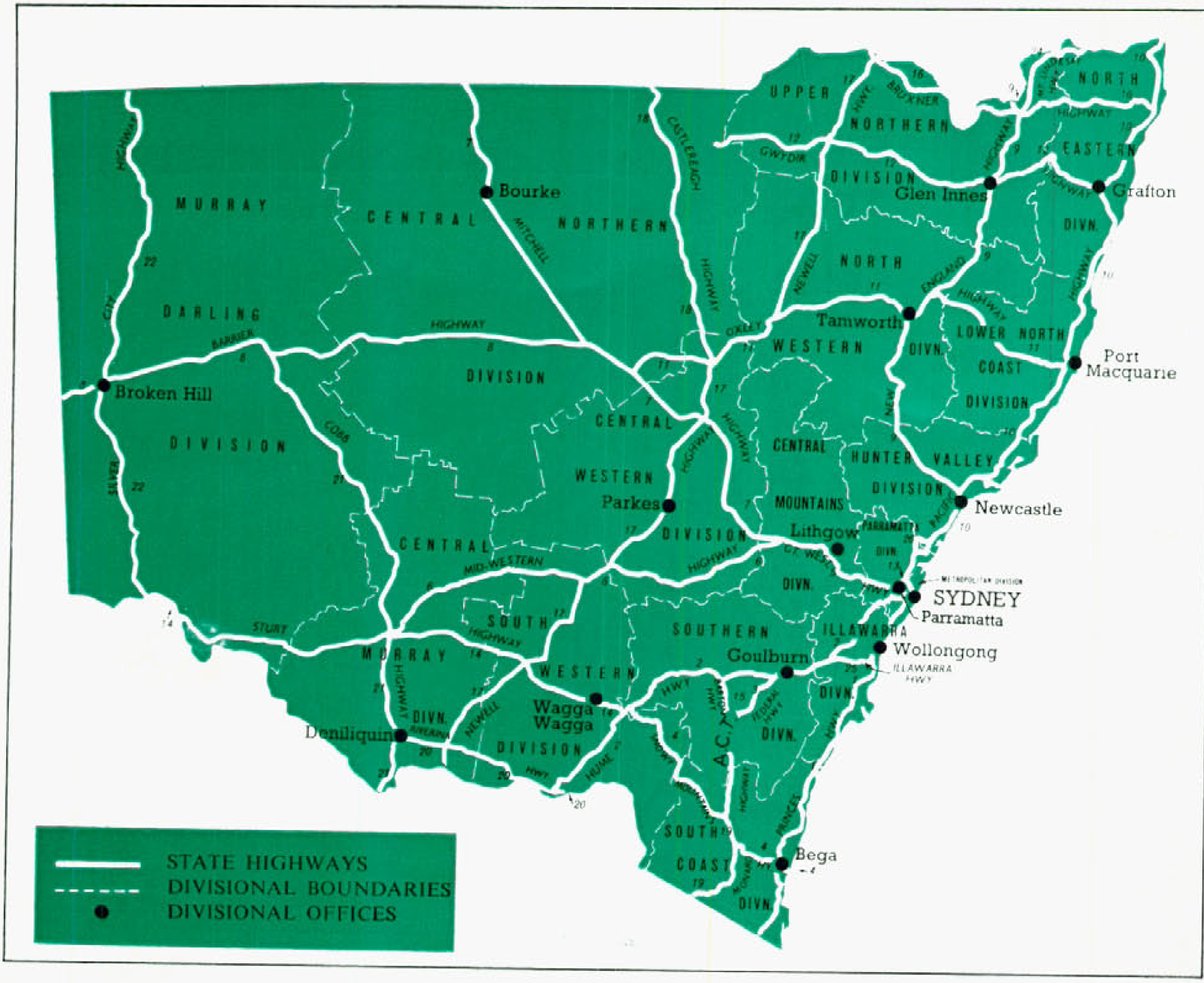
MAIN ROADS

MARCH 1975



New South Wales

Area—801 431 km²

Population as at 30th June, 1974—4 254 400 (estimated)

Length of Public Roads—208 890 km

*Number of Motor Vehicles registered as at 30th June, 1974—2 426 078.**

* *"This figure has been obtained from the Australian Bureau of Statistics. It should be noted that, due to the exclusion of certain categories of vehicles (such as tractors and trailers), etc., this figure is considerably lower than the previously published figure, which was obtained from the New South Wales Department of Motor Transport."*

ROAD CLASSIFICATIONS AND LENGTHS IN NEW SOUTH WALES

Lengths of Main, Tourist and Developmental Roads, as at 30th June, 1974.

Freeways	84
State Highways	10 501
Trunk Roads	7 037
Ordinary Main Roads	18 461
Secondary Roads	291
Tourist Roads	405
Developmental Roads	3 661
Unclassified Roads	2 477
Total	42 917 km

MAIN ROADS

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CONTENTS

(*Front Cover*): *Two bridges under construction at Carcoar—the bridge crossing the Belubula River and in the background a bridge over Eulamore Street.*

(*Back Cover*): *Construction progress on the North Parramatta by-pass, showing the bridge which will carry Kissing Point Road over the route of the new county road.*

NEVER GIVE A THOUGHT

Engineers in the Department of Main Roads can solve any problem associated with road and bridge building in this State. The community's heightened sense of environmental consciousness, however, has added to the scope of engineering and emphasised that profession's responsibilities beyond the purely technical and economic.

All the road and bridge works undertaken by the Department of Main Roads are designed to harmonise with their surroundings, although occasionally, the initial impact of a newly completed project might make this hard to visualise.

When first planned, the Gladesville Bridge complex and the Warringah Freeway were obviously going to make an impact on the environment. Both might have adversely intruded on their surroundings by their sheer size alone, but good design mitigated this. After completion, the landscaping of man assisting nature gradually did its work; grass and trees grew; the harshness of new concrete and bitumen faded; and the constant passage by thousands of vehicles mellowed the unfamiliar new curves of man's engineering, transforming them into an everyday part of man's world.

Recent photographs of these two projects which have now been in use for a number of years, appear on page 95.

In designing the two works mentioned, engineers were dealing with modern roadworks in a modern city. Problems of a different nature occur when a modern road is to be constructed through a location closely resembling a nineteenth century village which is a part of our heritage. This location is Carcoar, steeped in history and nestled in its lovely, basin-shaped valley on the far western slopes of the Blue Mountains.

It had long been known that it would be impractical and unaesthetic to reconstruct the existing route of the Mid Western Highway through Carcoar because a new road built to today's standards would effectively divide the town in two and destroy a part of living history. The designers looked instead to the hills and selected a route for a deviation which would place the town of Carcoar reasonably close to the deviation and yet would not detract from the historical harmony of the setting. The result is a road which, though sweeping through some of the surrounding hilltops, will be hardly visible to any but those driving along it. Later, as the construction scars heal and the carefully selected trees begin to mature, the environmental engineering efforts will be forgotten. Man's work here again is designed to so blend with nature that motorists and local residents might never give it a thought.

That a project can be designed to produce such a negative attitude in the public mind, is the truest indication of a successful environmental engineering ability.

An article describing progress with the deviation and the historical significance of Carcoar, begins on page 76.●

New Federal Roads Legislation

THE ROADS GRANTS ACT, 1974.

THE NATIONAL ROADS ACT, 1974.

THE TRANSPORT (PLANNING AND RESEARCH) ACT, 1974.

The Meaning for Motorists

The summary of the three Acts set out here describes the Acts but does not explain their full implications.

The limited extent of finance provided by the Federal Government under these Acts is such that eventually it will be difficult to avoid a gradual deterioration of roads other than those classified as National Highways.

In effect, the State roadbuilding authorities are experiencing a serious reduction in the level of Federal financial assistance for roads other than National Highways. This will result in the road and bridge building operations of both the Department of Main Roads and Local Government Councils diminishing through lack of sufficient finance to proceed with the planned road construction and maintenance programmes.

The money allocated to the States by the three Acts is simply not sufficient; taking into account the inflationary rate, now approaching 20% per year, and allows nothing for the reduction in effective work values.

The Acts

The Acts which define the Federal Government's principles and policies for the construction and maintenance of roads for the three years from 1st July, 1974, are:

The National Roads Act, 1974, The Roads Grants Act, 1974, (both assented to on 20th September, 1974) and The Transport (Planning and Research) Act, 1974, (assented to on 21st August, 1974).

These three Acts authorize payments of $350 million to the State of New South Wales for the three year period to 30th June, 1977.

The increase in total grants to the State for the year commencing 1st July, 1974, is only $9,730,000 or less than 10% above the grant provided for in the year ending 1st July, 1974, the last year of the 1969 C.A.R. Act. The increase from 1974–75 to 1975–76 is less than 6% and the increase from 1975–76 to 1976–77 is less than 13%.

With inflation increasing at a rate of approximately 20% per annum, it is apparent that there must be fewer capital works which can be carried out on roads using the new Federal grants than were carried out in the 1973–74 financial year.

The matching quota (to attract the full Federal grant) demanded of the State by the Federal Government in 1974–75 has been increased to approximately 115% of the total Federal grants to the State for that year as compared with 88% in 1973–74.

National Roads Act

The major new initiative in the legislation is the National Roads Act. As well as establishing the means to categorize certain roads as National Highways, the Act also provides for the establishment of Export Roads and Major Commercial Roads. Export Roads are those roads which will facilitate or, if built, would facilitate overseas trade and commerce. Major Commercial Roads comprise roads or proposed roads that facilitate trade and commerce between the States. Roads to airports or ports could fall into either of the two categories.

The power to declare a road a National Highway, an Export Road, or a Major Commercial Road lies with the Federal Minister for Transport.

National Highways

Roads which may be declared National Highways are those roads which, in the opinion of the Federal Minister are or will be the principal roads linking:

(a) two or more State capital cities;
(b) a State capital city and Canberra;
(c) a State capital city and Darwin;
(d) Brisbane and Cairns;
(e) Hobart and Burnie;
(f) other roads which, in the opinion of the Minister, are of national importance.

To maintain National Highways to an adequate standard the Federal Minister may request a State to furnish information on the use of National Highways and the effect which other works in the State may have on National Highways. The Federal Minister may also determine after consultation with the State what works of construction and maintenance should be carried out on National Highways, the order in which these works should be carried out and the standards of construction and maintenance.

Under the Act, the Federal Minister has authority to request a programme from the States, in which they give details of projects to be carried out by them on National Roads. The Minister is further empowered to specify dates for submission of such programmes, and the particular projects and classes of projects they are to include. Finally, the Minister has the authority to vary programmes proposed by a State.

These provisions ensure that the Federal Government controls the future development of those roads which are National Highways. The State Government will be responsible for their construction and maintenance.

The precise routes of parts of some of the National Highways have yet to be determined and will be the subject of corridor studies.

On 5th November, 1974, the Federal Minister for Transport declared the following roads in New South Wales to be National Highways within the meaning of the National Roads Act, 1974:

1. Sydney-Melbourne

South Western Freeway

From the intersection with Glenfield Road and Campbelltown Road at Cross Roads to Main Road No. 178 near Campbelltown.

Main Road No. 178 (*Camden-Campbelltown Road*)

From the junction with the South Western Freeway near Campbelltown to the intersection with the Hume Highway at Narellan.

Hume Highway

From its junction with Main Road No. 178 at Narellan to the border between New South Wales and Victoria at Albury.

Although the declaration is not specific, it is intended that the lengths of the Hume Highway and of Main Road No. 177 south of Cross Roads to the junction with the South Western Freeway be regarded as National Highways. The length of the Hume Highway between the junction with the exit ramp from the South Western Freeway at Cross Roads and the intersection with Main Road No. 178 near Narellan does not form part of the declared route of the National Highway.

2. Sydney-Brisbane

Pacific Highway

From Berowra Waters Road, Berowra, to the Berowra-Calga Tollwork at the Berowra Toll Plaza.

Sydney-Newcastle Tollway

From the Pacific Highway at the Berowra Toll Plaza to the junction with State Highway No. 26 (Calga-Ourimbah Road) at Calga.

State Highway No. 26

From the junction with the Berowra-Calga Tollwork at Calga to the junction with the Pacific Highway near Ourimbah.

Pacific Highway

From the junction with State Highway No. 26 near Ourimbah to Parbury Road, Swansea.

New England Highway

From the intersection with the Pacific Highway at Hexham to the border between New South Wales and Queensland at Wallangana.

3. Sydney-Canberra

Federal Highway

From the intersection with the Hume Highway near Goulburn to the border with the Australian Capital Territory.

4. Canberra-Melbourne

Barton Highway

From the intersection with the Hume Highway near Yass to the border with the Australian Capital Territory.

At this stage, there is no apparent Federal intention to declare the routes

New Federal Roads Legislation

continued

of National Highways within the inner areas of the Sydney, Newcastle and Wollongong Statistical Districts.

Roads Grants Act

The Roads Grants Act provides for financial assistance to New South Wales totalling $207,500,000 over three years for urban arterial, urban local, rural arterial and developmental roads, rural local roads and minor traffic engineering and road safety improvements. This assistance applies to construction of all categories, as well as maintenance for rural local roads.

The new legislation provides for the Federal Government to approve annual programmes for all categories of roads financed from its own grants. In addition, it is a condition of the grants that the Federal Minister for Transport may require all urban arterial road projects to be included in the programme submitted for his approval, including those financed from State and Local Government funds.

Where the Minister has so required, it is a condition of the grants that the Minister may require repayment by the State to the Federal Government of any part or the whole of the grants made for urban arterial roads, if the State or a municipal, shire or other local authority, expends any funds on carrying out projects of the kind not included in the programme approved by the Federal Government.

A new initiative in the Roads Grants Act is the introduction of urban local roads as a category for the first time. An amount of $9,900,000 has been made available to New South Wales for this purpose. For roads in this category, the Australian Department of Transport will be working in close co-operation with the Australian Department of Urban and Regional Development. Local Government will be responsible for initiating proposals for inclusion in a programme of urban local road works, which will be considered by a tri-level meeting of Local, State and Federal Government officials to formulate submissions for approval.

A total of $29,700,000 has been provided for rural arterial roads in New South Wales. Of this amount $11,200,000 is available for expenditure in 1974-75 reducing to $9,700,000 in 1975-76 and further reducing to $8,800,000 in 1976-77.

Under the 1969 Commonwealth Aid Roads Act this category of rural arterial roads included those roads which are now National Highways and catered for under the provisions of the National Roads Act. However, the Roads Grants Act has augmented this category of road by the inclusion of regional connecting roads which previously formed part of the "rural roads other than arterial" roads category. These are roads whose main function is to provide an avenue of communication between those roads which were previously classified as rural arterial (linking important centres) and those of an arterial nature (within towns).

The development of rural arterial roads is important. They play a major role in joining the cities, towns and principal centres of population in regions outside the capital and major provincial cities.

The use which urban dwellers make of these roads (currently 25 per cent of total travel) indicates that direct benefits from rural arterial roads flow to urban communities as well as rural communities. The Commonwealth Bureau of Roads has estimated that by the year 2000 the proportion of use by urban dwellers will have increased to 40 per cent.

The Roads Grants Act provides funds for developmental roads. These roads will be nominated by the Federal Minister for Transport who can determine that up to 10 per cent of the moneys available for the construction of rural arterial roads be expended on the construction of developmental roads. These new developmental roads will comprise selected rural roads and could include, for example, roads of importance to the tourist industries and roads serving growth centres, such as Albury/Wodonga.

New South Wales is to be provided with $43,000,000 for the construction and maintenance of rural local roads.

These roads are those which provide an access function to residences within rural cities, towns and other centres of population as well as to farm properties.

Under the 1969 Commonwealth Aids Roads Act, the States were provided with sums of money for expenditure on a relatively few broad road categories, and were left to make decisions on the nature of the roadworks to be financed and the establishment of priorities relating to particular works.

An amount of $7,900,000 has been allocated to New South Wales by the Roads Grants Act, 1974, for expenditure on minor traffic engineering and road safety improvements over the three years commencing 1st July, 1974, and this money is available for use on roads in both urban and rural areas.

Situations for Assistance

The Bureau of Roads, in making recommendations on urban local roads in its "Report on Roads in Australia 1973" identified four major areas of need.

The first concerned the need to assist local government authorities on the fringes of the urban areas which face difficulties in financing the roads programme required to keep pace with development. In these areas, local road development often precedes growth in local rates.

The second situation relates to the need to assist local government authorities with special burdens on street reconstruction. They may have in their area, for example, streets with abnormal traffic conditions due to congested arterials. The long term solution is, of course, to provide arterial roads adequate for traffic needs, but having regards to the reducing grants provided for urban arterial roads under the Roads Grants Act, 1974 it appears that this solution is not at present a priority project of the Federal Government.

The third situation is the assistance needed for areas such as the fast developing western suburbs of Sydney.

Fourthly, funds should be provided to allow for initial road construction in "System cities" (a medium size city with new business centres located outside the edge of the existing built-up suburbs) therefore easing the task of providing fast transport links between these centres ahead of the availability of local government rate finance for this purpose.

