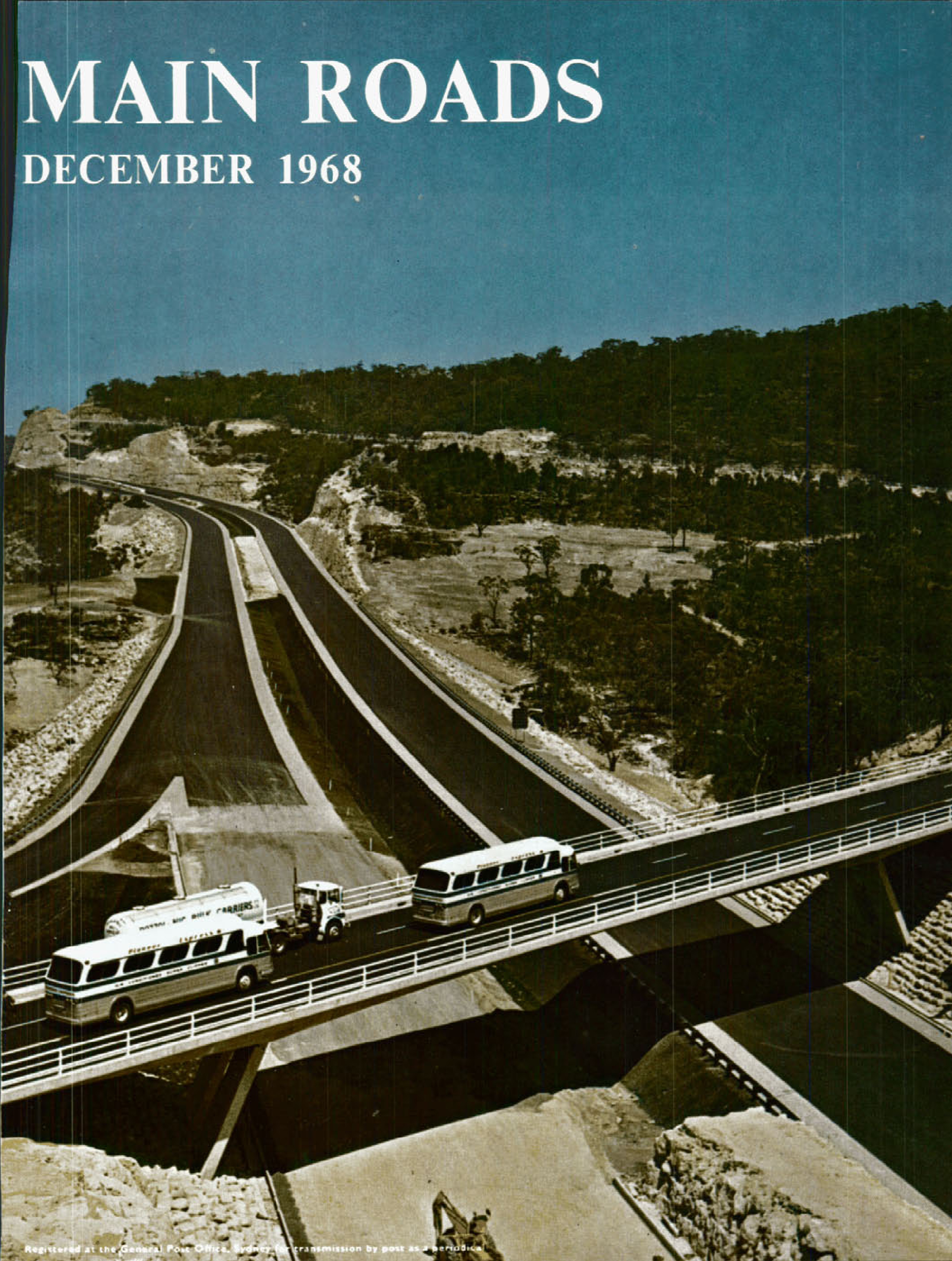
MAIN ROADS

DECEMBER 1968



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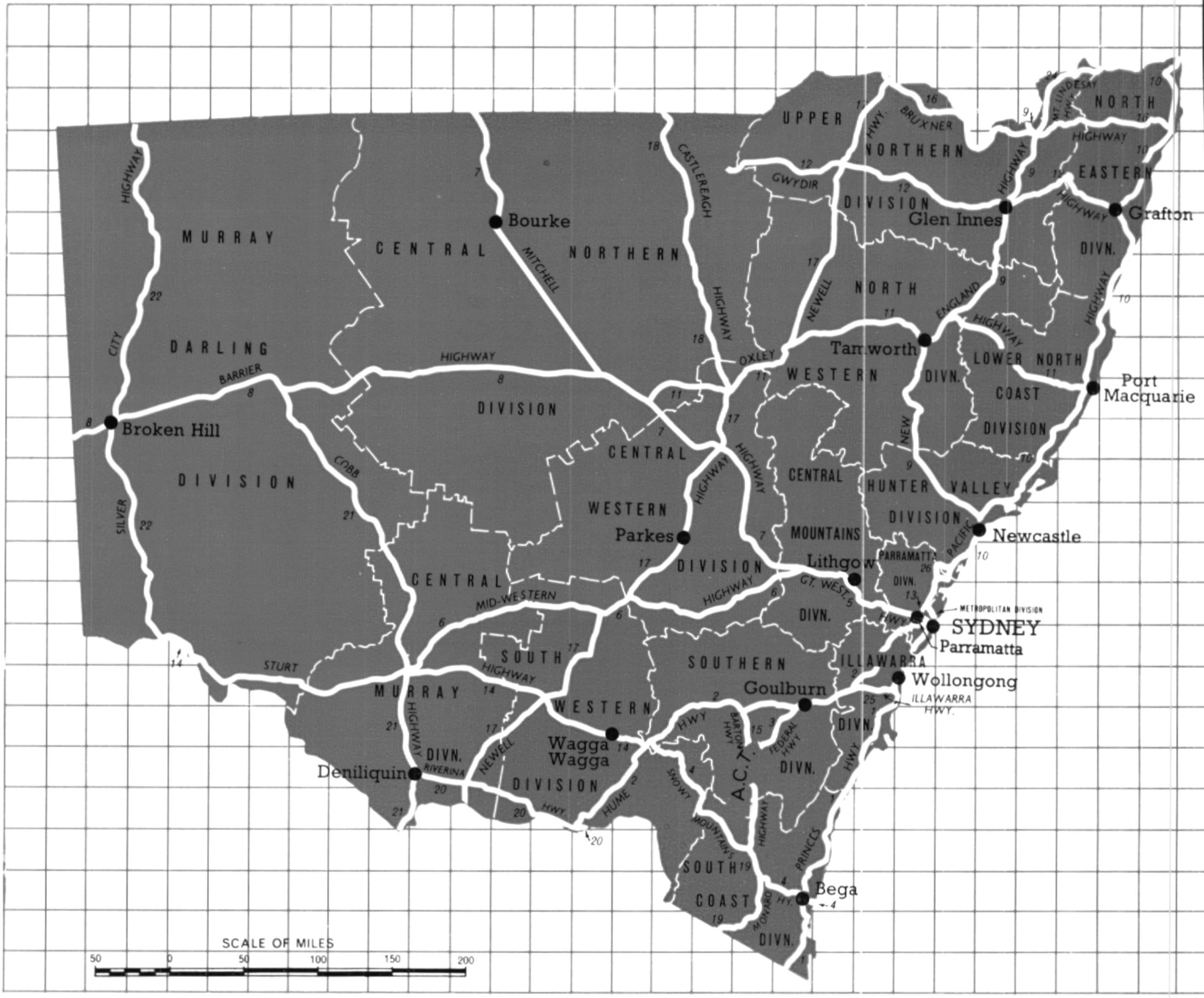

HIGHWAY SYSTEM OF NEW SOUTH WALES

Mileage of Main Tourist and Developmental Roads, as at 30th June, 1968

Expressways	21
State Highways	6,542
Trunk Roads	4,228
Ordinary Main Roads	11,593
Secondary Roads (County of Cumberland only)	159
Tourist Roads	218
Developmental Roads	2,746
	25,507
Unclassified roads, in Western part of State, coming within the provisions of the Main Roads Act	1,529
TOTAL	27,036

Area of New South Wales, 309,433 square miles
Length of public roads within New South Wales, 131,300 miles

Population of New South Wales at 31st March, 1968—4,370,307

Number of vehicles registered in New South Wales at 30th June, 1968—1,741,961

STATE HIGHWAYS
DIVISIONAL BOUNDARIES
DIVISIONAL OFFICES

MAIN ROADS

Journal of the Department of Main Roads, New South Wales

DECEMBER, 1968

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Front and back covers: Construction work on the Sydney-Newcastle Expressway between the Hawkesbury River and Berowra interchange.
(*More photos on pages* 45, 46, 47.)

Sydney—Newcastle Expressway

Vastly improved conditions will be available to travellers heading northwards from Sydney from about mid-December when the section of expressway between the Hawkesbury River and Berowra will be opened to traffic.

Every effort is being made by the Department to make this section of road available to the great volumes of traffic expected during the forthcoming holiday season.

When this new length of expressway is opened motorists will be able to use:

☐ The Pacific Highway comprising at least four lanes from Sydney to Berowra.
☐ The Expressway from Berowra to Calga as well as the Pacific Highway, with the Hawkesbury River bridge being common to both.
☐ State Highway No. 26 from Calga to Ourimbah via Peats Ridge and Somersby or the Pacific Highway via Gosford.

It can be expected that the congestion which has occurred on the narrow section of the Pacific Highway south of Hawkesbury River will be eliminated with the opening of the new section of expressway.

