slight reduction in travel distance.

In assessing fuel consumption rates, average travel speeds of 90 km/hr may be assumed for the freeway travelling conditions of the new highway, while 70 km/hr may be taken as being representative of the average travel speed on single carriageway, rural sections, and 50 km/hr on urban sections, of the equivalent length of Hume Highway. The most economic fuel consumption for operating vehicles is achieved when the average steady speed is between 40 and 60 km/hr and there is as little acceleration/deceleration variation as possible. Frequent acceleration and deceleration cycles, together with stop-start conditions encountered on the existing road system, result in an energy consumption penalty. For example, even at higher running speeds, provision for free-flow and hence, steady speed conditions on the new section of dual-carriageway highway is expected to provide fuel savings of 10 to 15% for comparable distances on the existing Hume Highway route. Where the more congested urban conditions prevail, such as through Mittagong and Berrima, the fuel penalty would be approximately 55% higher than on the new highway for a standard vehicle.

Allowing for diesel consumption by heavy vehicles at an average rate of 34 litres per 100 kilometres, and petrol consumption for other vehicles at an average rate of 12 litres

per 100 kilometres, together with the foregoing penalty rates and projected traffic volumes (Figure 11), an estimate has been made of the annual fuel savings possible with the project. This estimate indicates an annual saving of approximately 40,000 litres of diesel (35% of consumption without project), and of 13,000 litres of petrol (17% of consumption without project). Also, a saving of 12 minutes in travel time is possible between Aylmerton and Hoddles Cross Roads with the project.

The main beneficiary of these savings will be the road freight industry, reflected in the considerable reduction in diesel fuel consumption. As indicated in Section 6.5, the Hume Highway is by far the most important road freight artery in New South Wales, accounting for 43% of the total tonne-kilometres and 63% of the interstate tonne-kilometres.

11.3 ENERGY SOURCES STERILISED

For more than half the length of the route (approximately 55%) there is either no economic coal traversed or the coal is inferior or cindered. Where reasonable quality coal does occur it is at depths varying from 100 to 200 metres (Shiels, 1978) and underground methods of extraction can be employed. These coal measures are overlain by Narrabeen Group, Hawkesbury Sandstone and Wianamatta Group rocks. Very little, if any, extraction of the coal has taken place from under the proposed route (Summerell, p.13). Since mining of these seams could result in some subsidence hazard, information regarding likely extraction dates and possible ground movement is being collected.

12. SUMMARY ASSESSMENT

In assessing the impacts associated with constructing a divided-carriageway standard road for the Hume Highway between Aylmerton and Hoddles Cross Road, comparison has been made between the preferred western route, doing nothing, improving the existing highway, and four alternative routes. The "do nothing" and "improve existing highway" options are not acceptable because they do not comply with the Commonwealth standards set for national highways, they would not relieve the congestion and noise situations in Mittagong and Berrima, and because the potential savings in lives, in numbers of accidents, and in fuel consumption would not be realized. When the alternative routes were placed on public exhibition in the towns of Mittagong, Bowral and Moss Vale, a large majority of both rural respondents (67%) and town respondents (69%) favoured the western route. This route was also favoured by two of the three Councils involved at the time, and has, subsequently, been adopted by the Commonwealth Government. A summary of the main effects of constructing the highway on this route follows.

For the physical environment, there are potential erosion problems with most of the soils of the area, and consequent sedimentation problems in the rivers. Both temporary and permanent erosion control measures will be designed into the project to address these problem areas.

Air pollution is not considered to be a problem in the vicinity of the proposed bypass sections of the highway. For most part, the bypass is away from built up areas, and the prevailing winds and the rain pattern should normally prevent any concentration of pollutants. The flat grades and free-flowing traffic conditions will help to minimize vehicle emissions. Diverting long distance traffic away from built up areas will also reduce the vehicle emissions resulting from congested road conditions.

The main impact on the biological environment will be the loss of approximately 65 hectares of native bush, representing a 4.4% decrease on the existing area of native vegetation (see Table 9.1). Of the identified eight communities, those most affected in percentage reduction would be Woodland: *Eucalyptus ovata* and *E. amplifolia* (9 ha or 9%), Woodland/Open Forest: *E. sclerophylla* (34 ha or 8%), and Woodland: *E. pauciflora* and *E. mannifera* (½ ha or 8%). The decrease in area is the minimum essential for construction purposes.

Three plant species in the study region have been listed as being "vulnerable" to extinction. Only one, *Eucalyptus macarthurii* (Paddy's River Box), will be physically affected by construction. Advice received from the Royal Botanic Gardens indicates that this plant is common in the Nattai River area and is found in a number of localities from Mittagong to Marulan (Cooper, Powrie and Benson, page 26). The proposed bridging of Nattai River and Gibbergunyah Creek will help reduce any destructive effect on this plant.