Transport (Planning and Research) Act

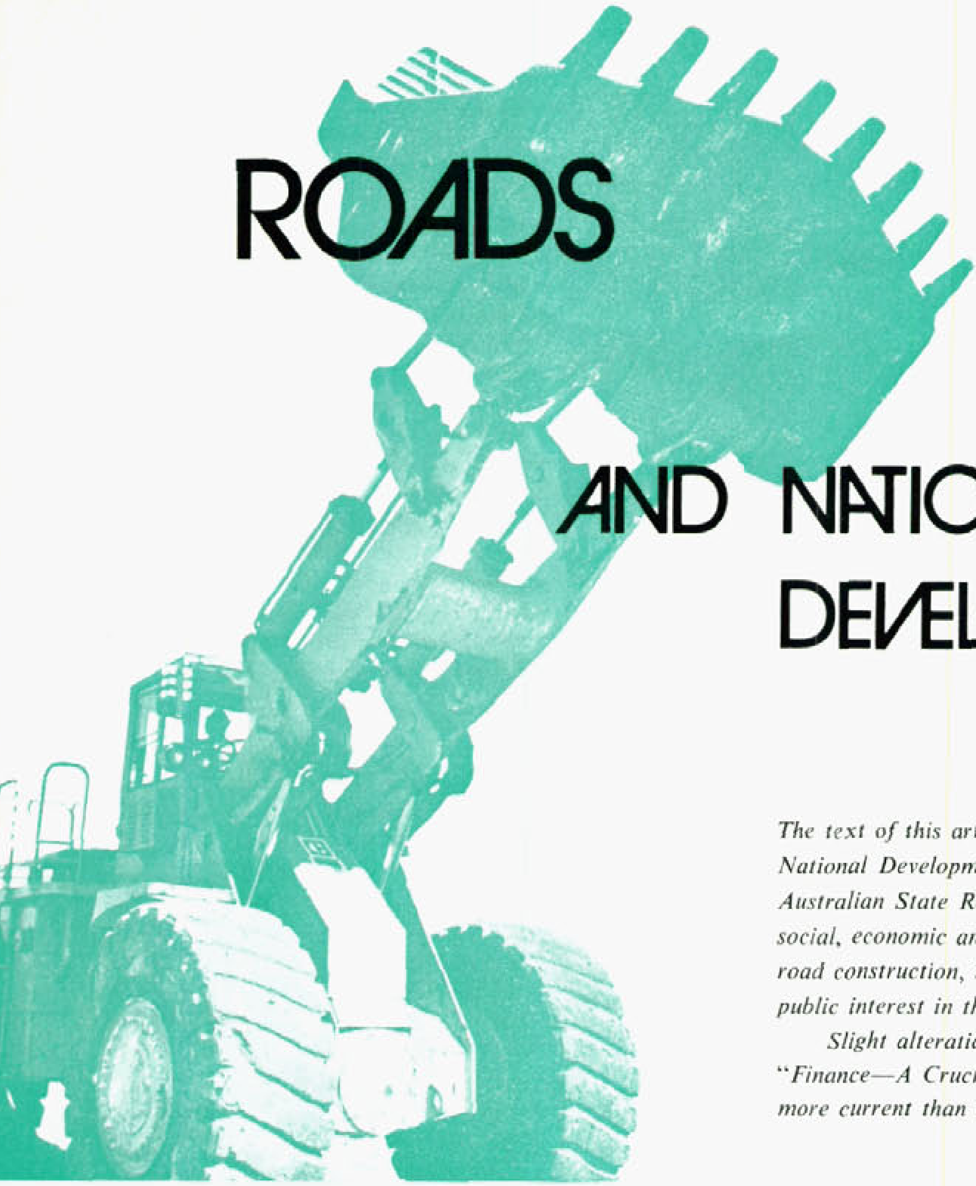
The third Act, the Transport (Planning and Research) Act, is the first step in presenting a multi-modal approach to providing assistance for land transport. This Act covers planning and research for both roads and public transport. Road projects are therefore considered in relation to their priority with urban public transport and vice versa. For this purpose, the Act provides a basic allocation of $5,800,000 to New South Wales. A further $11,000,000 is provided as additional assistance but has not been allocated to particular States and the Federal Minister for Transport has a complete discretion in regard to allocation of this amount.

Programmed Legislation

The new Federal Roads legislation has been restricted to a three year term but the Federal Government has announced that further legislation to provide assistance to the States for a number of land transport modes will be introduced by the end of 1975, to become operative at the termination of the current legislation in 1977. The proposed new legislation will embrace not only roads assistance but also that presently voted separately for all forms of urban public transport. The introduction of this legislation at the end of 1975, even though it will not come into effect until 1977, is designed to give the States sufficient time for forward planning.●

Copies of the three Acts are available from—Australian Government Publication Enquiry Centre, 309 Pitt Street, Sydney, 2000.

ROADS AND NATIONAL DEVELOPMENT



The text of this article is reprinted from the brochure "Roads and National Development" issued by the National Association of Australian State Road Authorities. A series of brochures outlining the social, economic and environmental issues associated with present-day road construction, is being produced by NAASRA to encourage public interest in the work of its Member Authorities.

Slight alterations have been made to the section of text—"Finance—A Crucial Factor"—which now includes financial figures more current than those in the brochure.

Australia has emerged so rapidly into the forefront of the *developing* countries that we are prone to expect the highest achievements immediately in every aspect of national growth, without recognising the restrictions imposed by economic considerations. Today, all public authorities are besieged with appeals for the immediate provision of the most *up-to-date* facilities. We want bigger and better roads and we want them *now*.

The major function of roads in Australia's development is to allow for the easy, unimpeded circulation of goods and people. It is clear that the nature, size and rate of expansion of our country's primary and secondary industries are, to a large degree, directly related to the availability of adequate transport facilities, particularly by rail and road. It is equally clear that the accelerated growth of both production and population, coupled with a rapidly increasing ratio of motor vehicle ownership, has imposed a heavy strain on our existing road network. The symptoms have been the intensification of traffic congestion (especially in high density urban areas), greater *wear and tear* on road pavements by heavy trucks, and more apparent inadequacies in alignment and width as higher volumes of faster-moving vehicles call for higher standards of road design.

To meet the constant clamour for improved driving conditions, the various State Road Authorities have had to plan and implement programmes for the widening and bituminous surfacing of existing roads and for their construction to higher standards. They have also had to provide for the building of new roads to and through areas of rising population and production. These new roads vary from multi-lane freeways or dual-carriageway highways to pioneering *developmental* or *tourist* roads opening up areas which are otherwise virtually inaccessible to vehicular traffic.

Such improvements help not only to cater for the increased personal mobility of the Australian people but also to encourage flexibility in the economy, by making business and marketing movements in many regions more a matter of convenience and less a test of reliability or patience. It is an obvious but seldom advertised fact that better roads and bridges bring immediate social and commercial benefits to the community. They make a significant contribution to our *quality of life* and represent a valuable investment in the future prosperity of the nation.

Big Country—Big Problems

In spite of the popular image which pictures Australians as being a race of rugged farmers fighting against almost overwhelming odds to protect their crops and stock from fire, flood and famine in the vast lonely outback, we are in fact one of the world's most urbanised societies. Out of a total population of 13.2 million, more than 8.6 million (63 per cent) live in the capital cities.

Although the four largest of these urban centres are *concentrated* in the southeastern quarter of the continent, they are, by world standards, widely separated. The distance from Brisbane to Sydney (1,015 km) is comparable to the distance between London and Berlin, while the 5,755 km coastal route from Brisbane to Perth (via Melbourne and Adelaide) is more than three times the distance from London to Moscow.

To infer that our road building programmes suffer solely from *the tyranny of distance* is too simple a diagnosis but nevertheless the term does emphasise that one of the major factors influencing the rapid provision of better roads throughout Australia is the very magnitude of the distance involved. Other factors can be seen in the table below which compares the Australian situation with that in other countries. For example, the combination of Australia's large size and small population has meant that the ratio of lengths of road to population is extremely high while the ratio of money spent per kilometre of road is extremely low.

It can also be seen that Australia is one of the most car-conscious communities in the world, having one motor vehicle for every 2.4 persons. The urgency of the task of today's roadmakers and the financial priority that must continue to be given to their work can be gauged from estimates which indicate that Australia's motor vehicle population will double again within ten years.

The Business Benefits of Better Roads

Progressive improvements to the Australian road network have meant, and will continue to mean, that across the nation traffic can move with more safety, speed, security and certainty, as well as with less vehicle wear and less driver worry. Distances are shortened by new deviations which take the old tortuous twists out of travel. Greater volumes of traffic can drive in more comfort and safety following road widening work, the construction of dual carriageways and the use of lane linemarking. Frustrating and profit-paring delays are eliminated by the provision of climbing lanes, the avoidance of steep grades, the replacement of railway level crossings and slow-moving ferries by bridges, and the diversion of through traffic away from suburban shopping centres and busy streets in country towns. One of the greatest benefits to our economy comes from the provision of bituminous road pavements to replace gravel or dirt surfaces. In fact, in the ten years 1961–71, the length of sealed roads throughout Australia was increased by over 70 per cent.

These improvements mean that motorists—from holiday makers to transport operators—are using less fuel for each kilometre travelled. Faster and more consistent travelling times mean more certainty about time-tables which, in turn, leads to better business organization and therefore more money saved. Long distances in Australia (as well as the bulky nature of most rural produce) make transport charges a large component of the total production costs paid by consumers and any reduction in these costs enables products to be sold more cheaply on home markets and more competitively overseas.

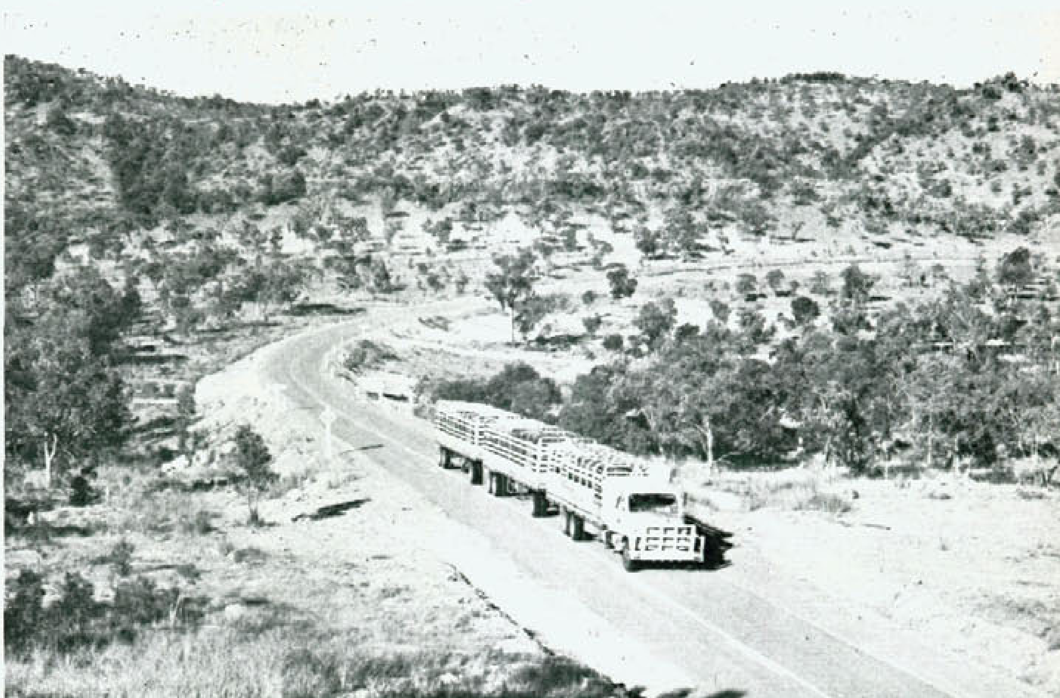
By contributing to the reliability and regularity of road transport, better roads have lessened the need for stockpiling of supplies in more isolated areas and have reduced the cost of goods *imported* from other districts. Wherever there are only poor road connections, high transport costs frequently act as a trade barrier to industry by restricting the market potential and thus retarding large scale production. On the other hand, efficient low-cost inter-regional road transport increases the number of selling centres and keeps the economy flexible and competitive.

National road growth is therefore an essential factor in gaining full advantage of *regional* development opportunities. Good interstate as well as intrastate routes have also been largely instrumental in fostering *product specialization* by widening, to the greatest extent, the marketing possibilities of small or newly-established industries. This is particularly important in Australia where there are relatively few people employed in rural primary production whereas high numbers participate in the *service* industries in urban areas.

The relationship between roads and national development is well expressed in the following American assessment and is relevant to anyone who is interested in either aspect of the Australian situation.

> *We were not a wealthy nation when we began improving our highways . . . but the roads themselves helped us to create a new wealth, in business, in industry, and in land*

Commercial transport forms a large percentage of the traffic using Australian roads. One of the largest road vehicles is the road train, such as this one on the Georgetown-Mt Surprise beef-road in far north Queensland.



values. So it was not our wealth that made our highways possible, rather it was our highways which made our wealth possible.

As well as being good for business, better roads bring more personal benefits to all road-users in the form of less driver strain and passenger tension. It is evident that, by keeping a continuing emphasis on the provision of good roads, Australia's State Road Authorities are implementing a serious strategy of significant consequence, which will win rich rewards and worthwhile community benefits for us all.

Finance—The Crucial Factor

Australia's increasing investment in the planning, reconstruction and maintenance of roads is clearly evident from the fact that Commonwealth, State and Local Government Authorities are now spending more than $900 million each year on these vital avenues of trade and development. This amount is almost 29 per cent of all capital expenditure by public authorities in Australia and represents more than one dollar per week.

Of the money expended on all road-works within Australia, approximately 40 per cent is provided by the Federal Government, 32 per cent by the State Governments and 28 per cent by Local Government and other Authorities.

The following table shows who spent the money and where. These and other interesting statistics are published in the NAASRA brochure *Australian Roads* which is issued every two years.

Increasing mobility of the private individual in recent years has placed fresh emphasis on tourism, and Tourist Roads such as No. 4020 in New South Wales are maintained to give access to lovely areas, in this case the picnic areas, lagoon and beach at Wattamolla.

City and Suburban Trends

Roads in major urban areas are generally only one part of a complex integrated system of public transport which may also include railway and waterway connections. However, in some cases, urban expansion is continuing at a faster rate than railway extensions and consequently transport to many new outer residential areas is often restricted to private motor vehicles and buses operating to and from the nearest established railway station. Roads therefore frequently have to bear the burden of coping with the immediate traffic needs of developing urban regions.

To alleviate this problem, the State Road Authorities have increased traffic flow and the carrying capacity of existing roads by widening, channelising intersections, adding turning lanes and building bus bays as well as supporting parking restrictions, such as peak-hour clearways. However, many miles of new high-volume, limited access highways and freeways are considered necessary to cope with the increasing amount of traffic and to allow through vehicles to be diverted away from areas of concentrated local activity. In its "Report on Roads in Australia—1973", the Commonwealth Bureau of Roads advised the Australian Government that an amount of $1,634 million was the warranted and feasible road programme needed for urban arterial roads in Australia for the period 1974–75 to 1978–79.

Improved and new urban main roads ensure maximum convenience for inter-suburban movements, widen the range of shopping, social and recreational activities and provide increased opportunities for employment. Where the labour force has easy access to a greater number of jobs across a city there can be more specialization. Consequently, productivity can increase and prosperity can rise. Increased road accessibility for motorists and bus commuters clearly results in less time wasted in travelling—and time saved means money saved or leisure gained.

In the urban areas of Australia, heavy reliance is placed upon bus transport as a means of moving the work force, especially in morning and evening peak

Payments on all roads during 1973–74 ($*M*)

State	By NAASRA Member Authority	By All Public Authorities
New South Wales	184	328
Victoria	143	206
Queensland	103	151
South Australia	67	68
Western Australia	70	86
Tasmania	29	29
Australian Capital Territory	19	19
Northern Territory	16	16
TOTAL	631	903

Source: NAASRA Table IV.

To Sydney residents this familiar pattern of intense traffic on Parramatta Road (State Highway No. 5), highlights the heavy volume of vehicles carried on existing road facilities.

periods. Each year throughout the continent, buses carry 800 million passengers, a large percentage of whom travel twice daily between their home and work centre or between home and railway station. Consequently, buses help keep urban economies in motion and are a most important user of the roads. In the future, higher standard roads will continue to make bus travel more attractive by improving comfort and reliability as well as shortening travel times.

The consistent growth of urban populations and commercial activities is bringing with it an allied expansion in traffic volumes and as this trend continues it is placing an increasing strain upon existing urban road facilities. Illustrating the effects of this growth, between 1971 and 2008, rural traffic is expected to more than double while, in the same period, urban traffic will probably increase, on an average, more than four-fold and, in some States, more than five-fold.

Developing Our Rural Resources

Throughout Australia's pastoral and agricultural areas, roads provide the arteries along which primary produce flows from farms to markets or to storage silos, rail depots, ports and manufacturing centres. Good roads which are located to give year-round access to the maximum number of properties (in spite of seasonal hazards, such as floods) provide communication links which are essential to the life and growth of all rural industries.

The heaviest traffic volumes on rural roads are registered, as might be expected, along the eastern section of the continent, within the natural watershed of the Great Dividing Range where productive capacity has been enhanced by wide-ranging irrigation schemes. This area has the advantage of being liberally sprinkled with established market outlets in metropolitan areas and large country towns.

In the realm of mineral mining, the strengthening of roads and bridges has been, in recent years, a feature of the upgrading necessary to cater for the trucking of heavy loads of raw materials to industrial centres.

The pattern of rural road usage and projected percentage increases are indicated in the table, page 75. It can be seen that the highest predicted rate of growth (in terms of vehicle kilometres travelled) is expected to be in the developing areas across the *top* half of the continent, extending from Western Australia, through the Northern Territory to Queensland. With advanced techniques being used in new mining, irrigation, agricultural and pastoral projects, the production and settlement possibilities of over one million square miles of once dormant land are being investigated with fresh enthusiasm. As new industries develop, roads will continue to be an essential factor in their growth, by allowing convenient access to new port facilities and by providing overland routes to centres of supply and sale.

Surrounded in South-East Asia by many countries with serious population problems, Australia will undoubtedly play an increasingly valuable role as a supplier of meat and wheat and other foodstuffs. Following further industrialization and technological advances, these countries will also be looking to Australia for more raw materials.