With a view towards further improvements, plans are well advanced towards the provision of a new six-lane bridge over the Hawkesbury River to serve expressway traffic only. This new bridge is planned for completion in 1972.

COMMONWEALTH AID TO THE STATES FOR ROADS

The Commonwealth Government first accepted responsibility for providing some finance to the States for roads in 1923. Since then there have been many changes in the legislation which provides for this assistance and a resume of the first and subsequent enactments is here described. The section of this article dealing with the period from 1923 to 1956 was published in the June 1957 number of *Main Roads*.

1923 TO 1925

The provision of money by the Commonwealth Government for expenditure by the States on roads commenced in 1923 with the passing by the Commonwealth Parliament of the Main Roads Development Act. By this Act the Commonwealth provided \$3·5 million to the States between 1922–23 and 1925–26 subject to the States providing an amount of \$3 million. The Commonwealth money was divided among the States on the basis of three-fifths in respect of State population, and two-fifths in respect of State area, and was to be spent on construction only, on the following classes of roads:

☐ Main Roads which open up and develop new country;

☐ Trunk Roads between important towns; and

☐ Arterial roads.

While the assistance to the States under this Act was relatively small, it was a prelude to a succession of subsequent Acts providing a substantial degree of assistance. The essential features of these are outlined hereunder, including the methods of assessing the amounts paid, and the conditions attaching to payments.

1926–27 TO 1930–31

In August, 1926, the Commonwealth Parliament passed a Federal Aid Roads Act which provided for the execution of formal Agreements between the Commonwealth and States whereby a total of \$70 million would be spent on road works over a period of 10 years from 1st July, 1926. The Commonwealth Government undertook to provide a fixed amount of \$4 million per annum, three-fifths of the total to be distributed among the States on the basis of population, and two-fifths on the basis of area. The States were required to find 75 cents for each dollar contribution by the Commonwealth, a total of \$3 million per annum. Under this Agreement the classes of roads eligible for Federal assistance were the same as in the Main Roads Development Act, 1923–1925.

While at least one-fourth of the money provided for each State was required to be spent on construction, the whole of it had to be expended on construction and reconstruction, it being left entirely to the States to provide for maintenance. Commonwealth approval was required for each individual work proposed by a State.

1931–32 TO 1936–37

In May, 1929, an amendment of the Agreement was mooted because of the difficulty being experienced by the States in providing their contributions, and the need was expressed by several States for the expenditure of some portion at least of the Commonwealth money on maintenance and repair works, rather than on new construction and reconstruction. From the Commonwealth point of view, too, there was a need for a revision of the Agreement, for the reason that whilst the Commonwealth proportion had been found originally by an increase in the customs and excise duties on petrol and imported motor bodies and parts, the general economic depression was considerably reducing importations of petrol and motor accessories by the latter end of 1929. In November, 1929, the Commonwealth Government indicated that it would be agreeable to amend the Agreement so as to discontinue the requirement for the State contributions and also to provide for the expenditure of the money in such a way as would best meet the needs of each State.

These proposals were embodied in an amendment of the Federal Aid Roads Agreement which was adopted as from 1st July, 1931. The following were the principal variations resulting from the amendment:

☐ The States were relieved as from 1st July, 1931, of the obligation to contribute pro rata with the Commonwealth.

☐ The Commonwealth grants to the States were as follows:

2½d. per gallon on imported petrol from a total tax of 7d. per gallon collected by the Commonwealth Government.

1½d. per gallon on locally refined petrol from a total tax of 4d. (increased to 5½d. in May, 1932) per gallon collected by the Commonwealth Government.

☐ The money could be expended on the maintenance, repair, reconstruction, or construction of roads irrespective of their classification.

☐ Commonwealth approval to individual works to be carried out was no longer required.

1937–38 TO 1946–47

New Agreements to operate for 10 years from 1st July, 1937 to 30th June, 1947, were entered into following the passage of the Federal Aid Roads Act, 1937. The new Agreements continued the form of Commonwealth assistance much along the lines of the old Agreements; matters of interest connected with the new Agreements were as follows:

☐ The proportion of the taxes on petrol made available for distribution between the States was increased to the following amounts:

3d. per gallon on imported petrol;

2d. per gallon on locally refined petrol.

Note—At the commencement of the 1937 Act the Commonwealth Government was collecting 7d. and 5½d. per gallon on imported and locally refined petrol, respectively. During the currency of the Act these taxes were gradually increased until at the time the Act expired they were 10d. on imported petrol and 8½d. on locally refined petrol.

☐ Five per cent of the total grant was paid to the State of Tasmania, and the remaining 95 per cent continued to be distributed between the other States on the basis of three-fifths according to the population of each State and two-fifths according to the area of each State.

☐ Certain amounts due to the National Debt Sinking Fund on account of loan moneys provided by the States under an earlier Agreement were deducted from the amounts payable to the States.