Fragmentation of habitat is seen as being potentially the most significant faunal impact. Three large bridges are proposed: over the Wingecarribee River, Nattai River and Gibbergunyah Creek. These will allow movement of mammals and reptiles across the road reserve in the native vegetation areas. Bridges will also be provided at most other road and rail crossings and large structures will also be provided at Cutaway, Cordeaux, Black Springs and Oldbury Creeks.

Platypus occur in the Wingecarribee River, downstream from the proposed bridge. To protect these animals, the banks of the river near their breeding burrows will be left undisturbed, special precautions will be taken to minimize construction sediment runoff entering the river, and a research project is under investigation to monitor the effects of the roadworks on the platypus population.

For the human environment, the effects will be mainly beneficial. Land use planning and development is proceeding on the assumption that the highway will be built along the route proposed. Job opportunities will be created by the proposed construction. Private individuals, commerce, and industry will be able to gain direct benefits from the improved accessibility between Sydney, Canberra and Melbourne. These benefits will result from lower transportation costs, quicker delivery of products, reduced accident

potential, and energy savings. The Hume Highway accounts for 43% of the State's long distance road freight. Calculation of the cost and benefits involved indicate benefits amounting to \$9.4 million in the first year of full operation and a benefit/cost ratio of 2.7/1. Prevention of a potential 10 fatal accidents and 140 injury accidents each year is estimated.

On the debit side, it is estimated that 10 residences and one school will need to be either demolished or moved in order to construct the 35 kilometres of highway involved. A further 16 houses would lie within 100 metres of the highway and occupants may experience some proximity effects. These would not be as significant as those currently being experienced by residents in the houses fronting onto the existing Hume Highway.

Efforts are being made in planning the location and construction of the highway to minimize adverse impacts upon both the natural and the built environments, while maximizing the community benefits to be gained. It is considered that all significant environmental effects have been identified. In summary, it is concluded that construction and operation of the proposed section of national highway can be undertaken in a manner which is environmentally acceptable, and that the benefits to be gained at the local, state, and national levels are substantial.

APPENDIX A

SUMMARY OF REPLIES FROM AUTHORITIES

Authority	Comments
Australian Museum	(1) Letter dated December 15, 1976. ● Most of the investigation corridors would have little impact on native fauna. Exception is upper reaches of Nattai and Nepean Rivers, away from marked corridors. (2) Letter dated July 19, 1978. ● Brief report on faunal effects of western and eastern routes. Noted barrier effect of western route on faunal movements, but since no survey carried out, not possible to estimate significance.
Berrima District Association for Planned Development	● At local public meetings very strong objections were raised to the eastern route. The Association strongly supports the western route.
Bowral Municipal Council	(1) Letter dated February 2, 1977. ● Sought information on alternative routes. A route to the east of Bowral may affect future development. (2) Letter dated August 5, 1977. ● Council favours route west of Berrima.
Department of Agriculture	● The four alternative routes compared for agricultural impact. The western route would have least effect, passing through generally poorer country.
Department of Education	(1) Reply dated March 21, 1979. ● For the time being, Aylmerton Primary School will continue at its present location. ● Demographic surveys are being undertaken to establish the appropriate location for the new school when necessary. ● Present indications are that replacement school will be located in Colo Vale. ● Advice on timing sought. (2) Advice dated March 6, 1980. ● Ministerial approval has now been given to the acquisition of an alternative site at Colo Vale. ● Cost of relocation will be included in compensation claim following acquisition of Aylmerton site.
Department of Environment and Planning	● Appropriate for proposal to be treated under Part V of the Act and for preparation of an E.I.S.

Authority	Comments
	● Advisable to consult with Council. ● E.I.S. to be prepared in accordance with Clauses 57-59 and Sections 112 and 113. ● Meet legislative requirements for preservation of Aboriginal places. ● Meet legislative requirements relative to air, water and noise control. ● Consult with N.P.W.S. re parks and wildlife. ● Identify and make provision for faunal movements. ● Assess visual and ecological impacts of alternatives routes and identify proximity effects. ● Address need to control construction sedimentation. ● Describe atmospheric conditions and air pollution potential. ● Provide details of any marsupial proof fences or other control.
Department of Mines	● Both the eastern and western routes are underlain by coal. ● The eastern traverses some areas of cindered and poor quality coal while the western between Berrima and Exeter Road is still the subject of continuing lease application and exploration interest. ● At some future time coal may have to be extracted from beneath all or most of the alternative routes. Final design should allow for total extraction of coal.
Department of Public Works	● Forwarded map showing proposed route of a 450 mm main for Berrima district water supply.
Electricity Commission	● Forwarded map showing Commission's assets in the area and effect of eastern and western routes. ● Eastern route opposed because of its proximity to transmission lines and substations.
Heritage Council of N.S.W.	● Only one conservation instrument so far made for land in study area — I.C.O. for Berrima. ● It appears western route will not be within Berrima's visual catchment. ● While eastern route will not physically affect any notable heritage value buildings, there are five such buildings which may have the visual quality of their situation destroyed.