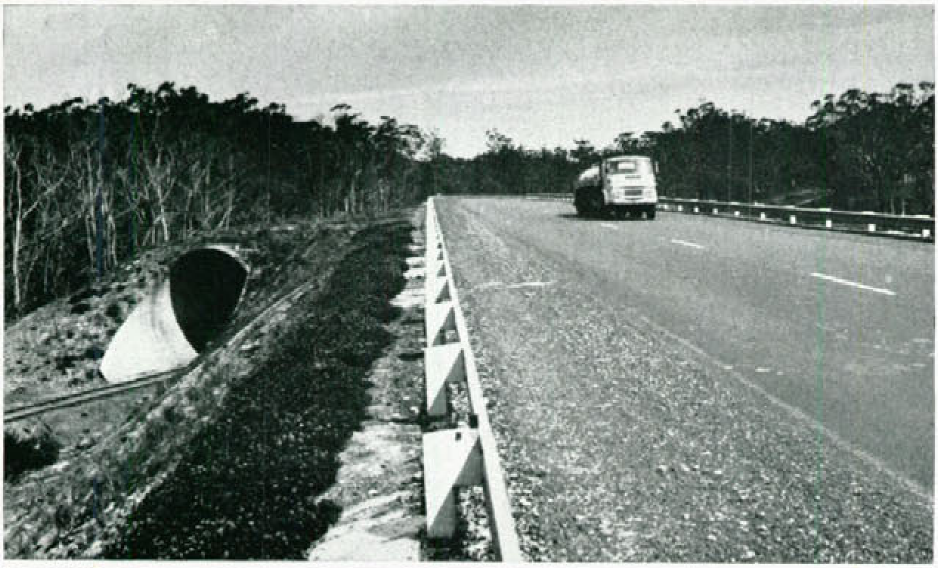
Roads therefore take an undeniably important part in upholding and strengthening Australia's vital position as an energetic and efficient trading nation. As an impetus to properly controlled and worthwhile development of our precious natural resources and primary produce, roads have few equals. They have always made a unique contribution to rural development and their function in the future is indispensable.

Developmental and Beef Roads

Australia's rural economy has been successfully stimulated in many districts by expenditure on *developmental roads*, which improve essential access routes to otherwise isolated centres of primary production. Attention is usually focused on relocation and realignment work, widening, bituminous surfacing and bridging to replace causeways subject to frequent flooding—and work is concentrated on areas where the greatest economic bonus for local farmers and other primary producers can be expected to follow the improvement of road links.

In conjunction with the railways, which they frequently serve, *developmental roads* have provided an intricate framework along which our rural and mining industries have been able to grow and flourish. They have also opened up the possibilities for quick and efficient communication by the many persons and organizations involved in supplying goods and services throughout country areas. However, as well as providing *direct* marketing and business benefits to all manner of country enterprises, improvements to these roads have resulted in marked *secondary* advantages of a social nature for those living in the sparsely settled regions through which they run. By bringing better connections with other centres, developmental roadworks have helped to lessen feelings of loneliness and to quicken the tempo of life for those in the outback. Thereby they have encouraged people to stay on in outlying areas rather than gravitate towards major towns, as has so frequently happened. This work is a direct contribution by the State Road Authorities to the quality of rural life throughout the nation and enables the "man on the land" to stay there without too many drawbacks or too much discomfort.

Beef roads can be regarded as an extension of the principle of *developmental*



The benefit brought to the community by road improvements is obvious here at Lyons, Victoria, where a railway level crossing has been eliminated, saving many travel hours each day for the total number of vehicles using this section of Princes Highway.

Connecting the major cities of Sydney and Melbourne, the Hume Highway has important economic implications but needs a large sum of money spent on reconstruction before it can approach international standard.

roads into the realm of roadworks for particular purposes. Work on *beef roads* is undertaken to specifically provide for the fast movement of cattle by trucks and trailers (usually referred to as "road trains") in order to overcome heavy stock losses, particularly during times of drought.

Following the allocation of finance by the Australian Government, the first programme of *beef road* construction was commenced in Queensland in 1961 and soon after in Western Australia, South Australia and the Northern Territory. Investigations had shown that the capital and maintenance costs of these roads would soon be matched by the value of additional beef available from more cattle marketed in better condition.

There are now over 6 400 kilometres of *beef roads* in Australia and, since 1961, over $109 million has been spent on them. This expenditure allows the rapid transport of cattle to agistment areas, as well as from breeding to fattening districts, and to markets. In this way, the adverse effects of seasonal extremes in weather and of long time-consuming droving operations are reduced. With other vehicles making use of new *beef roads*, the advantages accruing to the whole community are as widespread as the roads themselves.

COMPARISON OF ROAD, POPULATION AND MOTOR VEHICLE STATISTICS

Showing percentage increases between 1961 and 1971*

	Length of Sealed Road—km			Population			Number of Registered Motor Vehicles (including motor cycles)		
	1961	1971	Increase per cent	1961	1971	Increase per cent	1961	1971	Increase per cent
New South Wales ..	33 488	55 924	67	3 917 013	4 640 813	16	1 024 519	1 869 882	83
Victoria	34 829	52 008	49	2 930 113	3 530 735	20	892 144	1 416 764	59
Queensland	16 327	34 106	109	1 518 828	1 848 611	22	421 736	755 477	79
South Australia ..	8 586	15 738	83	969 340	1 184 571	22	312 775	502 805	61
Western Australia ..	14 728	25 278	72	736 629	1 045 755	42	223 021	475 252	113
Tasmania	3 025	6 062	100	350 340	392 515	12	98 068	167 904	71
Australian Capital Territory	522	1 038	99	58 828	150 622	156	18 643	69 966	280
Northern Territory ..	2 207	4 160	88	27 095	87 442	223	10 997	31 195	184
TOTALS	113 712	194 414	71	10 508 186	12 881 064	23	3 001 903	5 289 245	76

* These figures have been extracted from Commonwealth Year Books.

Tourism—A New Role for Roads

Following worldwide trends and increases in leisure time and spending power, tourism is fast becoming one of Australia's most important industries. International travel will certainly be the habit rather than the exception in the fast-approaching 21st Century and good roads to and through areas of high tourist interest will make travel within Australia more appealing to overseas visitors.

Road travel, as distinct from rail and air travel, allows tourists more flexibility in seeing our natural *wonders* and encourages more personal encounters between people of different nationalities. To many shopkeepers and businessmen, any influx of tourists means a welcome boost to sales of local products, and roads help to disperse these sales away from air and sea ports and to spread the associated profits more equitably throughout the community.

A significant proportion of motor traffic within and between States is already made up of vehicles involved in tourist and holiday excursions. This is clearly indicated by a 1969–70 study which revealed that 73 per cent of all holidaymakers and tourists in Queensland journeyed by private car. This figure underlines the fact that, to most Australians, car travel represents a popular, convenient, low-cost way of touring, with the maximum degree of independence and freedom.

Properly-planned and environmentally-blended roads enhance the tourist potential not only of well-known sights such as Ayers Rock, the Flinders Ranges and the Gold Coast but also open up opportunities for Australians and overseas visitors alike to see hundreds of less familiar *gems* of natural and historical interest. It is worth noticing that many modern bridges (such as the Batman Bridge near Launceston) and even sections of new artistically-designed and land-scaped freeways have become tourist attractions themselves.

Road authorities in all States are eager to co-operate with other responsible bodies in the development of the best possible means of access to places of growing tourist interest and in some States a separate classification of *Tourist Roads* has been introduced. *Tourist Roads* lead to all kinds of prominent and spect-acular landmarks (including lookouts, headlands, waterfalls, beaches, mountains and dams) as well as to historic sites which preserve precious parts of our vulnerable architectural heritage.

However, roadworks are not the only contribution to tourism made by Australia's roadbuilders. The well-being of visitors travelling along our highways is catered for in the provision of convenient roadside rest areas where motorists can relax in pleasant open-air surroundings, enjoy a picnic or view some nearby scenic feature. The costly collection of roadside litter along many highways and freeways helps to keep our countryside clean and beautiful while more and more treeplanting and land-scaping schemes add a fresh, attractive touch of greenery and colour to our major avenues of travel.

With constant co-operation and co-ordination in the fields of planning, construction and research, the skills of Australia's individual State Road Authorities have risen to new and exciting levels, and recent achievements and innovations have been dramatic. We have the capacities and, given adequate finance, we can confidently answer the challenge of building and maintaining the modern integrated road network upon which Australia's national development and the continuing welfare of our whole community are vitally dependent.

This is the second in a series of brochures being published by THE NATIONAL ASSOCIATION OF AUSTRALIAN STATE ROAD AUTHORITIES to encourage public interest in the work being undertaken by its Member Authorities. These brochures will outline some of the social, economic and environmental issues associated with present-day road construction programmes. They will emphasise the many benefits which accrue to the community following the provision of better roads and will highlight the important role played by roads as one part of an overall transportation system.

The title of the first brochure was "The History and Challenge of Road Trans-port" . . . and subsequent subjects will include Roads and . . . Public Transport, Safety, Urban Communities, Town By-passes, Housing Sub-divisions, Public Utilities, Recreation and Tourism, Ecology, Pollution, Traffic Noise and Pedestrians.

The series will be interesting and informative, and will give valuable comments on matters which are of vital importance to all members of the community.

We hope you will read them.●

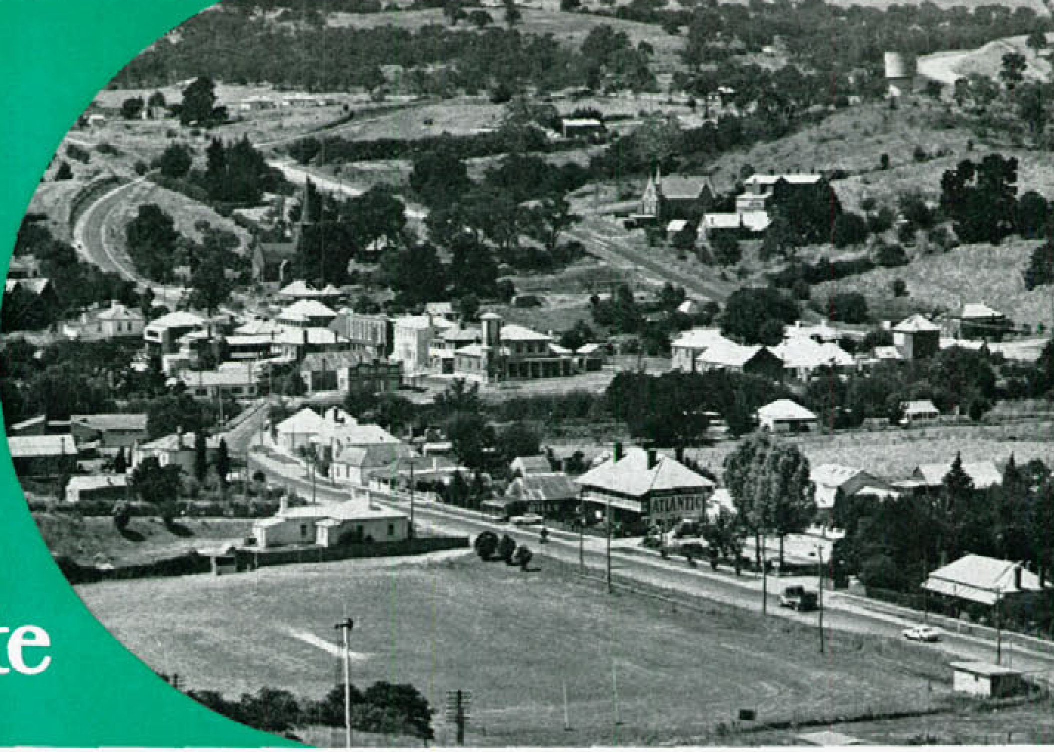
ESTIMATED TRAFFIC GROWTH—1971–2008

Millions of Vehicle Kilometres Travelled Per Year*

	In Rural Areas			In Urban Areas			In All Areas		
	1971	2008	Increase per cent	1971	2008	Increase per cent	1971	2008	Increase per cent
New South Wales ..	9 117	21 058	131	18 570	80 467	333	27 687	101 525	267
Victoria	5 639	11 964	112	15 500	65 940	325	21 139	77 904	269
Queensland	5 234	14 539	178	4 751	24 583	417	9 984	39 122	292
South Australia ..	2 580	5 594	117	3 355	19 558	483	5 935	25 152	324
Western Australia ..	2 857	9 947	248	4 408	22 592	412	7 265	32 539	348
Tasmania	1 221	3 301	170	1 178	4 208	257	2 400	7 509	213
Australian Capital Territory	53	409	662	893	6 762	657	946	7 171	658
Northern Territory ..	439	4 664	962	..	..	..	439	4 664	962
Australia (TOTAL)	27 140	71 476	163	48 655	224 110	359	75 795	295 586	290

* These estimated figures represent the sum of the distances travelled by the motor vehicles in each region for the years specified.

Highway deviation at Carcoar historic site



The small town of Carcoar, is situated about 15 km south of Blayney on the Mid Western Highway (State Highway No. 6). On 11th February, 1974, the National Trust gave the town a "Classified" rating, the higher of the Trust's two ratings.

The historic importance of Carcoar has been acknowledged for many years, along with the necessity to improve the fairly tortuous route of the Mid Western Highway through the town. This improvement will become reality for motorists when a 3·5 km long deviation of the Mid Western Highway, around the main streets of Carcoar, is completed soon. The many factors influencing its design and construction are detailed here. Important to our story, too, is the short summary of historical events which have contributed to the town's preservation as part of our national heritage.

DESIGN OF THE DEVIATION

Prior to 1940, several schemes for a deviation within the town of Carcoar were considered. During 1940–41, a short deviation of the Highway was constructed to improve the grades and eliminate several dangerous curves. However, the final descent from the east through the main streets (which form part of the Mid Western Highway) was still difficult, the grade remaining very steep at 10·2% for 183 m with a 90° bend at the bottom before again turning through a 70° bend to cross the Belubula River on a narrow timber bridge.

The deviation now under construction is of superior design, carefully planned to improve safety for travellers using the Mid Western Highway through this area.

Of the many routes considered during the initial investigation most were unsuitable for one or more of a number of reasons. There was obviously a need to avoid interference with Carcoar's historical buildings while avoiding the railway line on the western side and the Belubula River winding through the town. Added to this was the hilly nature of the terrain in the area. The location was eventually confined to a narrow band of land on the eastern side of the town.

From an engineering point of view, the most suitable route passed close to the historic public school. However, as one aim of the work was to preserve the historical entity of the town, an alternative but more costly route was selected, to meet, as far as practicable, local requirements and to accord with the wishes of the Lyndhurst Shire Council.

Design of the deviation allows for a 100 km/h travel speed on a pavement width of 7·4 metres and a formation width of 13·4 metres. The deviation will be proclaimed a motorway over 2·8 km of its total 3·5 km length. The work incorporates 2 km of access roads and 2·9 km of overtaking lanes. The maximum grade is 7·2% and the minimum curve radius is 670 metres.

To assist in the design of earthworks and estimation of costs, a seismic survey was undertaken along the selected route of the deviation. Of the material encountered during construction, 97% was earth or rippable rock and only 3% required blasting, which compared favourably with the results of the survey.

All works, with the exception of the bridges, have been undertaken by the Department's own organisation centred at Orange Works Office.

BRIDGES

The narrow wooden bridge crossing the Belubula River at Carcoar was constructed in 1876. It is a 51·2 metre long timber beam structure approximately 6·1 metres between kerbs with a 1·5 metre wide footway. Over the years, the combination of steep approaches and narrow bridge has contributed to many accidents, including several fatalities.

The new bridge over the Belubula River, designed by the Department, is on a 760 metre radius horizontal curve and on a 365 metre vertical sag curve. It is a five span, precast, pretensioned, concrete girder type structure with spill-through abutments. The width between kerbs is 9 metres, the clear width of the footway is 1·5 metres and the overall width is 11·8 metres. The superstructure is supported by single column piers. Each column, which is of an elliptical section, is supported by a pile cap with three 0·9 metre diameter cast-in-place piles of an average depth of 4·9 metres. Each span is approximately 19·5 metres long and comprises 13 precast, pre-tensioned girders which were manufactured by the contractor, Dyson Holland Concrete Pty Ltd of Narromine. Excluding the girders, about 650 cubic metres of concrete were used in the construction of the bridge. Asphaltic concrete 65 mm thick has been laid on the concrete deck. The contract price for the construction of the structure was $211,000.

The deviation is carried over Eulamore Street on a three-span, 45·9 metre long overbridge. The bridge was designed by the consulting engineers Bull Ferranti and Collier Pty Ltd of Sydney and built by Enpro Construction Pty Ltd, Tamworth, at a contract price of $96,225. It is built on a 760 metre radius horizontal curve and on a 6·3% grade. The width between kerbs is 9 metres and the overall width is 10·2 metres. The foundations are cast-in-situ piles at the abutments and 1·8 metre square spread footings at the two piers. The piers are of two column frame type, with the rectangular section columns tapering from 0·8 metres at the top to 0·6 metres at the bottom. An unusual feature in the construction of this bridge is the use of cardboard void tubes to reduce the quantity of concrete in the cast-in-situ deck. The deck is of 900 mm average depth and tubes with an outside diameter of 400 mm and up to 12·2 metres long were used.

Because some of the void tubes were continuous over the length of the bridge it was desirable for the deck to be placed in one pour. This became the largest one-day pour ever attempted by the Department in the Central West using 276 cubic metres of concrete with transit trucks being drawn from as far afield as Orange, Bathurst, Parkes, Lithgow and Cowra.

The third bridge structure on this deviation is the small, but important bridge at Mt. Macquarie Road. This road provides access to the town from adjacent farming lands and traffic is carried under the motorway.