☐ The proceeds of all but ½d. per gallon of the grant paid to the States were required to be spent on roads. The proceeds of ½d. per gallon could be spent on roads or on other works connected with transport, as determined by the State, except that one-twelfth of the proceeds of the ½d. per gallon mentioned could be required by the Commonwealth to be spent on the maintenance and repair of roads which approach or adjoin Commonwealth properties.

1947–48 TO 1949–50

In 1947, the Commonwealth Aid Roads and Works Act, 1947, was passed by the Commonwealth Parliament. It applied for a period of 3 years from 1947–48 to 1949–50. The completion of formal Agreements with the States was discontinued.

The new Commonwealth legislation provided for a continuation of the payment to the States of 3d. per gallon on imported petrol and 2d. per gallon on locally-refined petrol (excluding petrol used for aviation purposes) for expenditure on the construction, reconstruction, maintenance, and repair of roads, the distribution between the States to be on the same basis as previously. Petrol taxation levied by the Commonwealth Government continued during the currency of this Act at the same rates as obtained at the expiry of the 1937 Act, namely 10d. per gallon on imported petrol and 8½d. per gallon on locally refined petrol. The following were the principal changes incorporated in the 1947 Commonwealth Act:

☐ A new principle was introduced in this legislation in that the new Act specifically provided that there would be expenditure of Commonwealth Aid on local rural roads (i.e. rural roads which are not Main Roads). In implementing this new principle a fixed amount of $2 million per annum, over and above the gallonage payment, was to be distributed to the States for expenditure upon the construction, reconstruction, maintenance, and repair of roads through sparsely populated areas, timber country, and rural areas, or if the State thought fit, upon the purchase of road-making plant for use in areas where the purchase of such plant was beyond the resources of the local authorities; the money was not to be spent on proclaimed state highways, trunk roads, and main roads without the approval of the Commonwealth Minister. The original amount of $2 million per annum was increased to $4 million in 1948–49 and to $6 million in 1949–50. The distribution of this money between the States was on the same basis as applied to the distribution of the proceeds of the gallonage payment.

☐ The amounts made available to the States were to be expended in accordance with Commonwealth policy.

☐ A maximum of one-sixth of the gallonage payment to the States could be spent on works connected with transport other than roads.

☐ Expenditure on strategic roads and roads of access to Commonwealth property was not (as previously) required to be met from the funds made available to the States.

1950–51 TO 1953–54

The Federal Parliament passed the Commonwealth Aid Roads and Works Act, 1950, which provided the machinery for payment of road funds to the States for a period of 5 years from 1950–51 to 1954–55.

Prior to the enactment of the new Act, the States made strong representations to the Commonwealth for a substantial increase in payments to the States from the proceeds of petrol taxation on the grounds that there was need for additional revenue for expenditure on roads and that of the average gallonage tax of 9.75d. collected by the Commonwealth, only 4.70d., or less than half, was devoted to road works, the balance of 5.05d. being retained by the Commonwealth.

The principal departure from the former Commonwealth Act was in respect of the money provided for expenditure on roads other than main roads. Whilst the former Act provided for fixed amounts to be set aside ($6 million in the final year of the 1947 Act) the 1950 Act provided for expenditure on rural roads based on a rate per gallon of petrol consumed.

The main features of the 1950 legislation were as follows:

☐ Payments to the States were increased from 3d. to 6d. per gallon on imported petrol and from 2d. to 3½d. per gallon on locally refined petrol. Petrol tax rates levied by the Commonwealth Government remained unaltered at 10d. and 8½d. per gallon respectively.

☐ Of the amounts payable to the States, after payment of 5 per cent to Tasmania—

65 per cent (less $1.2 million expendable directly by the Commonwealth Government on strategic roads, roads of access to Commonwealth properties, and the promotion of road safety practices) was made available for expenditure on roads generally.

35 per cent was made available for expenditure on rural roads, including developmental roads, feeder roads, roads in sparsely populated areas, and in soldier settlement areas, but excluding state highways, trunk roads, and main roads; also on the purchase of road-making plant for use on the rural roads thus defined.

The only Commonwealth control exercised on the expenditure of the money made available to the States was in the form of an annual statement

State	Estimated Roads Needs	Estimated Commonwealth Aid Payments	Percentage of Needs estimated to be paid by the Commonwealth
	($ Million)	($ Million)	%
New South Wales	2,468	490	19.8
Victoria	1,888	342	18.1
Queensland ..	1,400	320	22.8
South Australia ..	598	200	33.4
Western Australia	484	310	64.0
Tasmania	246	88	35.7

FIGURE 1

State	Percentage of C.A.R. grants paid to the States	Area excluding A.C.T. & N.T.	Population 1967-68	Vehicles registered
	%	%	%	%
New South Wales ..	27.8	12.65	37.0	35.7
Victoria	19.5	3.59	28.1	27.8
Queensland	18.3	27.26	14.6	14.6
South Australia ..	11.5	15.54	9.6	10.1
Western Australia ..	17.9	39.89	7.4	8.5
Tasmania	5.0	1.07	3.3	3.3
	100	100	100	100

FIGURE 2

required to be certified by the St Auditor-General and forwarded to t Commonwealth covering the expen ture of Commonwealth funds.