Authority	Comments
	● From a heritage perspective, the Sutton Forest — Exeter district is significant and every effort should be made to restrict development which may adversely affect the landscape qualities. ● In summary, the western route appears to be the less disruptive, providing it is located at least 2 km west of the existing Hume Highway at Berrima.
Joint Coal Board	● Forwarded report by Board's District Geologist dealing with the coal geology of western and eastern routes.
Mittagong Community Development Association	● The Association confirms and supports view of Mittagong Council favouring the western route. Supporting reasons given.
Mittagong Shire Council	(1) Letter dated November 28, 1972. ● Request to ensure any bypass be constructed around northern side of Mt. Alexandra. (2) Letter dated January 8, 1974. ● Request for construction of Mittagong bypass. (3) Letter dated September 23, 1976. ● Advice sought on route of bypass. (4) Letter dated January 17, 1978. ● Copy of Field Officer's report from Southern Highlands Bushfire Prevention Association. From a bushfire prevention viewpoint, the eastern route favoured over the western. (5) Letter dated May 13, 1980. ● Request for an approximate time for construction of the Mittagong/Berrima bypass.
Metropolitan Water Sewerage and Drainage Board	● The eastern route would affect a proposed canal between Wingecarribee Dam and Lake Burragorang. ● Special precautions required for construction within catchment areas.
National Parks Association of N.S.W.	(1) Letter dated January 29, 1975. ● Forwarded list of birds and mammals in Nattai River area. (2) Letter dated August 10, 1979. ● When western route is built there will still be a fairly extensive natural area with wildlife on the eastern side. ● Request an underpass in vicinity of Gibbergunyah Creek for wildlife movement.

Authority	Comments
National Parks and Wildlife Service	(1) Reply dated December 22, 1976. ● Map forwarded showing Service estate and areas of interest. (2) Letter dated September 11, 1978. ● Western route cuts across eastern extremities of two areas of fairly natural land. ● While each route would pass through a Wildlife Refuge, none is liable to be seriously affected. ● As regards Aboriginal relics, the most suitable route is the western. An archaeological survey needed. (3) Letter dated August 27, 1979. ● The Service holds a register of Aboriginal sites. (4) Letter dated September 26, 1979. ● Advice sought on route. (5) Letter dated March 8, 1982. ● In letter of 11th September, 1978, Service advised that the western route would not traverse the Nattai National Park proposal. It has now become apparent that this is not the case. ● Recently completed identification of provisional park boundaries conflict with route.
National Trust of Australia (N.S.W.)	(1) Letter dated January 23, 1975. ● Imperative that the integrity of Berrima and its setting be maintained. ● A visual catchment outlined. (2) Letter dated July 10, 1975. ● Planning guidelines for Berrima forwarded. (3) Letter dated December 14, 1977. ● Trust favours the western route.
Planning and Environment Commission	● Commission favours, in principle, the western alternative, provided route altered to avoid residential development at Welby.
Wingecarribee Shire Council	(1) Letter dated November 24, 1977. ● Council resolved that it support, as a matter of policy, adoption of the modified eastern route.

Authority	Comments
	(2) Letter dated December 12, 1977. ● Concerned at barrier effect of western route in event of a major fire occurring in the west. ● Of the opinion that a freeway would not be of assistance in preventing the spread of fire. (3) Letter dated January 25, 1978. ● Set out points for and against alternative routes. (4) Letter dated January 15, 1979. ● Council accepts the recommendation of the State Minister for Transport to the Commonwealth Minister for Transport for the adoption of the western route, but strongly urges construction of Moss Vale bypass roads as associated works.