Bull Ferranti and Collier Pty Ltd, also designed this bridge, which is a 19 metre long, single span, reinforced concrete slab, portal frame structure. It was constructed by A. Cipolla and Co. Pty Ltd, Sydney, at a contract price of $129,775. Its overall width is 14·9 metres and it is 13·7 metres between kerbs. It is on a 35° skew and a 6·3% grade and the abutment walls are supported on a total of 58 circular piles which were bored to an average depth of 5·8 metres.

ROADWORKS

The deviation involves a balanced design of 189 000 cubic metres of earthworks. Most of the material encountered has been of good quality (approximately 125 millimetre cover) and where it could not be removed by scrapers it was ripped by D8 and D9 dozers.

DRAINAGE

The major drainage structure in the deviation (with the exception of the bridges) is a 3·8 metre diameter multi-plate Armco culvert on a 30° skew, 71·3 metres long and under 16·2 metres of fill (invert to centreline). It is the largest corrugated steel pipe culvert constructed in the Central Western Division and was built by the Department's direct control forces at an approximate cost of $28,000.

Access from the deviation to the town of Carcoar is via Icely Street. The reconstruction of this access road required a structure over Carcoar Creek in the form of a 2-cell 3 x 3 metre reinforced concrete box culvert, 24 metres between kerbs and on a 15° skew. It was built by Herbert Constructions Pty. Ltd., of Dubbo at a contract price of $32,264. This structure replaced a narrow 6·1 metre span timber bridge which was in poor condition.

Approximately 1·4 km of concrete catch drains were constructed and 2·4 km of kerb and guttering provided together with 1·4 km of concrete dished gutters adjacent to earth cuttings.

Because the site is hilly with a heavy run-off, special attention has been paid to culvert inlets and outlets. At the outlets of most of the pipes, energy dissipators (or stilling ponds) have been constructed to reduce scouring on the downstream side of culverts with potentially heavy water flow. These consist of two concrete chambers 3 metres and 1·8 metres long respectively with an 0·2 metres baffle wall at the downstream end of each chamber. The invert level of the second chamber is approximately 0·6 metres below the first. The area of the stream bed beyond the second chamber is being protected with stone pitching for a further length of 3 metres as are the inlets to all culverts.

On the western extremity of the deviation the roadway passes over a railway tunnel, the roof of which is approximately 9·1 metres below the table drain. This section of the deviation is in approximately 7·5 metres of cut and, due to the nature of the rock, extreme care was taken during construction to avoid damage to the walls of the tunnel which are old and already extensively cracked. Although the cut involved the excavation of some hard rock, explosives were not used and all material was excavated by ripping with dozers.

ENVIRONMENTAL CONTROL

The indigenous surface material of the area is very prone to scouring and this feature was considered during design. The Soil Conservation Commission advised on the most appropriate method of treating the exposed soil and their suggestions incorporating scour treatment, batter slopes and grass and tree planting were implemented at a cost of $22,475.

Hydromulching has been carried out on some batter slopes and has proved to be very effective in establishing an early grass cover and in preventing scour.

The tree planting scheme was prepared by officers in the Principal Architect's Section within the Department to complement the historic nature of Carcoar. Species such as elm, willows and oaks, were chosen to blend into the natural setting of the village, supplemented by plantings of several native eucalypts and acacias.

The estimate for the cost of the deviation, including bridgeworks is approximately $1,500,000 or an average cost of $428,600 per km.

The second oldest hospital west of the Blue Mountains is at Carcoar, where it was constructed in 1861–62

THE FASCINATING PAST

SETTLEMENT

Carcoar's distinction, from a historical point of view, is its age. It is the third oldest town west of the Blue Mountains, and contains many old buildings with significant historical and architectural value.

A parade of interesting personalities has been woven through the colourful local history of this small settlement beside the banks of the Belubula River.

The first white visitors are believed to have been Surveyor George Evans and his party who camped in the area on 17th May, 1815. Several graziers occupied the area for short periods between 1821 and 1828, the first land grant being 560 acres made to Thomas Icely on 26th May, 1829. Ten years later, the Government Gazette of 29th August, 1839, officially recognised the establishment of a town at Carcoar.* The Municipality of Carcoar was formed on 1st February 1879, and in November 1935, the town was included in the Shire of Lyndhurst.

Thomas Icely enlarged his original land grant many times over and it eventually became "Coombing Park". He built his first homestead on the bank of the Belubula River opposite the village reserve then known as "Carcuan".

Almost concurrent with Icely's property development, his brothers-in-law, Frederick John and William Montague Rothery obtained land grants nearby and named their properties "Cliefdon Springs" and "Cliefdon". This family group were the pioneers of the pastoral industry in this section of the Belubula Valley, then the extreme outpost of the Colony's western boundary and known as the Coombing District.

Sales of allotments of land in the town during 1840–41 brought new settlers and the town grew so that by 1850, its population had reached about 500 and there were three coaches to Bathurst every week. Edward Hargraves' discovery of gold in the Orange district in 1851 brought further changes. Although gold was not discovered at Carcoar for another twenty years, the town was affected by the passing trade of men on their way to places linked to the magic word "gold". For a brief period around 1871, Carcoar experienced its own gold rush but this declined prematurely due to the rich finds at Parkes, Gulgong and Hill End, before seeing some action again in the 1880's.

A setback in the growth of Carcoar came in 1876 when the Western Railway Line was completed between Bathurst and Blayney. It was intended to continue the line further, but Carcoar languished for twelve years until the line caught up with the town. Travellers to Carcoar had to suffer extremely bad roads during this time and the final arrival of the railway line in 1888 apparently made little difference to the progress of the town by comparison with others.

The nearby towns of Cowra and Blayney have mitigated any great increase in population at Carcoar, while the Bathurst-Orange growth centre will soon be a populous neighbour. Carcoar, it seems is to remain forever as it is today, a charming reminder of a 19th century village.

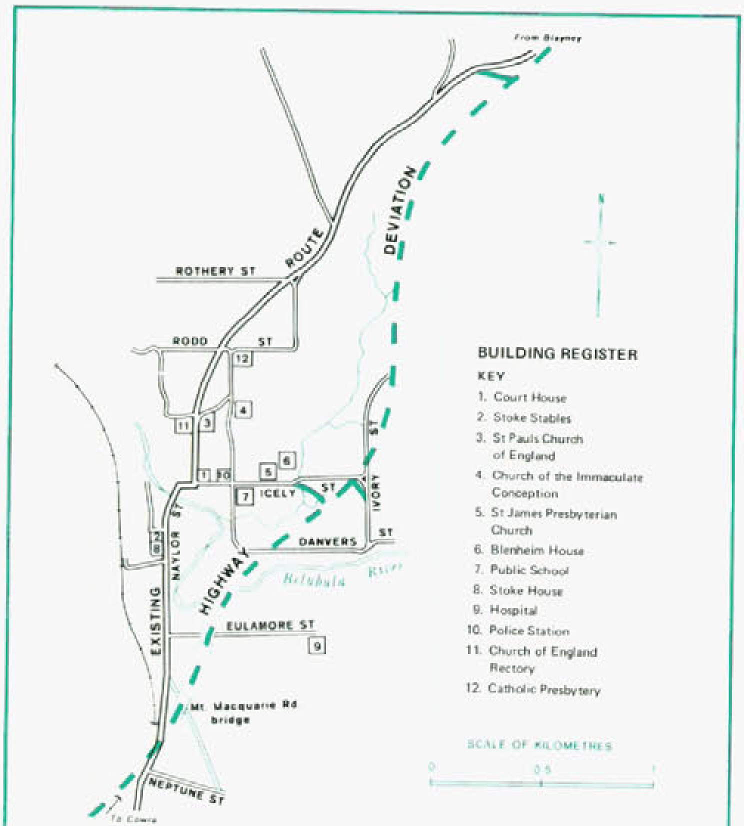
* The name "Carcoar" is believed to have come from the sounds made by birds in the area, or the name of an early settler possibly called "Carcoran". "Belubula", an Aboriginal word means "Stoney river".

(Left) One of the major reasons for constructing the deviation to take through traffic out of the main streets of Carcoar was to avoid the sharp curve of the Mid-Western Highway where traffic comes off the Belubula River Bridge into Icely Street and then almost immediately turns sharply into Belubula Street.

Three churches, illustrated below and across the page, are amongst prominent historic buildings. (Far Right) The spire of St Pauls Church of England dominates the town. Designed by famous architect Edmund Blacket (1817–83) the church holds a National Trust "A" classification. The foundation stone was laid on 27th January, 1845, but the tower and steeple were added in 1874–75.

(Centre right) St James Presbyterian Church, built in 1861.

(Below) The Roman Catholic Church of the Immaculate Conception was completed in 1870. It has an unusual cooling system which allows air from outside to pass through cavities in the stone walls and enter the Church through trapdoors in the window sills.



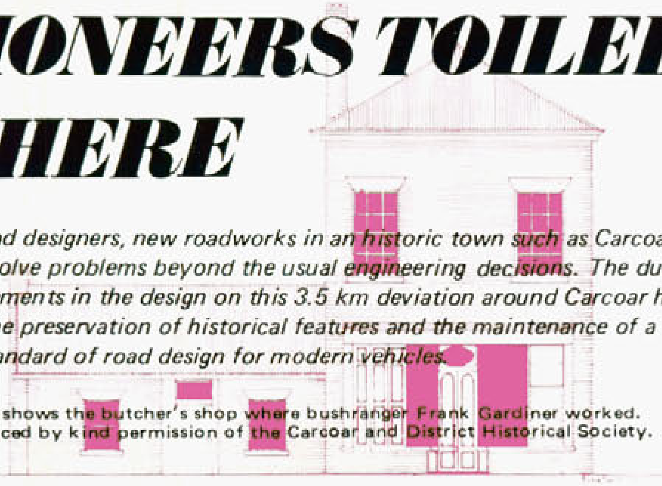
(Left) A general view of the Carcoar Deviation showing the plentiful growth of several species of non-indigenous trees in the area. This has led to the selection of weeping elms and willows, as well as the native wattles and eucalypts, for landscaping the deviation.

(Above) An energy dissipator at the outlet to a culvert pipe reduces scouring by breaking the flow of water.

(Right) The new crossing of the Belubula River, and, in the background, another bridge crossing Eulamore Street, are both near completion.

PIONEERS TOILED HERE

For road designers, new roadworks in an historic town such as Carcoar can involve problems beyond the usual engineering decisions. The dual achievements in the design on this 3.5 km deviation around Carcoar have been the preservation of historical features and the maintenance of a high standard of road design for modern vehicles.



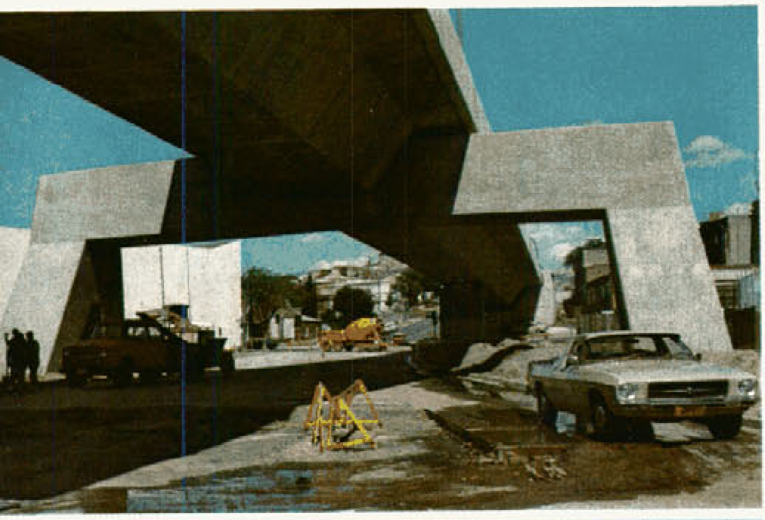
Drawing shows the butcher's shop where bushranger Frank Gardiner worked. Reproduced by kind permission of the Carcoar and District Historical Society.

(Above) The Commercial Bank was the site of a holdup by bushrangers during 1863, its first year of operation.

(Right) Built of local stone by convict labour in 1849, Stoke Stable is reputed to be the oldest building standing in Carcoar. Originally the stable for the adjoining "Stoke Hotel", now "Stoke House", it has been extensively renovated by Carcoar and District Historical Society, with protective galvanised iron laid over the original wooden shingles.

(Below right) A fine example of early colonial architecture is the Court House, opened on 10th November, 1882. Its judicial use ended in 1936.

BIG CHA
at THE CR



(Top left) Inside the "tunnel", shown here still in its open cut stage, but which was closed over in late March this year.

(Above) Interesting shapes in concrete beneath the railway viaduct. This portal frame replaces a single pier and spans the roadway which will carry westbound traffic.

(Centre) Progress towards completion of the work is best seen from the air. Both the western and eastern portal bridges of the future tunnel are visible in this photograph.

(Top right) The western portal of the Kings Cross Road Tunnel at the top of William Street where the famous "Cross" itself is located.

(Centre right) The Eastern Suburbs Railway is bringing another change to the face of the area surrounding Kings Cross. Rail commuters will have a fine panorama of the city as they travel along this railway viaduct.

(Bottom right) At the eastern portal of the tunnel, pedestrians will cross the busy roadway on this pedestrian bridge, now under construction near Roslyn Street.

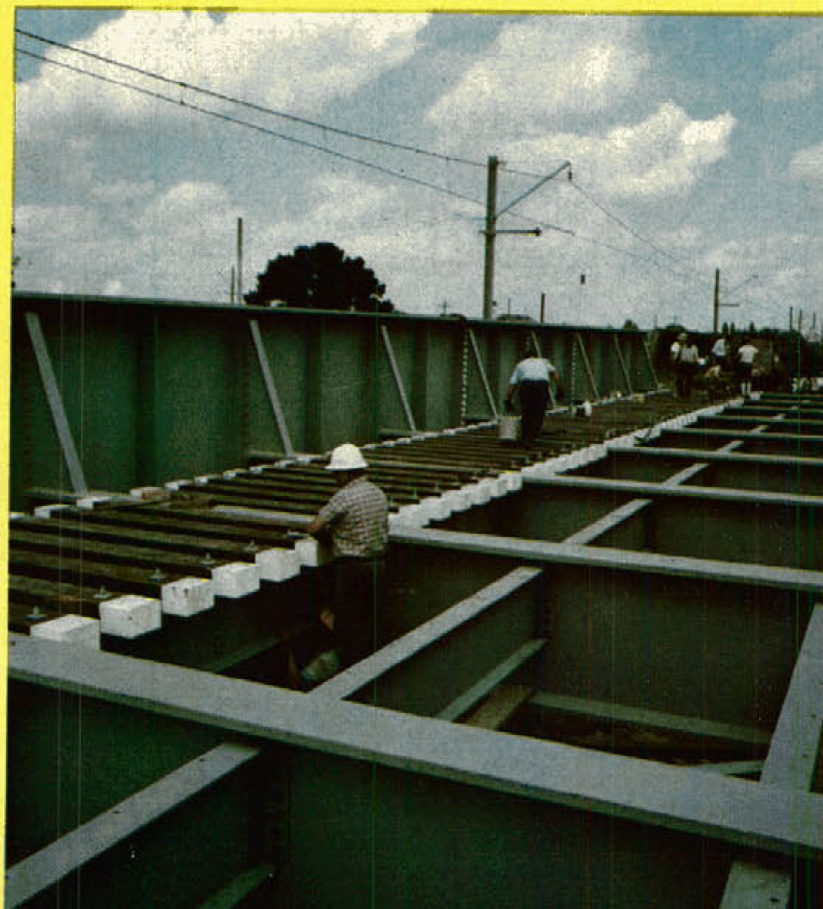
GES
OSS

The worn footpaths and familiar traffic patterns along a section of famous William Street, Kings Cross, have disappeared. A new William Street is emerging as construction progresses on Kings Cross Road Tunnel.

(Above) Silverwater Road crossed by a completed Freeway bridge.

(Left) Looking west along the Freeway the two railway bridges to the abattoirs can be seen in the foreground, further west the twin bridges over King Avenue, and in the distance, the bridges at Hill Road and the bridgeworks at Haslams Creek.

(Below) Laying the railway track on the eastern railway bridge to the abattoirs the day before the bridge was moved into correct position.



Current construction on the Western Freeway

Work now under way on the Western Freeway (F4) is centred on the 6·5 km length between Homebush and Clyde, in Sydney's Western suburbs. At a future date, adjoining lengths of Freeway will be constructed easterly towards the City and west to Mays Hill, so bringing the Western Freeway closer to its objective as a through route for traffic travelling between Sydney and the Blue Mountains.

When the Homebush–Clyde section is completed, traffic will use it to by-pass a nearby length of busy Parramatta Road (State Highway No. 5).

At Homebush it is proposed that the traffic will enter and leave the Freeway on a temporary connection. Travelling west, the Freeway will cross Saleyards Creek Stormwater Channel and passes through land once used as grazing and holding paddocks by the Metropolitan Meat Industry Board. The Freeway will then pass under two railway lines which lead into the State Abattoirs and Meatworks and cross King Avenue at Lidcombe. From King Avenue, the Freeway will pass through a rapidly developing industrial area before crossing Hill Road and Haslams Creek Stormwater Channel. After crossing Silverwater Road (Main Road No. 532), it will then cross over Duck River to its temporary terminal near the Clyde Showground. Where the current construction terminates at Clyde, traffic will be able to proceed to Parramatta Road, or along Berry Street to Rydalmere Avenue (Main Road No. 309) and connect with the Parramatta By-Pass which is also under construction.

The combination of the State Abattoirs and Meatworks, and the Farm Produce Markets makes this area of particular importance to primary producers supplying Sydney. Although rail links are available to both these establishments, the importance of road transport to the area, is obvious.