1954–55 TO 1958–59

A new Commonwealth Aid Roa Act came into force on 1st July, 195 in replacement of the Commonweal Aid Roads Act, 1950. The 1950 Act wa not due to expire until 30th Jun 1955, but in order to correct a situatio brought about by the rapidly increasin quantity of petrol refined locally, o which a lower tax rate was payable tha on imported petrol, a situation which wa adversely affecting the amount receive by the States, the Commonwealth Parliament repealed the 1950 Act one year before its expiry date.

The principal effects of the 1954 Act were as follows:

☐ A uniform and increased rate of 7d. per gallon on petrol was paid to the States in respect of both imported and locally refined petrol, although taxation continued at 10d. and 8½d. per gallon respectively.

☐ At least 40 per cent of the amounts paid to the States were required to be set aside for expenditure on local roads in rural areas which were not state highways, trunk roads, or main roads. (The percentage provided in the previous Act was 35 per cent.)

☐ An additional sum of $600,000 per annum was retained by the Commonwealth Government for expenditure on road safety practices, strategic roads, roads of access to Commonwealth property, and other roads serving or likely to serve Commonwealth purposes. The amount retained was thus increased to $1.8 million per annum ($0.2 million for expenditure on road safety practices and $1.6 million for expenditure on strategic roads, etc.).

☐ The basis of distribution between the States (i.e. 5 per cent to Tasmania, and the balance among the other five States on the basis of three-fifths in respect of population and two-fifths in respect of area) continued to apply as in previous Acts, but the 1954 census replaced the 1947 census for the purpose of establishing the population of the various States.

The 1954 Act was subsequently amended in 1955 and 1956—

☐ 1955 Amendment—As from 1st July, 1955, the amount originally retained by the Commonwealth Government for road safety practices ($200,000 per annum) was increased to $300,000 per annum. The amount of $1.6 million per annum for rategic roads, roads of access to Com-onwealth property, and for other roads rving or likely to serve Commonwealth urposes, remained unaltered.

☐ 1956 Amendment—As from 1st April, 956 the payment to the States of 7d. per allon in respect of both imported and ocally refined petrol was raised to 8d. er gallon coincident with an increase of etrol taxation levied by the Common-ealth from 10d. to 1s. 1d. per gallon on mported petrol and from 8½d. to 11½d. er gallon on locally refined petrol.

1959–60 TO 1963–64

A new Commonwealth Aid Roads Act came into force on 1st July, 1959 and continued for a period of 5 years.

The 1959 Act represented a fundamental departure in Commonwealth policy which, since 1st July, 1931 had provided for payments to the States based on—

☐ Quantity of petrol consumed.

☐ Distribution between the States according to a formula based on area and population.

The main features of the 1959 Act were as follows:

☐ (*a*) Annual grants, starting at \$80 million in the first year and increasing by \$4 million in each succeeding year until \$96 million was reached in the fifth year were paid to the States and were known as "basic" grants.

☐ (*b*) "Supplementary" annual grants starting with \$4 million in the first year and increasing by \$4 million in each succeeding year until \$20 million was reached in the fifth year were also paid to the States subject to the following proviso, viz:

> that the supplementary grant was made available to a State only to the extent that annual road expenditure from the State's own resources exceeded road expenditure which had already been made from State funds in the financial year 1958–59, i.e. the year immediately prior to the commencement of the 1959 Act.

The total amount paid to the States in accordance with (*a*) and (*b*) above was \$500 million over the five years from 1959–60 to 1963–64 inclusive.

Other important provisions of the 1959 Act were as follows:

☐ (*c*) After setting aside 5 per cent for Tasmania, the balance was distributed to the remaining five States on the basis of one-third according to area, one-third according to population and one-third according to the number of motor vehicles registered.

☐ (*d*) The Commonwealth reservation for expenditure on roads serving Commonwealth purposes or for promotion of road safety was discontinued.

☐ (*e*) The provision requiring that no less than 40 per cent shall be expended on rural roads other than highways, trunk roads, and main roads was retained in the 1959 Act.

☐ (*f*) Up to \$2 million of the total amount paid to the States each year could be diverted to expenditure on works connected with transport by road or water, the amount of \$2 million being apportioned between the States in the same ratio as set out in (*c*) above.

1964–65 TO 1968–69

The Commonwealth Aid Roads Act, 1964 came into effect from 1st July, 1964 and is due to expire on 30th June, 1969.