APPENDIX B

REFERENCES

- Anonymous (1982), "Transportation and Economic Activity", **Texas Transportation Researcher**, 18(4), October, pp.3-4.
- Atkins, A.S. (1981), **The Economic and Social Costs of Road Accidents in Australia: With Preliminary Cost Estimates for Australia 1978**, Centre for Environmental Studies, University of Melbourne, Melbourne.
- Australian Bureau of Statistics, NSW Office (N.D.), **Deaths, New South Wales, 1981**, Catalogue No. 3307.1, Sydney.
- Australian Bureau of Statistics (1982), **Year Book Australia**, No. 66, Canberra.
- Blainey, Geoffrey (1966), **The Tyranny of Distance. How Distance Shaped Australia's History**, Sun Books, Melbourne.
- Brizga, V. (1978), "Preliminary Geological Report on the Aylmerton to Exeter Road Freeway Deviation", Department of Main Roads report on Papers F5/287.1222 dated 10th August, 1978.
- Clark, W.A.V. & J.L. Onaka (1983), "Life Cycle and Housing Adjustment as Explanations of Residential Mobility", **Urban Studies**, 20(1), February, pages 47-57.
- Commission of Enquiry into the N.S.W. Road Freight Industry (1980a), **First Report on Economy, Efficiency and Road/Rail Rationalisation**, Volumes I, II and III, January, Sydney.
- Commission of Enquiry into the N.S.W. Road Freight Industry (1980b), **Second Report on Rationalisation, Costs, Charges, Licensing, Safety, Environment, Industry Organisation, Training**, Volume IV, January, Sydney.
- Commonwealth Bureau of Roads (1975), **National Highways Linking Sydney, Melbourne and Canberra**, First Report, Melbourne.
- Coneybeare, C.H. (1978), "State Highway No. 2 and Freeway F5 from Aylmerton to Exeter Road, Location Investigation", Department of Main Roads report on Papers F5/287.1222 dated 26th July, 1978.
- Cooper, M., S. Powrie, E.D. Benson (1983), **Vegetation Survey of Freeway No. 5, Aylmerton to Hoddles Cross Roads**, Royal Botanic Gardens, Sydney.
- Department of Agriculture (1978), Letter of reply dated 5th July, 1978 on Papers F5/496.114.
- Department of Environment and Planning (1981), **Illawarra Regional Plan. Landscape and Environmental Study**, Wollongong.
- Department of Environmental and Planning (1982a), **Planning for Blue Metal Quarrying in the Municipalities of Shellharbour and Kiama and Tablelands Sub-Region**, Wollongong.
- Department of Environment and Planning (1982b), **Draft Illawarra Regional Planning Report**, Wollongong.
- Department of Main Roads, N.S.W. (1948), "Historical Roads of New South Wales. Development of the Route of the Hume Highway", **Main Roads**, 23(4), June 1948, Pages 122-126.
- Department of Main Roads N.S.W. (1976), **The Roadmakers**. A History of Main Roads in New South Wales, Sydney.

- Department of Main Roads, N.S.W. (1980a), **Heavy Vehicle Percentages in N.S.W.**, Sydney.
- Department of Main Roads, N.S.W. (1980b), **Freeway F3: Sydney-Newcastle Freeway. Section: Mount White to Ourimbah. Environmental Impact Statement**, Sydney.
- Department of the Environment (1975), **Calculation of Road Traffic Noise**, Welsh Office, London.
- Edwards, K. (1979), **Rainfall in New South Wales. With Special Reference to Soil Conservation**, Soil Conservation Service, Technical Handbook No. 3, Sydney.
- Else-Mitchell, R. (1940), "Mittagong and District. Its industrial Developments", **J. Royal Australian Historical Society**, 26, pages 418-478.
- Finsterbusch, Kurt (1980), **Understanding Social Impacts. Assessing the Effects of Public Projects**, Volume 110, Sage Library of Social Research, Sage Publications, Beverly Hills.
- Haight, Frank (1983), "Some Theoretical Aspects of Road Safety", Keynote Paper, **Esso-Monash Civil Engineering Workshop on Traffic Accident Evaluation**, Monash University, 15-17 February, 1983.
- Hamilton, G.J. (1976), "The Soil Resources of the Hawkesbury River Catchment, N.S.W.", **J. Soil Conservation Service**, 32(4).
- Harrington, P.R. (1981), **The Planning Implications of Tourism in the Illawarra**, produced by the Illawarra Regional Information Service for the Department of Environment and Planning, Wollongong.
- Heritage Council of N.S.W. (1978), Letter of reply dated 25th October, 1978 on Papers F5/287.1222
- Highway Research Board (1965), **Highway Capacity Manual, 1965**, Special Report 87, National Academy of Sciences, National Research Council, Washington, D.C.
- Holmes, T.H. & R.H. Rahe (1967), "The Social Readjustment Scale", **Journal of Psychosomatic Research**, 11, pages 213-218.
- Jeans, D.N. & Peter Spearritt (1980), **The Open Air Museum. The Cultural Landscape of New South Wales**, George Allen & Unwin, Sydney.
- Jervis, James (1937), "The Wingecarribee and Southern Highlands District. Its Discovery and Settlement", **J. Royal Australian Historical Society**, 23, pages 247-300.
- Joint Coal Board (1978), Letter of reply dated 5th July, 1978 on Papers F5/287.1333.
- Kenderes, M. (1982), "South Western Freeway: Accident History", Department of Main Roads minute on Papers F5/259.5115, dated 19th October, 1982.
- Koettig, Margrit (1981), **Hoddles Crossing to Alpine. Archaeological Survey of the Proposed F5 Extension**, Sydney.
- McDonnell, Gaven (1982) "Rail/Road Rationalisation, Transport Regulation and Section 92", **The Australian Quarterly**, Autumn, 1982, pages 30-42.
- National Parks and Wildlife Service (1976), Letter of reply dated 22nd December, 1976 on Papers F5/496.114.
- National Parks and Wildlife Service (1978 and 1982), Communications on Papers F5/287.1222 dated 11th September, 1978, 8th March, 1982 and 1st April, 1982.