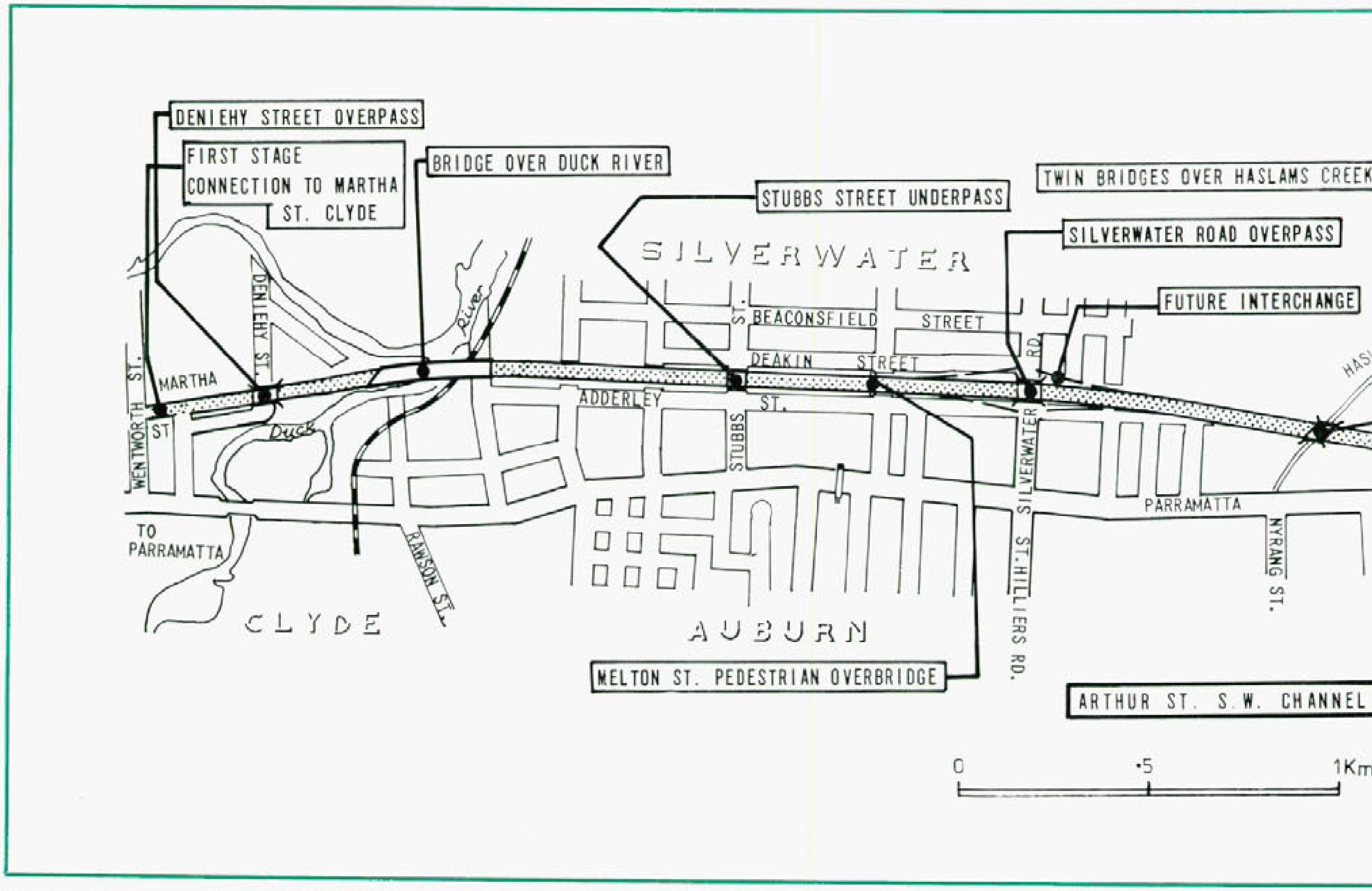
Road Design Details

The design which is to 100 km/h standard provides for two-lane carriageways, separated by either a depressed median 17 metres wide of a 1·2 metre wide mountable kerb, depending on location. The lanes on each carriageway will be 3·4 and 3·7 metres wide with sealed shoulders of 2·4 metres on the right hand side and 3·1 metres on the left. At a later date, a second stage of construction will increase the number of lanes in each direction to four, all 3·7 metres wide and separated by a 2·4 metre wide median with mountable kerb.

(Top)—Western railway bridge to the State Abattoirs and Meatworks crossing the route of the Western Freeway.

(Centre)—Twin to the previous bridge is the eastern railway bridge. The prefabricated span of the superstructure is being pulled into position, and

(Right)—In final position, ready for the connection of the railway line.



Western Freeway—Homebush/Clyde

The design provides for a maximum depth of cutting of 11 metres and a maximum fill height of 10 metres. Earthworks on this length from Homebush to Clyde total 788 000 cubic metres of which 336 000 cubic metres will be borrowed off the work. Batters in cuts and fills have been designed at 5 : 1 for heights less than 1·8 metres and 2 : 1 for heights of 1·8 metres or more. Normal pavement crossfall is 2·5%.

Horizontal alignment in the design varies from a minimum curve radius of 760 metres to a maximum of 6 000 metres. Longitudinal grade varies from a minimum of 0·5% to a maximum of 3·5%.

The cost of these roadworks including public utility adjustments, is estimated to be about $9,300,000 which is broken up into the following broad categories:

	$
● Drainage	590,000
● Stormwater channels ..	290,000
● Service tunnels for public utilities	380,000
● Earthworks including landscaping	3,000,000
● Selected sub-grade layer ..	530,000
● Miscellaneous, including fencing, guardrail and mountable kerbs.	510,000
● Pavement	1,750,000
● Public utility adjustments..	2,250,000

In addition to major bridgeworks there are a number of important structures which form part of the roadworks. These include stormwater channels at Boundary Creek, Bachell Avenue and Derby Street and service tunnels for public utilities at Verley Drive, Marlborough Road, Telopea Avenue and Day Street.

Consulting engineers, Rankine and Hill, were involved in the design of the roadworks and many of the bridges on this section of the Freeway.

Road Construction Progress

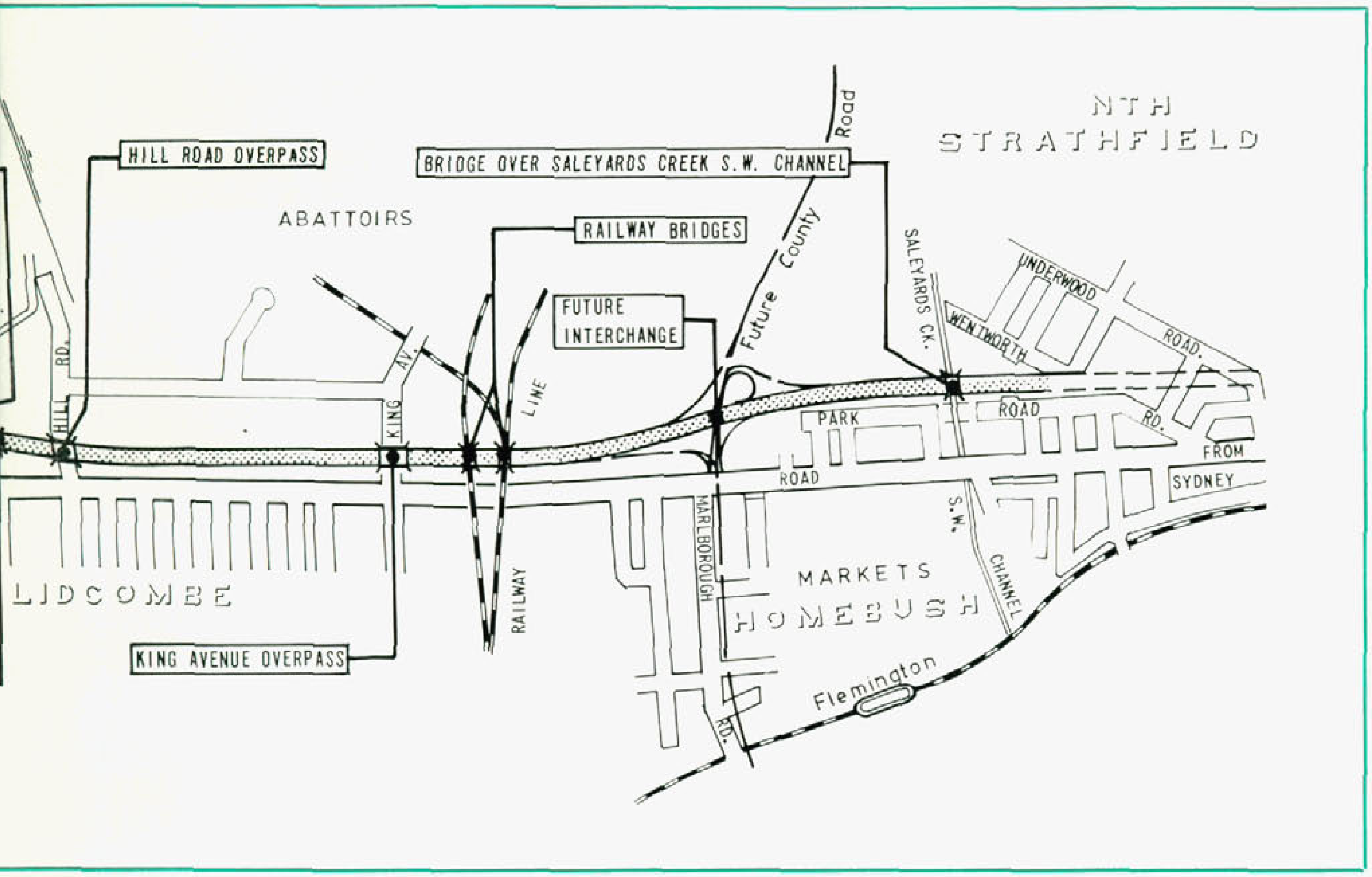
At present, earthworks are nearing completion between Saleyards Creek and Haslams Creek. At the eastern approach to the new bridge to carry the Freeway over Duck River, it has been necessary to acquire and fill a small portion of a privately owned disposal site for industrial waste (known locally as "the brick pit"). The hole required 230 000 cubic metres of fill to bring it up to natural surface level. Fill is also being placed at Clyde on the western approach to Duck River Bridge.

Work has been proceeding since 1973, but the complex public utility adjustments and protracted negotiations to obtain land have tended to slow progress.

Bridgeworks

Bridges will be required at 12 locations and are expected to cost a total of about $7·7 million. At many of these locations, twin bridges will be constructed in the first stage. Later in the Stage II, construction, these bridges will be joined to accommodate eight lanes of traffic and shoulders.

Twin bridges over Saleyards Creek Stormwater Channel are each 20·1 metres wide and 9·9 metres long in a single



span. The abutment and wing walls are supported on cast-in-place piles. Each bridge consists of T-15 prestressed girders with an infill concrete deck. Construction is by direct control, at an estimated cost of $200,000. The twin bridges have been designed to accommodate eight 3·7 metre lanes separated by a 2·4 metre wide concrete median.

Eastern railway bridge carries a single line of rail traffic over the Freeway from the State Abattoirs and Meatworks. The bridge is 65·2 metres long consisting of two spans of equal length. The possibility of an additional railway line being constructed by the N.S.W. Public Transport Commission has been allowed for in the design. The bridge is founded on bored piles with reinforced concrete headstocks. The superstructure consists of plate web girders fabricated by the Public Transport Commission at their Chullora Workshops. Construction is by direct control at an estimated cost of $502,000, part of which will be met by the Public Transport Commission.

Western railway bridge also carries a single line of rail traffic over the Freeway to the State Abbatoirs and Meatworks. The 57·6 metre long bridge, with two spans of 27·7 and 29·9 metres, has foundations on bored piles with reinforced concrete headstocks. The superstructure is plate web girders fabricated by the Public Transport Commission. Retaining walls faced with sandstone contain the spill through abutments. As with the eastern railway bridge, construction is by direct control but the estimated cost is slightly lower at $350,000.

Construction of both railway bridges proceeded without interruption to rail traffic. The drilling rig for the bored piles was located beside the rail track and later the railway lines were shored to allow excavation and construction of the concrete headstocks. After completion of the superstructure, one span was erected beside the railway line from where it was rolled onto the bearings. The procedure was repeated for the second span about six weeks later while in the meantime, rail traffic had commenced crossing the first span.

King Avenue Bridges at Lidcombe consists of twin bridges each 14 metres wide, 44 metres long with three spans of 9·5 metres, 25 metres and 9·5 metres. The abutments are supported on cast-in-place piles and the piers on spread footings. The deck of each bridge is supported on six precast prestressed concrete box girders. The end span box girders are 13·6 metres long and cantilever over the piers. The centre drop-in box girder is 16·8 metres long. The design of the bridge provides for two 3·7 metre lanes, one 2·4 metre shoulder and one 3·1 metre shoulder on each carriageway with provision for future widening in the median area. The bridges were built under contract by Pearson Bridge (N.S.W.) Pty Ltd at a cost of $302,000 and were completed in January, 1972.

Hill Road Bridges cross the Freeway on a skew. They are twin bridges each 14 metres wide, 46 metres long with three spans of 9·6, 27 and 9·5 metres. The abutments are supported on cast-insitu piles and the piers on spread footings. The deck of each bridge is supported on six precast prestressed concrete box girders. The end span box girders are 13·6 metres long and cantilever over the piers while the centre drop-in box girder is 19·2 metres long. Design of the bridges provides for two 3·7 metre lanes on each carriageway with shoulders of 2·4 and 3·1 metres and with provision for future widening in the median area. The bridges were built under contract by Pearson Bridge (N.S.W.) Pty Ltd at a cost of $338,000 and were completed in May, 1972.

Structure over Arthur Street Stormwater Channel consists of a single cell culvert 6·1 metres wide, 2·3 metres high and 71·3 metres long over an existing stormwater channel. The culvert has a cast-in-place base and walls, with prestressed girders forming the roof section. The work was carried out by direct control at a cost of $82,000 and was completed in October, 1973.

Bridges over Haslams Creek Stormwater Channel. The bridge on the westbound carriageway consists of a three span bridge 69·5 metres long with spans of 21, 27·5 and 21 metres. The bridge is 12·8 metres wide and includes two 3·7 metre lanes with 2·4 and 3·1 metre shoulders. The bored pile foundations have reinforced concrete headstocks and the deck is supported on eight prestressed concrete "I" girders. The work was carried out under contract to Peter Verheul Pty Ltd at a cost of $190,000 and was completed in November, 1974.

The bridge on the eastbound carriageway will be constructed by direct control and is similar to the westbound bridge. Construction cannot commence until public utilities are relocated onto the new Haslams Creek services bridges.

A services bridge over Haslams Creek Stormwater Channel is being constructed under contract to Peter Verheul Pty Ltd, at a cost of $100,700. This bridge will allow the relocation of public utility services clear of the proposed eastbound Haslams Creek road bridge. The services bridge is a two span steel bridge 70·7 metres long with the abutments and pier supported on cast-insitu piles socketted into rock. The services and three walkways are supported on cross beams. All steel work will receive suitable protective treatment.

Bridge over Silverwater Road is a continuous inclined pier structure, 52 metres long, 20 metres wide, with three spans of 11·4, 29·2 and 11·4 metres. The abutments are supported on cast-in-place piles and the piers on deep pad footings, stressed to the bed rock by anchors. The superstructure is made up of both cast-in-place and precast elements post-tensioned to form a continuous deck. A cast-in-place section forms the end span and cantilevers over the inclined piers. Ten precast prestressed drop-in girders, 22·6 metres long, are used to complete the centre span. The bridge accommodates four 3·4 metre lanes, with 2·4 and 3·1 metre shoulders. The four lanes are separated by a median 1·2 metres wide. Pearson Bridge (N.S.W.) Pty Ltd constructed the bridge for the Department at a cost of $378,000, completing it during November, 1972.

Between Silverwater Road and the Bridge over Duck River, grade separated crossings will be provided to cater for pedestrian and vehicular traffic.

Bridge over Duck River will be 300 metres long, with nine spans; one at 27·4 metres, five at 36·5 metres, one at 27·4 metres, one at 35·1 metres and one at 27·4 metres. Three rectangular reinforced columns on bored piles will form the piers. The eastern abutment is a reinforced concrete counterfort wall anchored to rock. The western abutment is a spill-through counterfort on pile foundations. Both abutments will be constructed to the full width of the ultimate Freeway while the remainder of the bridge will accommodate the four lanes required in Stage I construction. The superstructure will consist of 14 broad flanged girders made in segments 5·2 metres long and stressed together. The top flange section is cast-insitu. The bridge will have an overall width of 22 metres, with two 3·4 metre traffic lanes in each direction separated by a 1·2 metre median. Each carriageway will have 3·1 and 2·4 metre shoulders.

Deniehy Street Bridge is a three span continuous voided slab bridge. The bridge is skewed and of varying width with spans of 10·1, 21·3 and 10·1 metres. The abutment and piers are supported on cast-insitu piles. The superstructure consists of two adjacent cast-insitu slabs with circular voids in the longitudinal direction, connected with a reinforced concrete infill slab. The slabs are fully prestressed in the longitudinal direction and partially prestressed in the transverse direction. The bridge will cater for the ultimate westbound formation of the Freeway including the temporary off-load ramp to Wentworth Street, Clyde, and for that immediate purpose will have

Portion of the "Brick Pit", on the eastern approaches to Duck River Bridge, is being filled to the natural surface level.

shoulders of 2·4 metres each, four 3·7 metre lanes, divided by median of varying width, and additional 3·7 metre lane.

Public Utilities

A considerable number of public utility adjustments are required and these complex alterations will cost about $2,250,000. Public utility adjustments have been in progress for some time and they are expected to continue until the end of 1976. The adjustments form a complex interdependency between property acquisition, roadworks and bridgeworks.