The main provisions of the 1964 Act are as follows:

☐ Basic grants commencing with \$124 million in the first year and increasing by \$4 million in each succeeding year until \$140 million is reached in the fifth and final year under the Act is payable to the States.

☐ Supplementary grants commencing at \$6 million in the first year and increasing at the rate of \$6 million in each successive year until \$30 million is reached in the fifth year is payable to the States subject to the following proviso, viz. that each State, in order to qualify for the supplementary grant, must expend from its own resources on road maintenance and construction, as defined in the Act, a fixed minimum amount as specified in the Schedule attached to the Act. The "supplementary" amount payable to a State in any one year shall be the amount by which road expenditure from State sources exceeds the amount specified in the Schedule, or the quota calculated in accordance with the "area-population-motor vehicle formula", whichever is the less.

☐ After setting aside 5 per cent for Tasmania, the balance is required to be distributed to the remaining five States on the same formula basis as in the previous Act, viz: one-third according to area, one-third according to population, and one-third according to number of vehicles registered in each State.

☐ The provision requiring at least 40 per cent of the money paid to the States to be spent on rural roads other than highways, trunk, and main roads was retained in the 1964 Act as was also the clause enabling up to \$2 million to be expended annually on works connected with transport by road or water in the same ratios as previously.

COMMENTS ON THE LEGISLATION

The existing formula, under which funds are distributed on an area-population-motor vehicle basis, is unfair to some States as it fails to return to those States an equitable amount according to needs.

The table shown in Figure 1 illustrates this deficiency. It sets out the estimated road needs of each State, determined by an Australia wide Road Needs Survey for the period 1964-1974, compared with the estimated amounts payable by way of Commonwealth Aid Road grants under the current formula for the same period.

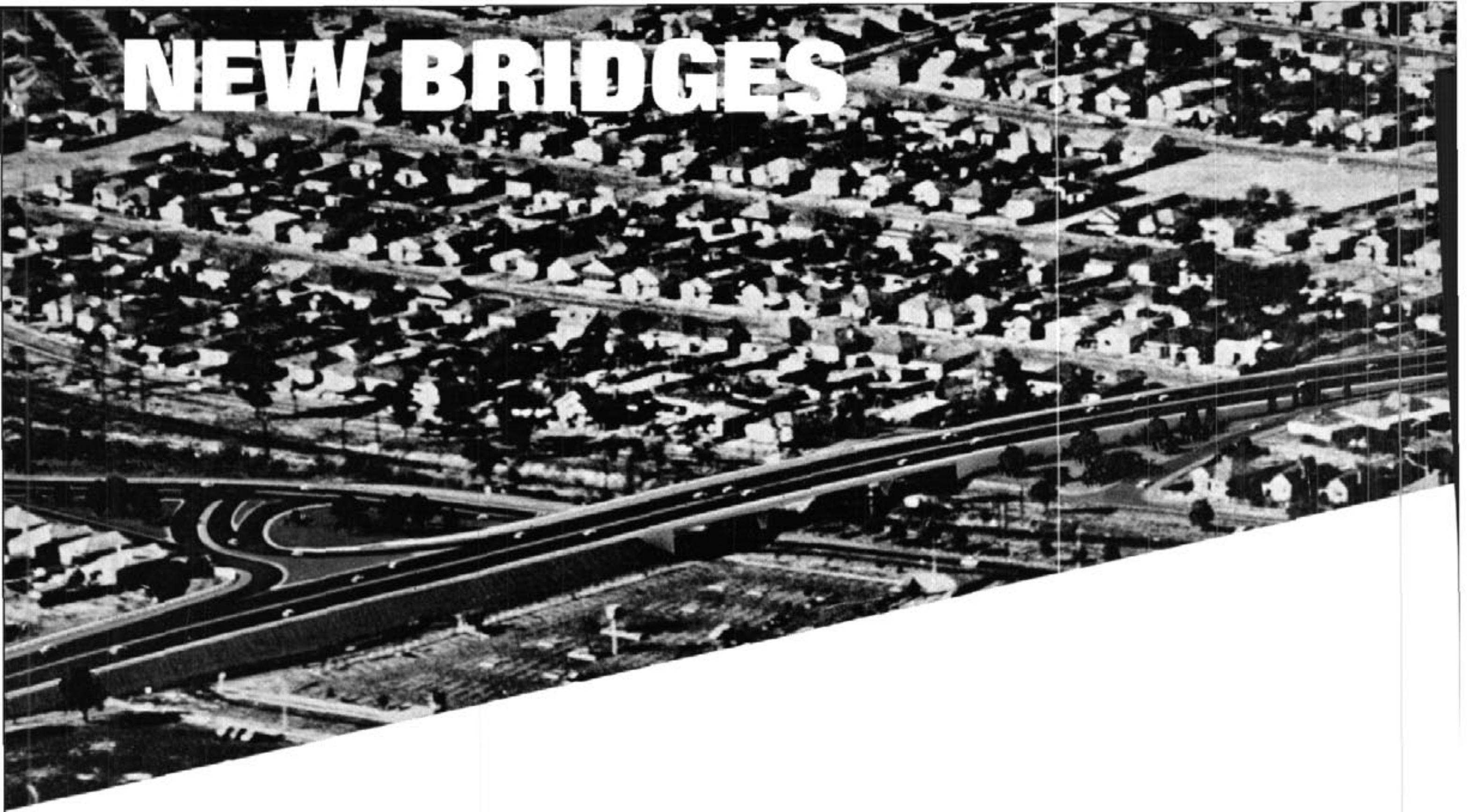
There is no doubt that the "area" content of the formula unduly favours the States with smaller populations and larger areas at the expense of the more populous States, which with their greater concentration of population and traffic have greater responsiblities and in consequence greater demands on their finances for road facilities.