- National Trust of Australia, N.S.W. (1977a), **Berrima. Guidelines for Planning and Landscape**, Sydney.
- National Trust of Australia, N.S.W. (1977b), Letter dated 14th December, 1977 on Papers F5/496.114.
- National Trust of Australia, N.S.W. (1982), **National Trust Register**, Sydney.
- N.S.W. Planning and Environment Commission (1975), **Illawarra Regional Strategy. Tablelands Reconnaissance**, Wollongong.
- N.S.W. Planning and Environment Commission (1978), Communication dated 10th May, 1978 on Papers F5/496.114.
- N.S.W. Planning and Environment Commission (1979), **Draft Illawarra Regional Plan**, Wollongong.
- Population Projection Group (1982), **Interim Population Projections for New South Wales, 1981-2001**, Department of Environment and Planning, June, Sydney.
- Principal Architect (1978), "Landscape Investigation Aylmerton to Exeter Road, Department of Main Roads report dated 1st August, 1978 on Papers F5/287.1222.
- Richardson, A.J. (1983), "The Economic Evaluation of Traffic Accidents", Paper No. 15, **Esso-Monash Workshop on Traffic Accident Evaluation**, Monash University, 15-17 February, 1983.
- Robinson, N.H. (1976), "Mammals and Expressways", **Parks and Wildlife**, 1(5), May, pages 172-173.
- Rochfort, Peter (1982), "N.S.W. Transport Expenditure — Putting Carriages Before the Hauliers?", **Australian Transport**, September, 1982, pages 12-15.
- Rose, A. Barclay (1976), "Cats", **Parks and Wildlife**, 1(5), May, page 170.
- Searles, B. (1980), **Traffic Volume Trends in N.S.W.**, National Roads and Motorists' Association, Sydney.
- Shiels, O.J. (1978), Report of District Geologist, Southern and Western Districts, dated 30th June, 1978, to Chief Mining Engineer, Joint Coal Board, Papers F5/287.1222.
- Somerville, C.J. and A.J. McLean (1981), **The Cost of Road Accidents**, The University of Adelaide Road Accident Research Unit, Adelaide.
- Summerell, S. (1983), **F5 — South Western Freeway. Aylmerton to Hoddles Crossroads. Geological and Soils Investigation**, Report No. 1089, Department of Main Roads, N.S.W., Sydney.
- Upton, W.G. (1982), "Driver Motivation is Major Factor in Road Safety". **Australian Transport**, September, pages 17-19, 35.
- Whelan, Paul (1982), "Programme of Works for Continuation of South Western Freeway from Casula to Beverly Hills", press release date 16th September, **Weekly Notice**, Department of Main Roads, 15(38), 27th September.
- Whelan, Robert J. (1983), **Faunal Survey. Freeway No. 5 — South Western Freeway. Aylmerton to Hoddles Cross Roads**, Biology Department, University of Wollongong, Wollongong.
- Wild, Ronald A. (1970), **Bradstow**. A study of status, class and power in a small town in New South Wales, Thesis submitted for the degree of Doctor of Philosophy in the Department of Anthropology, University of Sydney, on 29th July, 1970.

Wotherspoon, G. (1980), "An Historical Review of Rail Freight and Road Freight in New South Wales: Some Aspects of Development, Competition, and Regulation", prepared for the **Commission of Enquiry into the N.S.W. Road Freight Industry**, January, Sydney.