The route of the Freeway currently under construction is crossed three times by a major utility easement—at the eastern end of the Freeway; Telopea Avenue, Lidcombe, and Day Street, Auburn. This utility easement contains up to ten different types of public utilities belonging to five different authorities. The easement crosses the Freeway through four service tunnels which are about 3 metres wide and 2 metres high and range in length from 57 to 120 metres. The tunnels have been constructed across the full width of the Freeway. The utility authorities will have continuous access to their respective services to obviate the need for these authorities to enter the Freeway to carry out maintenance on their services. In addition to these four major tunnels there will be four private service tunnels to carry additional utilities under the Freeway.

Once the Haslams Creek services bridge is completed, a further series of public utility adjustments will commence. Some services will be relocated from Adderley Street, Auburn through the Day Street services tunnel and across the services bridge at Haslams Creek. Other utilities will run from Wetherill Street, Auburn parallel to the north side of the Freeway and then across Haslams Creek services bridge. The adjustments in this area are expected to take up to 12 months to complete. Following these adjustments, further services in Wetherill Street can be lowered and encased in concrete to allow the commencement of a cutting across Wetherill Street.

To date, approximately 40% of the services have been relocated. The adjustments through the Telopea Avenue services tunnel which have involved the Australian Gas Light Company and the Sydney County Council are nearing completion. Utilities in side streets are being adjusted progressively. Following the adjustments through Day Street Services tunnel and over Haslams Creek services bridge, adjustments will be carried out at the eastern end of the work.

The bridges carrying the Freeway over Hill Road.

Job Planning and Control

The interdependency between acquisition of properties, public utility adjustments, road construction and bridge construction, makes Freeway planning a complex task, particularly when the route passes through an established residential/industrial area, such as Homebush to Clyde. Initially, construction on this section of the Western Freeway was commenced on a small scale with some selected bridgeworks being carried out. More involved planning preceded the progression of the work to more complex construction.

Planning and control is being carried out using a precedence network. Because the overall work is dynamic rather than static, it has not been practicable to compile a bar chart from the precedence network. Rather, selected bar charts have been prepared for groups of individual items on the network. Constant changes in interdependencies between various items have led to a need for continual up-dating of the precedence network. The network required continual revision because of excessive wet weather in the early part of 1974, industrial unrest during the same period and delays in the completion of bridge construction.

Much of the planning and co-ordination of the various public utility adjustments has been done by the Homebush Works Office staff. Joint meetings with representatives from the various utility authorities have co-ordinated the operations and minimised the duration of the adjustments.

To The East and West

Planning is well advanced on the adjoining sections of the Western Freeway.

Easterly to Concord Road, Concord, work on the section will involve the construction of a viaduct over Powells Creek Stormwater Channel, George Street, Homebush, the Main Northern Railway Line and Queen Street, North Strathfield.

On the section westerly, from Wentworth Street, Clyde, to the Great Western Highway, near Hawkesbury Road, Mays Hill, there will be bridges and viaducts for the crossing of Berry Street, Granville, the Western Railway Line and Church Street, Parramatta.

Co-operation with Local Authorities

Freeway design must always closely consider the requirements of traffic needing access across the route of the Freeway. Another consideration is the likely traffic concentration at either end of a length of Freeway and the provision of facilities to efficiently disperse this traffic into existing roads.

For the length of Western Freeway detailed in this article, the Department is maintaining close liaison with the Strathfield and Auburn Municipal Councils with regard to the flow of traffic and other requirements.●

The Hon. Wal Fife

Changes in Highways Ministry

Sir Charles Cutler

On taking office, one of the first acts of the Premier of New South Wales, The Hon. T. L. Lewis, M.L.A., was to announce the reorganization of functions and responsibilities within the machinery of government. This announcement also included changes in Ministers appointed to portfolios.

The Department of Main Roads was affected in both respects. The Hon. W. C. Fife, M.L.A., as Minister for Transport and Highways is now responsible for functions that were previously administered by three different Ministers. The Minister for Transport had formerly controlled motor and transport services, the Minister for Local Government and Highways had a number of road construction functions and the Minister for Public Works had also been concerned with roads.

The Department's new Minister, **The Hon. Wal Fife** holds the Parliamentary distinction of being, at 45 years of age, the youngest member of the New South Wales Cabinet. In 1957, when elected to Parliament as the Member for Wagga Wagga, he became the youngest member of the Legislative Assembly and the first Liberal Party member of Parliament for his district.

In the Askin Government, Mr Fife was first appointed Assistant Minister for Education in 1965. He became Minister for Mines in June, 1967, and Minister for Conservation from February, 1971. Another change occurred in June, 1972, when he became Minister for Mines and Power as well as Assistant Treasurer. As Minister for Mines and Power, Mr Fife was Executive Head of the Department of Mines, the Joint Coal Board, the Electricity Commission and the Electricity Authority.

With his appointment as Minister for Transport and Highways on 3rd January, 1975, Mr Fife assumes control of the Ministry of Transport, the Public Transport Commission, the Department of Motor Transport and the Department of Main Roads.

Since 19th June, 1972, the Minister for Local Government and Highways had been the Deputy Premier, **Sir Charles Cutler, K.B.E., E.D., M.L.A.** Sir Charles now holds the portfolio of Local Government and Tourism.

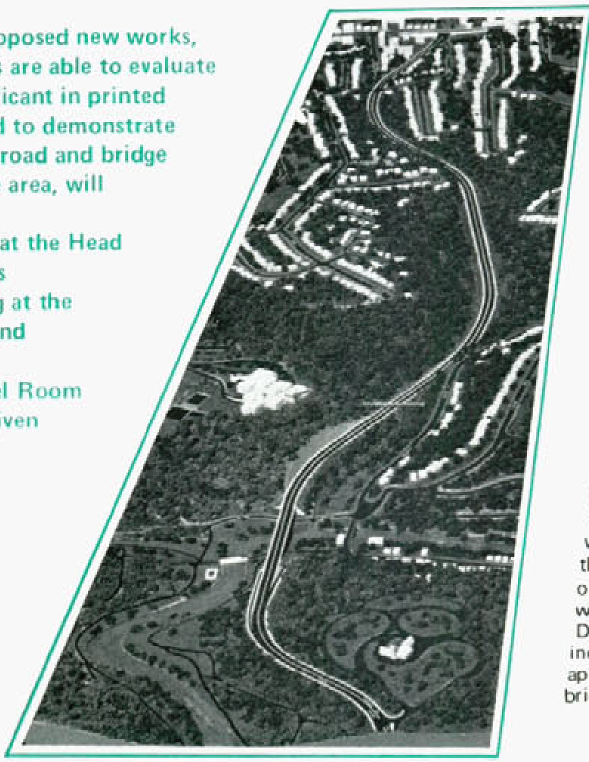
Sir Charles' term as Minister for Highways occurred during a time of changing attitudes in government and community. This very capable Minister came to the Department with a long history in public life, commencing after his war service. He was first elected to New South Wales Parliament in 1947 as member for Orange, nine years later being elected by his colleagues of the Parliamentary Country Party as Deputy Leader, and in 1959 as Parliamentary Leader. He became Deputy Premier in 1965, after the election of the Liberal-Country Party Coalition Government, and Minister for Education and Science in the Askin/Cutler Ministry. Sir Charles is now the longest-serving Parliamentary party leader in Australia.

MODEL WORKERS

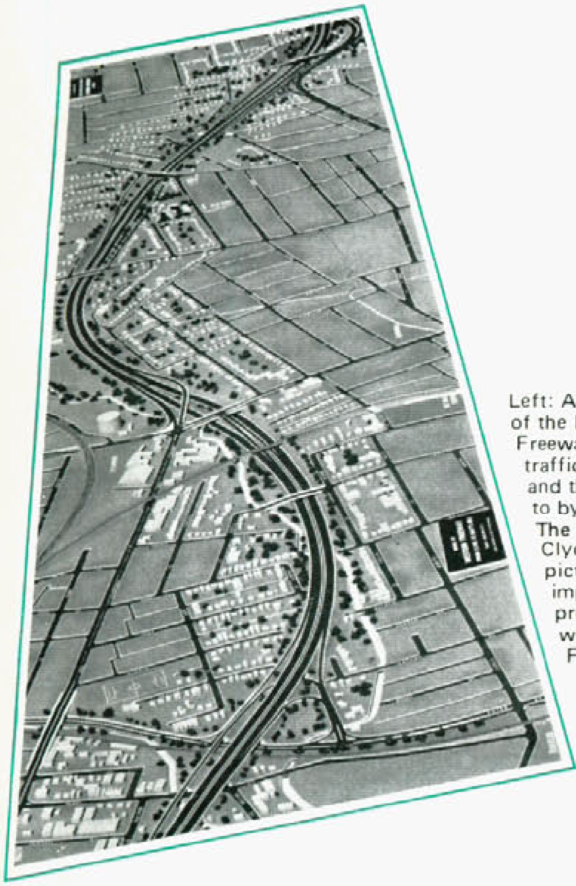
By closely studying three dimensional scale models of proposed new works, engineers and designers in the Department of Main Roads are able to evaluate technical and aesthetic points which are not always significant in printed plans and from site inspections. The models are later used to demonstrate to Councils, local organisations and the public, how new road and bridge proposals, as part of the total transportation needs of the area, will improve the amenity of a community.

Models are on permanent display in the Model Room at the Head Office of the Department and those who wish to visit this informative display may make arrangements by enquiring at the Public Relations Section, 3rd Floor, between 8.30 a.m. and 4.30 p.m. weekdays.

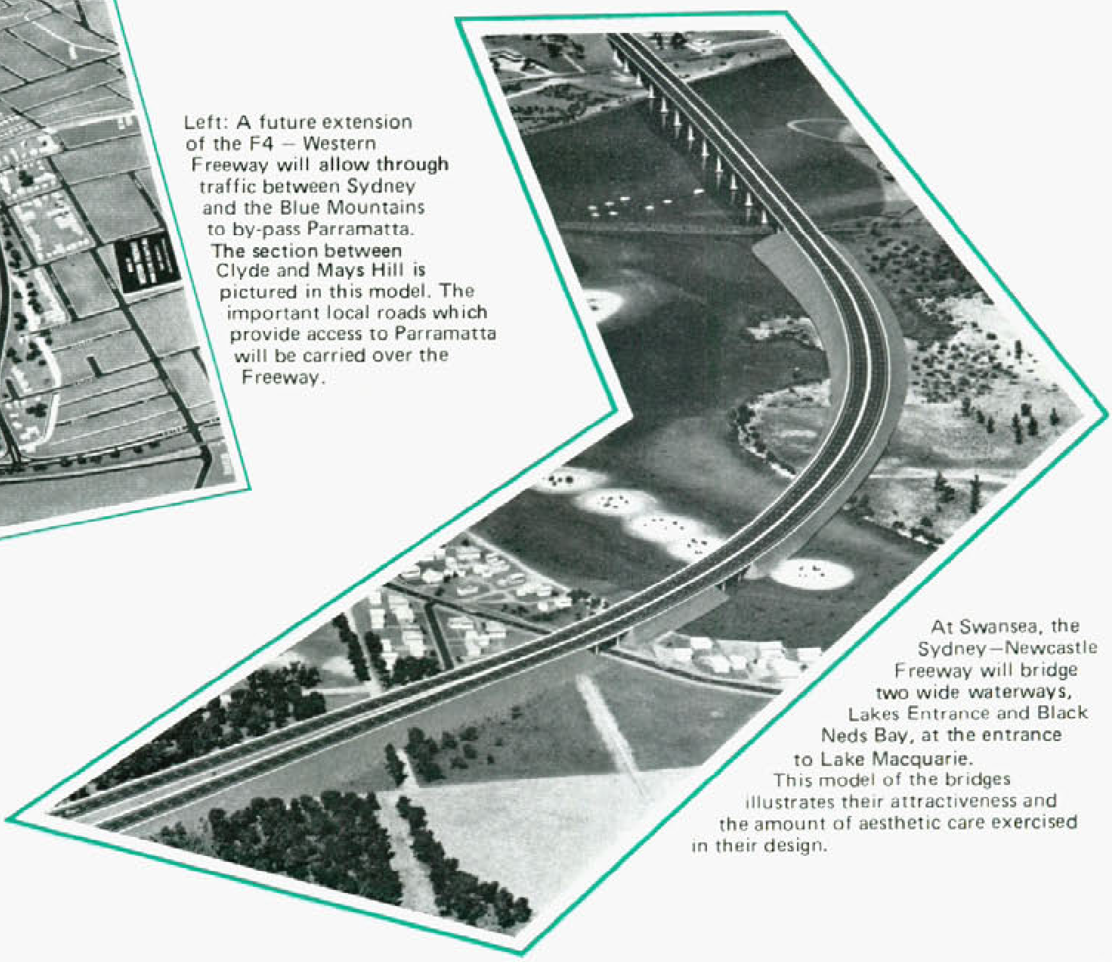
Three new models were recently included in the Model Room display. A photograph and short explanation of each is given on this page.



A new bridge and approach road will replace Fullers Bridge over the Lane Cove River and a section of Main Road 191. This model shows the proposed replacement bridge and its approach roads, in relation to the existing bridge (constructed in 1918). Millwood Avenue on the eastern side of the river will be replaced as the through road by a road on a better alignment, while on the opposite bank, Delhi Road will be incorporated into the approaches to the new bridge.



Left: A future extension of the F4 – Western Freeway will allow through traffic between Sydney and the Blue Mountains to by-pass Parramatta. The section between Clyde and Mays Hill is pictured in this model. The important local roads which provide access to Parramatta will be carried over the Freeway.



At Swansea, the Sydney–Newcastle Freeway will bridge two wide waterways, Lakes Entrance and Black Neds Bay, at the entrance to Lake Macquarie. This model of the bridges illustrates their attractiveness and the amount of aesthetic care exercised in their design.

CADASTRAL SURVEYS by Photogrammetry

Photogrammetry is the science of taking measurements from photographs. In general, photogrammetry is used in mapping areas of land quickly and cheaply without tedious field survey.

The aim of this study however was to show what can be done using photogrammetric techniques for the definition of boundaries and the production of a plan suitable for title purposes.

The use of photogrammetry for cadastral surveys is well established overseas, especially in Europe. Also, a number of large rural subdivisions have been recently surveyed by photogrammetric methods in Australia, particularly in Tasmania, and it was recommended by the Principal Surveyor and Property Officer of the Department of Main Roads, N.S.W., Mr A. T. Lenehan, that the Department should study the feasibility of using photogrammetry for cadastral surveys in rural areas under the proposed Integrated Surveys Act of N.S.W. In the case of surveys by the Department, this would apply to fixing boundaries along newly constructed roads.

Approval was given for a trial survey to be carried out by photogrammetry as an item of the Department's research programme.

Trial Survey at Waterfall

In selecting a site for the trial survey, a number of freeways at present being constructed through rural areas near Sydney were examined. A section of the Southern Freeway was selected between Waterfall and Helensburgh over a length of approximately 5·5 kilometres. This section of the freeway passes through medium timbered, broken sandstone country with differences in height of 100 metres. The fence to be used to define boundaries of the freeway was generally found to be unobscured by overhanging trees. The fence itself was of a solid nature consisting of concrete posts set in concrete footings and with two barb and two plain wires. The angle posts were 15 cms square with the tops approximately 1·5 metres above ground level and rigidly stayed with iron pipes. Because of the permanent nature of these posts, they could be used as monuments for defining the corners along the freeway boundaries.

Under the planned Integrated Surveys Act of N.S.W. a set of standards of accuracy is given and at some future time the Registrar-General's Department will issue a direction as to which Class of Precision will be suitable for cadastral surveys.

From consideration of the mathematics involved it was felt that class of Precision F could be attained easily using cameras available to the Department. Photography was taken with a WILD R.C.5 210 mm focal length camera with a flying height of 610 metres and from a flying height of 400 metres with a WILD R.C. 10 152 mm focal length camera. These gave photo scales of 1 : 2 900 and 1 : 2 600 respectively meaning that if it was expected to attain an accuracy of measurement on the photograph of about 0·025 mm (25 micrometres) for the standard deviation of a position of a point it could be expected that the deviation would be 73 mm and 65 mm respectively on the ground.

Class of Precision F allows a standard deviation of the position of one point relative to another in close proximity of 100 mm and a ratio of relative standard deviation to distance apart of 1 : 2 000 over large distances.

Flight Planning

Normal Angle Photography

(f = 210 mm, format = 18 x 18 cm)

For a coverage of 1 : 2 900, four runs of photography were needed along the freeway, these were numbered QV1 to QV4. It was possible to align runs QV2 to QV4 along the three straight sections of freeway which they covered. Run QV3 is illustrated in this article. This helped the pilot and navigator to line-up for the start of these runs. With an effective flying height of 610 metres above the mean ground level of 240 metres above sea level, the differences in the level of the ground from 190 metres to 290 metres above sea level meant that the photo scale varied from 1 : 3 100 to 1 : 2 700 respectively over these areas. Consequently, for an overlap of 60% and a ground speed of 100 knots (51·5 m/sec), the interval between exposures varied from 4·4 seconds over the low areas to a minimum of 3·7 seconds over the high areas which was just above the minimum camera cycling time of 3·5 seconds. Since the aircraft moved about 172 mm during the 1/300 second that the shutter was open, the resulting component of image movement due to ground speed on the photography was about 60 μm; well above the recommended maximum of 25 μm. It was thought that the resulting blurring of the image might affect the accuracy of the photogrammetric observations, but the validity of this thought did not seem to be confirmed in practice.

Wide Angle Photography

(f = 152 mm, format = 23 x 23 cm)

By bringing the air speed up to 120 knots (62 m/sec), the aircraft was able to fly lower at a height of 400 metres above the mean ground level. This gave a mean photo scale of 1 : 2 600 with the same flight lines used as in the normal angle photography. These four runs, numbered QV5 to QV8 gave a ground coverage only slightly wider than that obtained by the normal angle photography and thus the same wing points could be used to control the photography.