The extent to which the area content of the formula favours the larger States is emphasized in Figure 2 which shows for 1967–68 the percentage of Commonwealth grants in relation to the respective percentages of area, population, and registered vehicles.

It can be readily seen that Victoria and New South Wales are very adversely affected. With almost two-thirds of the total population and registered vehicles between them, they receive less than half of the total grant because of the illogical importance placed on "area" in the formula.

The Commonwealth Aid Roads legislation is due to be re-enacted in 1969 and this would be an opportune time for a realistic appraisal of the adequacy of this legislation. To provide a basis for the new legislation a nationwide survey has recently been undertaken to determine Australia's road needs for the 10-year period 1969–1979. This survey was carried out by arrangement between the National Association of Australian State Road Authorities and the Commonwealth Bureau of Roads. It is to be hoped that the needs revealed by this survey will be critically examined not only in respect of the allocation of funds for roadworks in Australia but also in respect of the development of a new and more equitable formula for their apportionment. These needs are primarily governed by people and motor vehicles.

NEW BRIDGES



The Department of Main Roads is continuing with a major bridge building programme. Some of the more important bridges now under construction or planned for an early commencement are described here.

BANKSTOWN

A new concrete bridge now being built at Bankstown will, when completed, alleviate the present congested traffic conditions in this busy shopping and commercial centre. Bankstown, a suburb about 12 miles from the City, is the centre of a thriving and rapidly developing area which includes vast new residential districts and considerable industrial expansion. In consequence the central business area develops great volumes of traffic.

The bridge will span North Terrace, the railway line and South Terrace to provide a new direct connection between Stacey Street north and Stacey Street south.

Designed by the Department of Main Roads it will be 295 feet long with dual 33 feet wide carriageways separated by a median. A footway on the eastern side, 10 feet wide, will be connected to the northern footpath in North Terrace allowing pedestrians to pass under the bridge to gain access to a nearby regional shopping centre.

The bridge is being built by Pearson Bridge Pty Ltd, at a contract price of $518,115.

The whole work, including road construction by the Department, is scheduled for completion in March, 1970.

FORBES

The Department of Main Roads recently accepted a tender for the construction of a new bridge over Lake Forbes at Forbes. The bridge is being built on a deviation of the Newell Highway (State Highway No. 17) above flood level.

The new bridge will be of prestressed concrete construction, 470 feet long and 28 feet wide between kerbs. It will have two footways each 8 feet wide. The contract price of the bridge is $247,702.

The existing bridge which is narrow and subject to flooding will be retained to serve local traffic.

The Department of Main Roads engaged a firm of consulting engineers, Messrs Taylor and Herbert, to design the new bridge which is being built by Moy Bros Pty Ltd and expected to be completed in October, 1969.

VILLAWOOD

Railway level crossings always present a hazard to both road and rail traffic and this is particularly so when they are located on busy urban roads.

One such level crossing now exists on Woodville Road (State Highway No. 13) at Villawood but its life of uncertain usefulness will shortly end as a new overbridge now being built to replace it, is expected to be completed by December, 1969.

The new concrete bridge for which a contract amounting to $165,296 has recently been awarded to Arthur Boyd Constructions Pty Ltd, will be 198 feet long with dual three-lane carriageways separated by a narrow median. Two footways, each 8 feet wide, are being provided for pedestrians.

On completion of the overbridge and its immediate approaches, dual carriageways, each carrying three lanes of traffic, will exist throughout the full length of Woodville Road, from Parramatta Road at Granville to the Hume Highway at Lansdowne.

This will be the second railway level crossing to be eliminated from this road. Recently, a new overbridge was built to carry the main western railway line over Woodville Road at Dog Trap Gates, adjacent to Parramatta Road.

The Villawood overbridge was designed by the Department of Railways which will contribute towards the cost of the work.

REGENTVILLE

A new bridge to be built at Regentville, near Penrith, will form part of the first stage of construction of the Western Expressway. The new bridge is required to carry the expressway over the Nepean River about 2 miles upstream (south) from the Victoria Bridge on the Great Western Highway.