Using a shutter speed of 1/1000 second, the resulting image movement was about 24 μm and the interval between exposures varied from 4·4 seconds down to 3·4 seconds which was well above the minimum cycling time of 1·5 seconds for the WILD R.C. 10 camera.

Co-ordinate System

It was decided that since the Integrated Surveys Act will shortly be passed in N.S.W., the Integrated Survey Grid (I.S.G.) should be used for the co-ordinate system. This is a Transverse Mercator projection with zone width 2°, central scale factor 0·99994 and a false origin 5 000 000 metres south of the equator and 300 000 metres west of the central meridian. The Department of Lands N.S.W. is currently calculating I.S.G. co-ordinates for the first order network in N.S.W. and in the Waterfall area this calculation has been completed.

Ground Control

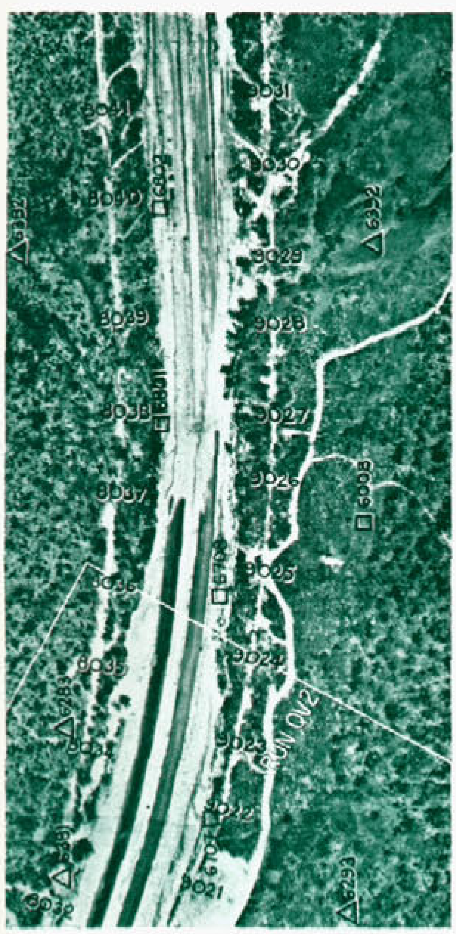
In theory, measurements could be taken from a vertical aerial photograph of flat terrain knowing the distance from the camera lens to the image plane and from the lens to the terrain. This is not possible in practice because the latter of these values, the flying height, is not accurately known. To control the scale, tilts and direction of the photography, three bands of two accurately known ground control points are needed for each run of photography. Twenty of these points, called wing points, were placed and co-ordinated by accurate electronic distance measuring equipment.

Targetting

Types of Targets Used for Control and Wing Points and Existing Cadastral Marks

Wing points were each targetted with a piece of hardboard 45 cm square painted with a yellow cross on a black background. For existing control points, 30 cm square Cane-ite was used where the points were concrete blocks while for those on rock, yellow crosses with black backgrounds were painted directly onto the rock. Where concrete blocks were buried below the ground surface, the Cane-ite targets were fixed to pegs and the difference in level between the target and spike noted. Existing cadastral marks were also targetted in this manner.

QV3—One of the four runs of photography needed for coverage of 1 : 2 900 along the Freeway.



The width of the arms of the yellow crosses was chosen to be 100 mm, since with the photo scale of 1 : 2 900, the floating mark in the instrument was equivalent to about 120 mm on the ground. After a certain amount of irradiation, the 100 mm width crosses on the ground would appear slightly larger than the floating mark, thus making them ideal for pointing.

Targetting the Fence Posts

It was decided that the fence should be contained entirely within the road reserve and that marks cut in the centres of the tops of the posts were to act as reference marks to the boundaries. It was found that to contain all the irregularities in the fence the boundary points had to be generally 0·25 metres from the centre of the post, so this figure was adopted in most cases.

The top of each post was 120 mm square, excluding the chamfer, which agreed well with the optimum target size. Thus the top of the post was painted yellow and used as a target. To ensure sufficient contrast, the sides of the posts were painted black for a distance of about 0·5 metres down from the top and the ground around the posts was sprayed with a solution of black road marking paint and acetone to a radius of about 1·5 metres. This generally gave a good background.

It may be thought that a black top on the posts would have been ideal for pointing to since the natural background was white, the posts were white and the floating mark in the instrument was a bright luminous dot. This would not be the case however as the black target could only be made 120 mm square and the effect of irradiation of the surroundings would reduce that apparent size considerably. Thus the floating mark would be much larger than the point to be co-ordinated. This could introduce comparatively large errors in the positioning of the floating mark.

Reference Points

Before the normal angle photography was taken, it was thought that some 15 of the 114 targetted posts might not be visible on the photography due to overhanging trees. In these cases a reference point was placed in a nearby clearing and a 30 cm square Cane-ite target was fixed to the point. These points were then connected to the fence posts in question by steel bands with azimuth being determined by sun observations with a WILD T2 theodolite. The observations were designed so that the error in position of each post relative to the reference point was less than 10 mm. However, nine of these posts were in fact visible on the normal angle photography so only six reference points were used to fix the positions of the obscured posts.

Normal Angle

This photography was first flown on 19th November, 1972, but difficulty was experienced in keeping the aircraft on course. This was due to the low performance of the aircraft in turbulent conditions when operating at a low altitude with a low air speed. Although each run was flown twice, only one attempt for each of the two runs QV3 and QV4 was acceptable. The other two runs were re-flown under similar conditions on 23rd November and these runs were accepted.

Wide Angle

Unfortunately a long delay occurred between the date when the wide angle photography was planned and when it was finally taken because the aircraft was not available during good weather conditions. Heavy rain caused the postponement of the photography during February, 1973. This rain also washed away background paint around the fence posts.

The photography was finally taken on 18th March under ideal conditions, little turbulence and good aircraft performance. All four runs were acceptable.

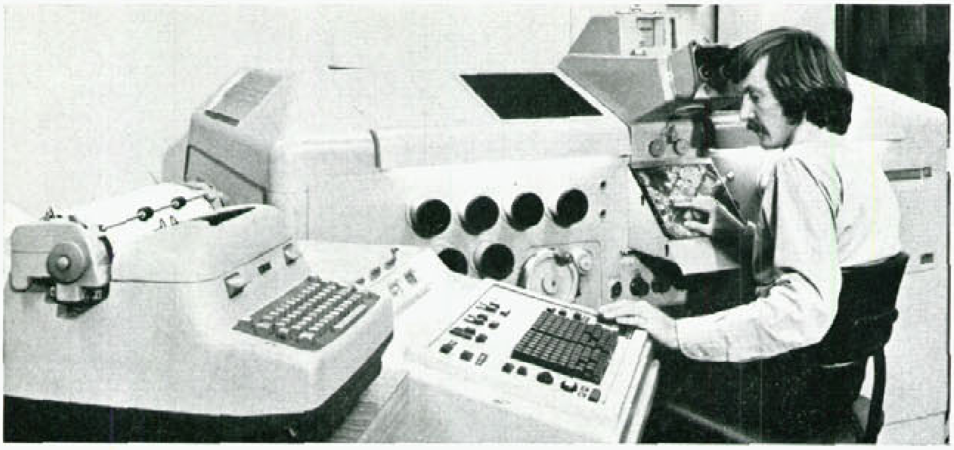
Observation of the Photography

Equipment Used

The following equipment was used to make the necessary observations:

(a) Topcon Mirror Stereoscope

This was used to identify the targetted points on the paper prints and to select five areas down the centre of each



Zeiss (Jena) Stereometrograph, Model D, with Coordimeter.

photograph for the marking of pass points used in forming each strip of photography.

(b) WILD PUG IV Point Marking and Transfer Device

This was used to mark the pass points by drilling a small hole in the emulsion within each of the five areas of the glass diapositives.

(c) Zeiss (Jena) Stereometrograph Model D with Coordimeter

The stereo-models were formed with this instrument and the co-ordinates of each observed point were measured by the Coordimeter and simultaneously punched on cards and typed on paper. These co-ordinates were measured in millimetres in the co-ordinate system of the instrument with a least count of 0·01 mm.

Method of Observation

(a) The co-ordinates of the two perspective centres in the Stereometrograph were determined by an indirect method. These co-ordinates remained fixed throughout the observations of the four runs of each type of photography; the points themselves being used in the computations phase for joining the stereo-models together to form a strip.

(b) After establishing the relative orientation for each stereo-model, the co-ordinates of the five pass points down each side of the stereo-model were recorded. This was followed by the co-ordination of all the targetted points, including fence posts that appeared in the stereo-model. The observations on these targetted points were then repeated and the two results meaned. If the co-ordinates differed by greater than 0·02 mm a further observation of the point was made.

(c) Some additional points were digitised. These included occupations such as fences and buildings as well as transmission-line poles and bridges.

Definition of Existing Boundaries Using Normal Angle Photography

Original marks were found in only seven locations on the whole length of the survey, none of these marks being outside the photography.

Comparisons between original distances and photogrammetric distances using the normal angle photography were made and the differences found to be in the ratios of 1 : 20 000, 1 : 10 000, 1 : 5 000, 1 : 10 000 and 1 : 20 000 to the lengths with which they were compared. These comparisons were used to fix the existing boundaries by swinging original bearings to fit photogrammetric bearings and adjusting distances linearly.

Field Survey and Comparison with Photogrammetric Survey

Field Survey

A field survey was performed over the area of the photogrammetric survey for two purposes. One was to check the photogrammetric determination of all relevant points and the other to prepare a plan of survey acceptable to the Registrar-General under the present Survey Practice Regulations.

Seven traverses were performed along the fences between points on the major control traverse, using a WILD T1, WILD T2 and steel band and these traverses were adjusted between the control points.

These traverses were found to be in Class of Precision D and can be considered error-free when they are compared to co-ordinates of a lower class.

Comparisons Between Photogrammetric and Field Co-ordinates

The expected standard deviation of a co-ordinate of 18 micrometres (equal to 25 micrometres in position) on the photograph is equivalent to about 52 mm on the ground using a photo scale of 1 : 2 900. It was found when comparisons were made between the photogrammetric and field values, that the standard error of both northing and easting co-ordinates was 48 mm which was in good agreement with the prediction. It was seen from histograms that all the errors in easting and 96% of the errors in northing were less than or equal to twice the standard deviation compared to the statistical prediction of 95% for a normal distribution.

Time and Cost Comparison between Photogrammetric and Field Survey

Before a comparison is made it must be noted that at least three circumstances were in favour of the field survey. The first was that in the field survey, traverses were run along the fence lines which had been cleared while in determining positions of wing points, the lines from control points were in general traversed through heavy undergrowth. The total of 20 wing points were co-ordinated at the rate of about three a day. In more open terrain this could have been improved upon.

The second was that when an unfamiliar task is undertaken as compared to one that is familiar, detailed instructions are necessary on almost every operation to be performed. This led to the third circumstance. While the conventional field survey was being performed the whole party, in the main, camped at Waterfall and eight hours per day were worked whereas when the party was engaged on photo control, instructions were necessary almost every day and the party based itself in Sydney allowing only about five hours per day of actual field work. This difference amounts to almost four days per fortnight and it is felt that if another survey of the same type was attempted now it would be possible to base the party on the job. This means that whereas the control for the normal angle photography took 68 days for the field party (costing $10,200) it could have been done in approximately 42 days (costing $6,300) had the survey been done using experienced personnel, giving a saving of $3,900 but with accommodation expenses of $1,050.

Time and Cost Comparison

NORMAL ANGLE		$
68 days Full Field Party	..	10,200
6 days Field Hands only	..	300
Photography	..	1,250
Observation and Computation	..	800
		$12,550
Working 8 hrs/day	*Subtract*	3,900
With accommodation	*Add*	1,050
		$9,700

CONVENTIONAL FIELD SURVEY		
51 days Full Field Party	..	7,650
24 days Expenses for Party	..	1,050
		$8,700

WIDE ANGLE		$
68 days Full Field Party	..	10,200
6 days Field Hands only	..	300
Photography	..	1,250
Observation and Computation	..	725
		$12,475
Working 8 hrs/day	*Subtract*	3,900
With accommodation	*Add*	1,050
		$9,625

This would tend to indicate that if the field work for the photogrammetric survey had been observed on an 8 hour day basis the photogrammetric survey would have been dearer than the conventional field survey by $1,000 but would have freed the field party nine days earlier. The field party was costed at $150 per day which is the estimate used by the Department of Main Roads. The observations and computations for the photogrammetric survey were costed at $25 per stereo-model which is the figure quoted by the Central Mapping Authority of N.S.W. However, the figures used here may not constitute a reasonable basis for costing.

Evaluation of Results with Respect to Survey Practice Regulations

Current Survey Practice Regulations, N.S.W.

Any survey intended to be registered by the Registrar-General's Department must comply with the Survey Practice Regulations currently in force. The use of photogrammetric methods for a cadastral survey is covered by Regulation 13A which states: "Notwithstanding the provisions of Regulations 10 and 13, a surveyor may use photogrammetric methods of measurement if appropriate".

Two Regulations where this survey could be questioned are Regulations 43 and 44. Regulation 43 deals with permissible misclose and since the notion of misclose is not compatible with a photogrammetric survey (photogrammetry determines co-ordinates not bearings and distances) this regulation does not apply. Regulation 44 states (for undulating country): "A surveyor shall, in making a survey, measure all lengths to a degree of accuracy so that the probable error of such measurement shall not exceed . . . one part in 9 000 . . . Where lines in a survey are so short that the above standard would demand precision ordinarily unattainable such lines shall be so measured so as to maintain the best possible standard consistent with the nature of the land measured over".

This means that for no line in a survey shall the ratio of probable error to distance exceed one part in 9 000. Now the probable error (p.e.) is related to the standard error (μ) in the following way:

$$\text{p.e.} = 0{\cdot}6745\mu$$
$$= \tfrac{2}{3}\mu$$

Now, if a tolerance for measurements of 2μ is accepted (95 per cent of observations should fall within these limits) then any survey where 95 per cent or more of the distances measured have a ratio of error to distance of less than 3 p.e./distance ($= 2\mu$/distance) is acceptable. This means that if 95 per cent of all ratios are less than one part in 3 000 the survey is acceptable. The normal angle photogrammetric survey in question has only 62 per cent of these ratios acceptable and so does not satisfy Regulation 44.

Future Survey Practice Regulations under the Integrated Surveys Act

(a) The standard error of the position of a point from the photogrammetric survey using the normal angle photography was found to be 68 mm. This means that all points in the survey, regardless of separation, fall into Class of Precision where a value of $\varphi \leq 100$ mm is required for points with a small separation. At this stage it has not been determined which Class of Precision will apply in rural areas but it may be Class E. This class could only be satisfied with a standard deviation in position of one point relative to another of 68 mm for a distance of 410 metres between the points. This would mean that all points within 410 metres of each other were in Class F while all points with greater separations were in Class E.

Since the photogrammetric survey was adjusted onto control points of Class D or higher, then any point in the survey is entitled to be considered Class E except where it is necessary to make use of that point and another point within 410 metres.

(b) If Class F was acceptable for this area, then a smaller photo scale could have been used. With a photo scale of 1 : 4 000, the expected standard deviation of the position of a point determined photogrammetrically would be 92 mm which would satisfy Class F for all points, irrespective of the separation. Instead of 4 runs of normal angle photography with a total of 31 models, only one run would be required with 20 models. The number of wing points required would be reduced from 20 to 6. This would have reduced the cost of the photogrammetric survey while Class of Precision F would still have been achieved for all points.

Conclusion

The aims of the survey described in this paper were:

- to influence the formation of the Survey Practice Regulations under the proposed Integrated Surveys Act;
- to influence the assignment of the standard of accuracy in rural areas of low value; and
- to obtain experience in the capabilities of photogrammetry in determining boundaries, particularly along roads.

With the experience gained from this survey, it is expected that Class of Precision F will be adopted for rural surveys where the value of the land is relatively low in relation to land in urban areas. This would be the case in central and western areas of New South Wales where it is felt that photogrammetry could have considerable application to cadastral surveys of large areas.●

Messrs. T. M. Clark and C. A. Woodham have been awarded the Halloran Prize for 1974 by the Institution of Surveyors, Australia, N.S.W. Division. These officers are co-authors of the paper "Cadastral Surveys by Photogrammetry" presented at the 17th Congress of the Institution in February, 1974, from which this article has been adapted.
It should be noted that the costs specified in this article were those relating to the period when the surveys were flown, that is, late 1972, early 1973, and that different costs are now in operation.

Statistics

		New South Wales	Victoria	Queensland	South Australia	Western Australia	Tasmania
AREA	Total Area (sq. km)	801 431	227 619	1 727 530	984 381	2 527 633	67 897
	Area in Economic Use (sq. km)	795 280 (99 %)	218 743 (96 %)	1 701 617 (98 %)	632 483 (64 %)	1 213 265 (48 %)	63 279 (93 %)
	Area covered by Local Govt. (sq. km)	478 455 (60 %)	227 619 (100 %)	1 727 530 (100 %)	163 408 (17 %)	2 527 633 (100 %)	67 897 (100 %)
ROADS	Bitumen (km)	60 673·82	53 488·3	35 917·97	17 937·25	28 397·71	6 292·36
	Gravel, crushed stone or other improved surface	65 405·17	46 552·2	31 267·09	21 667·6	29 530·66	13 410·29
	Formed only	39 875·23	31 547·1	61 982·19	24 448·49	43 079·35	994·54
	Cleared only	42 010·78	27 856·98	64 370·39	37 131·37	59 313·97	
POPULATION	Whole State	4 754 400 (estimated)	3 577 780	1 898 155	1 196 541	1 065 763	395 552
	Capital City	2 850 630	2 544 400	888 000	855 300	724 800	154 720
	Other cities greater than 10 000 people	896 500	394 240	403 402	77 723	89 339	100 511
	Rural	520 641	427 920	375 376	179 148	187 657	100 418
MOTOR VEHICLES	Total No. (excluding trailers)	2 048 543	1 473 100	809 600	536 000	478 700	171 600
	Persons/Vehicle	2·45	2·43	2·35	2·23	2·22	2·31
PRIMARY INDUSTRY	Sheep (No.)	62 000 000	29 496 000	14 604 000	17 970 000	34 405 000	4 237 000
	Beef Cattle (No.)	6 507 000	3 444 000	8 215 000	1 237 000	1 765 000	584 000
	Dairy Cattle (No.)	773 000	1 906 000	633 000	227 000	172 000	232 000
	Total Area of Crops excluding sugar and pastures (hectares)	4 182 351·2	1 935 900·1	1 839 588·2	2 278 006·4	3 751 662·1	69 424·21
	Sugar cut for crushing (hectares)	9 330	....	224 406·66	....	....	....
	Forests (hectares)	3 377 910·7	2 668 092·1	4 837 206·9	124 238·47	2 020 595·2	2 252 075·3

Figures quoted here are in all cases the latest available from official sources.

Looking Satisfied

Sometimes by looking back we can know more about the future. The success of completed works such as the Warringah Freeway (above) and Gladesville Bridge (below) confirms that future works of similar purpose and good design will play an important role in easing the traffic problems of Sydney. Although some people decry the initial visual changes and disruption to old living patterns, both these projects have proved the wisdom of their construction and are looking satisfied with their surroundings. More than that, they are wearing well and fulfilling their original promises.

Both photographs taken in recent months.

TENDERS ACCEPTED BY THE DEPARTMENT OF MAIN ROADS

The following tenders (in excess of $20,000) for road and bridge works were accepted by the Department for the three months ended 31st December, 1974.

Road No.	Works or Service	Name of Successful Tenderer	Amount
			$
Western Freeway	Municipality of Auburn. Supply, manufacture and delivery of grid flooring for bridge under East Abattoirs Railway Line.	Metalee Industries Pty Ltd	26,552.00
Southern Freeway	City of Wollongong. Erection of guardrail in section from Gladstone Avenue to Five Islands Road.	C. M. Smith	38,040.00
State Highway No. 2	Hume Highway. City of Goulburn. Construction of bridge over Mulwaree Ponds, 1·9 km north of Goulburn.	Transbridge Pty Ltd	554,565.13
State Highway No. 2	Hume Highway. Shires of Gunning and Goodradigbee. Supply, laying and spreading of asphaltic concrete between 4 km and 20 km north of Yass.	Pioneer Asphalts Pty Ltd	342,675.00
State Highway No. 2	Hume Highway. Shire of Goodradigbee. Supply, laying and spreading of asphaltic concrete between 16·5 km and 32 km south of Yass.	Pioneer Asphalts Pty Ltd	306,230.00
State Highway No. 8	Barrier Highway. Shire of Central Darling. Construction of nine pre-cast box culverts at various locations between 44·3 km and 49·2 km west of Wilcannia.	R. J. & R. J. Kurtze	28,809.00
State Highway No. 10	Pacific Highway. Shire of Byron. Widening of bridge over the middle arm of the Brunswick River at Brunswick Heads, 20·9 km north of Bangalow.	Kennedy Bros	206,939.00
State Highway No. 10	Pacific Highway. Shire of Wyong. Construction of bridge over Ourimbah Creek.	Civilbuild Pty Ltd	149,601.50
State Highway No. 10	Pacific Highway. Shire of Great Lakes. Surface preparation and painting of steelwork of bridge over Karuah River at Karuah.	R. A. Rogers Associates Pty Ltd	43,777.00
State Highway No. 11	Oxley Highway. Shire of Walcha. Construction of new bridge over Apsley River at Walcha and demolition of existing bridge.	M. & E. Firth Civil Constructions (Tamworth) Pty. Ltd.	228,163.00
State Highway No. 11	Oxley Highway. Shire of Peel. Construction of reinforced concrete box culvert at Bective Creek, 26 km west of Tamworth.	W. H. Marshall and Son	26,518.08
State Highway No. 15	Barton Highway. Shire of Yarrowlumla. Supply, laying and spreading of asphaltic concrete between 29·8 km and 41·3 km from Yass.	Allen Bros (Asphalting Contractors) Ltd	286,000.00
Main Road No. 208	Shire of Denman. Surface preparation and painting of steelwork of bridge over Goulburn River at Sandy Hollow.	Kada Painting Contractors Pty Ltd	34,850.00
Main Road No. 286	Shire of Snowy River. Haulage of pavement material for reconstruction on section from 36·6 km to 41·25 km west of Jindabyne.	Petamin Exploration	32,340.00
Main Road No. 405	Shire of Bourke. Construction of bridges over Paroo River and Bywashes No. 1 and No. 2 at Wanaaring.	M. & E. Firth Civil Constructions (Tamworth) Pty Ltd	452,704.00
Various	Pacific and Gwydir Highways. Supply, heat, haul and spray R.90 bitumen.	Albion Reid (N.S.W.) Pty Ltd	48,654.00

TENDERS ACCEPTED BY COUNCILS

The following tenders (in excess of $20,000) for road and bridge works were accepted by Councils for the three months ended 31st December, 1974.

Council	Road No.	Work or Services	Name of Successful Tenderer	Amount
				$
Ashford	S.H. 16	Construction of 10 span bridge 60·96 m long over Ottley's Creek 17·7 km west of Yetman.	Emoh Ruo Court Pty Ltd	89,953.76
Ashford	S.H. 16	Construction of 12 span bridge over Seerey's Creek, 16·9 km west of Yetman.	L. G. Rixon	95,172.27
Ashford	T.R. 63	Construction of single span bridge 10·69 m long over Rocky Dam, 23·8 km south of Yetman.	Emoh Ruo Pty Ltd	50,473.29
Bibbenluke	S.H. 19	Reconstruction to sub-grade level between 28·3 km and 30·3 km south of Bombala.	Monaro Road Construction Pty Ltd.	55,936.00
Bibbenluke	S.H. 19	Construction of bridge over Little Plains River at 19·3 km south of Bombala.	Nelmac Pty Ltd	138,616.00
Bibbenluke	T.R. 91	Reconstruction to sub-grade level, 21·1 km to 22·65 km east of Bombala.	G. N. Ryan Pty Ltd	39,771.88
Blacktown	S.R. 2084	Four-span prestressed railway overbridge at Seven Hills.	Peter Verheul	545,909.00
Demondrille	T.R. 84	Proposed new bridge over Spring Creek at Rocky Ponds.	Siebels Concrete Constructions Pty Ltd	216,831.65
Mumbulla	M.R. 320	Construction of bridge over Narira Creek, 2·1 km east of Cobargo.	N. J. McIntosh	134,482.00
Timbrebongie	T.R. 572	Reconstruction and bitumen surfacing 20·6 km to 24·1 km.	Shorncliffe Pty Ltd	20,569.38
Yallaroi	T.R. 63	Construction of new bridge over Oakey Creek 15·1 km south of Warialda.	N. Del Gatto	54,079.50

MAIN ROADS STANDARD SPECIFICATIONS

Note: Imperial drawings are prefixed by letter A, metric drawings by letters SD; instructions are so described; all other items are specifications or forms

ROAD SURVEY AND DESIGN

ROAD SURVEY AND DESIGN	Form No.
Design of two-lane rural roads (Instruction) (1964)	355
Data for design of two lane rural roads (1973)	892 (Metric)
Flat country cross sections—bitumen sealed pavement (Instruction) (1972)	A6132
Standard grading at drainage structures in flat country (Instruction) (1972)	A6161
Standard grading at approaches to culverts (Instruction) (1972)	A6162
Design of urban roads (Instruction)	369
Design of subsoil and subgrade drainage (Instruction) (1973)	513 (Metric)
Standard cross sections for bitumen surfaced two-lane rural roads (1974)	SD 6056

STREET DRAINAGE

Concrete converter	A 1418
Gully grating (1969)	A 190
Gully pit with grating	A 1042
with kerb inlet only	A 1043
with grating and extended kerb inlet	A 1352
with extended kerb inlet only	A 1353
with grating for mountable kerb	A 4832
Perambulator ramp	A 3491
Vehicular gutter crossing (1974)	SD 6247
Kerb and gutter shapes (1974)	SD 6246
Waterway calculations for urban drainage (Instruction) (1963)	371B

CULVERTS

(a) Cast in place reinforced concrete box culverts—	
Single cell, height of opening 2 ft (A 5791); 3 ft (A 5792); 4 ft to 12 ft	A 1014–20B
Two cell, height of opening 2 ft (A 5793); 3 ft (A 5794); 4 ft to 12 ft (1958)	A 1023–30A
Three cell, height of opening 2 ft (A 5795); 3 ft (A 5796); 4 ft to 7 ft (A 1033–36); 8 ft (A 1038); 9 ft (A 1040); 10 ft to 12 ft	A 4843–45
Four cell, height of opening 2 ft (A 5797); 3 ft (A 5798); 4 ft to 12 ft	A 4846–54
Reinforced concrete box culverts with concrete wearing surface and concrete handrailing, heights of opening 3 ft to 12 ft, 1, 2, 3 and 4 cells (1963)	A 4994–97
Posts and handrails for culverts	A 3732
(b) Precast reinforced concrete box culverts—	
Supply of precast concrete box culverts up to 10 ft high and 10 ft span	138A
(c) Pipe culverts—	
Construction concrete pipe culverts (1974)	25 (Metric)
Design concrete pipe culverts (1974)	25A (Metric)
Supply and laying of asbestos cement drainage pipes (1972)	861
Headwall drawings are available for the following pipe culverts— (a) Single row—15 in to 6 ft dia. (b) Double row—15 in to 6 ft dia. (c) Triple row—15 in to 3 ft dia.	

BRIDGES

Concrete work for bridges (1974)	350 (Metric)
Concrete end posts for concrete bridges	A 279
Concrete handrail for concrete girder bridges	A 279A
Concrete end post and handrailing for prestressed concrete bridge units (1959)	A 4932–33
Data for bridge design (1973)	18 (Metric)
Erection of precast, prestressed concrete bridge units (1971)	557
Erection of precast, prestressed concrete piles (1966)	558
Erection of precast, prestressed concrete bridge girders (1974)	561 (Metric)
Extermination of termites ni bridges (Instruction) (1958)	326
Excavation for bridges (1968)	563
Supply of high strength steel bolts (1974)	261 (Metric)
Erection of steelwork using high strength steel bolts	262
General notes on Assembly of bridge construction specifications (Instruction) (1962)	599
Manufacture of precast or cast-in-place, prestressed concrete bridge members (1970)	556
Manufacture of elastomeric bearings for bridge units and girders (1964)	562
Proforma specification for bridge construction (Instruction) (1962)	599A
Protection of steelwork by metal coating in shop (1961)	579
Protective treatment (Field) of steelwork—metal spraying and painting (1961)	584
Protection angles for bridges or culverts with concrete wearing surfaces (1960)	A 1272
Prestressed concrete bridge drawings—	
(a) Bridge units for square and skew crossings, 25 ft to 35 ft spans (1963)	A 4910–12
(b) Bridge girders pretensioned or post-tensioned, 40 ft to 70 ft spans (1964)	A 5540–49
(c) Reinforced concrete deck for precast, prestressed concrete bridge girders 24 ft and 28 ft between kerbs 40 ft to 70 ft spans (1963)	A 5550–59
(d) Formwork slabs for prestressed concrete bridge girders	A 5560
(e) Details of cast-in-place deck for prestressed concrete bridge units 25 ft to 35 ft spans (1967)	A 4931
(f) Prestressed concrete piles—12 in x 12 in—35 tons (A 4764); 14 in octagonal—45 tons (A 4943); 16 in octagonal—50 tons (1963)	A 4944
(g) Test load diagrams for prestressed concrete piles—12 in x 12 in (A 5601); 14 in and 16 in octagonal piles	A 5828
(h) Test loads for prestressed concrete bridge units (1964)	A 5514
(i) Flexural tension test loads for precast, prestressed concrete bridge girders (1964)	A 5538
(j) Principal tension test loads for precast, prestressed concrete bridge girders (1964)	A 5539
Reinforced concrete bridge drawings—	
(a) Flat slab bridges, 24 ft and 28 ft between kerbs; 20 ft to 30 ft spans (1958)	A 4862–71
(b) Piers with spread footings for flat slab bridges, 20 ft to 30 ft spans (1959)	A 4967–75
(c) Reinforced concrete piles, 35 and 45 tons (1963)	A 1207–8
Reinforced concrete piles for bridge foundations (precast)	564
Reinforced concrete cylinders for bridge foundations	565
Standard bridge loading (Instruction) (1957)	A 4
Substructure for bridges (567); Superstructure	568
Timber for bridges (1966)	140
Timber bridge drawings—	
(a) Timber beam bridge, 24 ft between kerbs (1961)	A 5593
(b) Timber beam bridge, details of construction (1961)	A 5594
(c) Low level timber beam bridge, 12 ft between kerbs	A 3470
(d) Running planks	A 1216
(e) Longitudinal deck sheeting (1961)	A 5576
Waterway diagram (0 to 200 acres)	A 26

BITUMINOUS SURFACES

Bituminous emulsion (cationic) (1973)	304 (Metric)
Bituminous emulsion (anionic) (1973)	305 (Metric)
Residual bitumen (1974)	337 (Metric)
Supply of prepared cutback bitumen for sealing purposes	740
Tar	296
Supply and spraying bitumen (1973)	898 (Metric)
Sealing and resealing with bitumen (1974)	93 (Metric)
Cut-back chart for bitumen seal coats (1973)	466 (Metric)
Cutting back bitumen—proportioning chart (1966)	466A
Bituminous surfacing daily record (1974)	400 (Metric)
Sprayer loading slip (1974)	401 (Metric)
Bituminous surfacing job summary (1974)	1011(Metric)
Standard performance requirements for mechanical sprayers for bituminous materials (1973)	272 (Metric)
Supply and delivery of cover aggregate for bitumen seal coats (1973)	351 (Metric)
Supply and laying of asphaltic concrete paving mixtures (1974)	612 (Metric)
Supply and delivery of asphaltic concrete (1974)	953 (Metric)

FENCING

	Form No.
Chain wire protection fencing (1970)	144, A 149
Corrugated guard rail (1971)	A 5595
Protection fencing using corrugated steel guardrail (1973)	A 5829
Warrants for use of guard fences (Instruction) (1973)	246 (Metric)
Erection of guardrail protection fencing (1971)	680
Ordnance Fencing	143, A 7
Post and wire fencing (1974) Drawings: Sheep SD 494 (1974); Rabbit-proof SD 498 (1974); Cattle SD 1705 (1974); Floodgate SD 316 (1974).	141 (Metric)
Removal and re-erection of fencing (1974)	224 (Metric)

FORMATION, INCLUDING EARTHWORKS AND RURAL DRAINAGE

Earthworks and formation (1974)	70 (Metric)
Shoulders and table drains (1973)	827 (Metric)
Standard rubble retaining wall	A 114
Standard mass concrete retaining wall (1959)	A 4934
Standard cantilever retaining wall (1959)	A 4935
Subsoil drains (1973)	528 (Metric)
Corrugated PVC subsoil drainage pipe (1972)	907 (Metric)

PAVEMENTS

Cement concrete pavement	A 1147
Preformed expansion joint fillers (1962)	610
Supply and delivery of ready mixed concrete (1973)	609 (Metric)
Design of non-rigid pavements	76
Construction of natural gravel or crushed rock road pavement (bitumen surfaced)	743
Supply of natural gravel or crushed rock for road pavements (bitumen surfaced)	744
Construction or resheeting of natural gravel or crushed rock road pavement (not to be bitumen surfaced)	800
Supply of natural gravel or crushed rock for road pavements (not to be bitumen surfaced)	801

ROADSIDE

Roadside fireplace	A 4671
Roadside litter bin	A 5841

TRAFFIC PROVISION AND PROTECTION

Floodway information sign (1966)	A 5752
Manufacture of warning signs (1968)	682
Motor grid 12 ft (A 5769); 24 ft (1964)	A 5770
Traffic arrangements at works in progress (1974).	121 (Metric)
Guide posts—supply (1973)	252 (Metric)
Guide posts—erection (1973)	253 (Metric)
White paint for guide posts (1963)	618
Roadmarking paint (1966)	671

CONTRACTS

Bulk sum tender form, Council contract (1966)	39
Bulk sum contract form, Council contract	38
Cover sheet for specifications, Council contract (1964)	342
Caretaking and operating ferry	498
General conditions of contract, Council contract (1966)	24B
Schedule of quantities form (1966)	64

MANUALS

Manuals, No. 1—Plant*; No. 3—Materials*; No. 4—Roadside Trees*; No. 5—Explosives*; No. 6—Bridge Maintenance*; No. 7—Road Maintenance*.

BOOKLETS

Guide to Main Roads Administration.
General Conditions of Assistance to Councils.
Miscellaneous Activities on Main Roads.
Schedule of Descriptions of Classified Roads and Works.
Duties and Responsibilities of a Superintending Officer.

N.A.A.S.R.A.

Guide to Publications and Policies of NAASRA.
Policy for Geometric Design of Rural Roads*.
Highway Bridge Design Specification*.
Highway Bridge Construction*.
Full list of publications and prices.

All standards may be purchased from the Plan Room at the Department's Head Office, 309 Castlereagh Street, Sydney. Single copies are free to Councils except those marked *. A charge will be made for a set of standards.

G 83082 D. West, Government Printer, New South Wales—1975