This prestressed concrete bridge will have an overall length of 1,045 feet, comprising two end spans each 170 feet long and three centre spans each 235 feet long.

Initially the bridge will be constructed with a single carriageway providing for two lanes of traffic and two footways. At a later stage when traffic conditions warrant, the bridge will be widened to provide dual three lane carriageways separated by a median and flanked by two footways.

When completed the bridge will provide a river crossing to serve a route which by-passes the very busy Penrith shopping centre.

The bridge was designed by Consulting Engineers, G. Maunsell and Partners.

Olympic standard rowing conditions on the river have been considered in the design of the bridge which provides space for four 50 metre rowing lanes under the centre span with a 15-metre clearance to the piers.

The contract for the construction of this bridge was recently awarded to M. R. Hornibrook (N.S.W.) Pty. Ltd., who have undertaken to complete the structure by December, 1970 at a cost of $1,454,400.

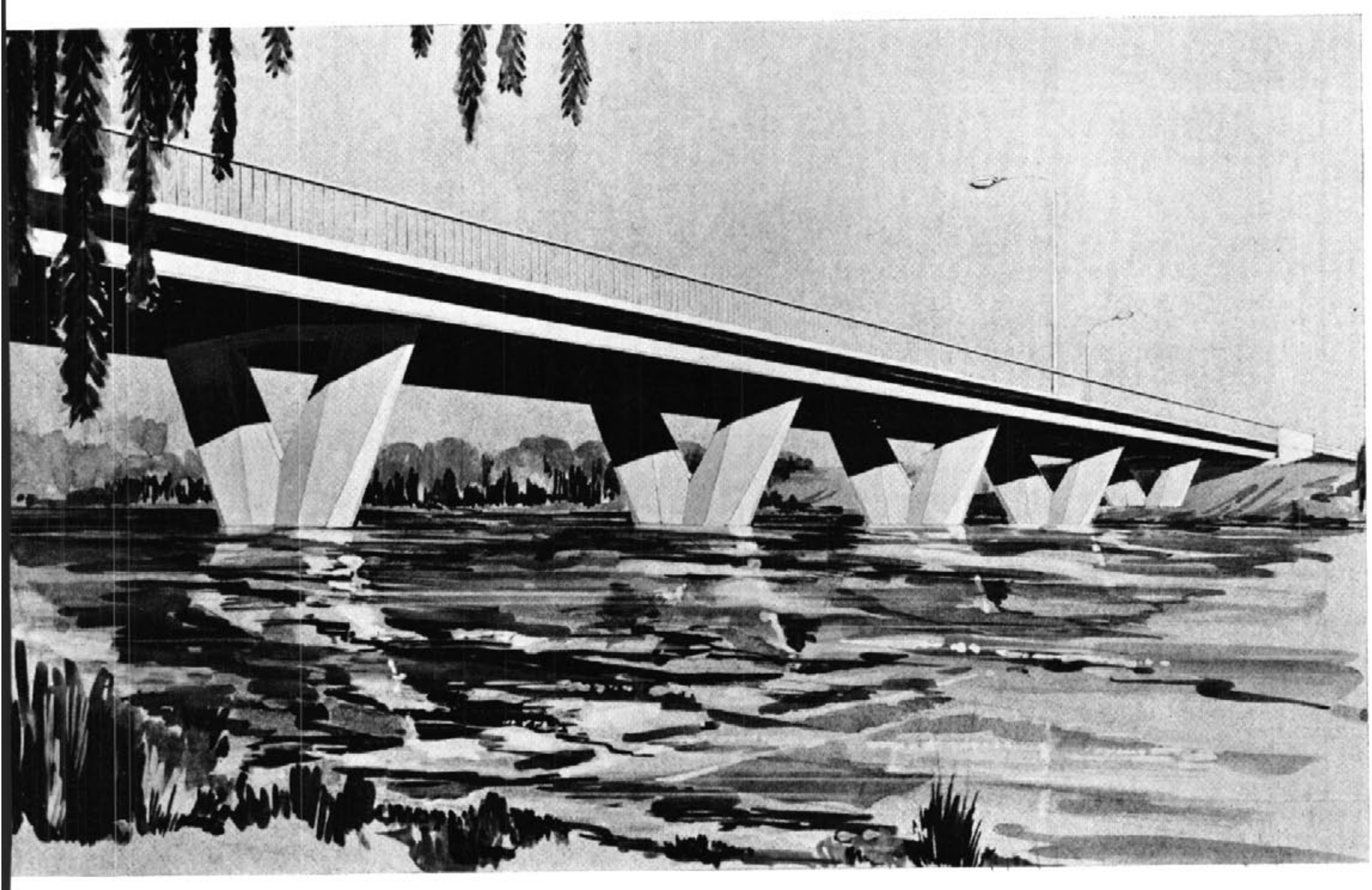
HAWKESBURY RIVER

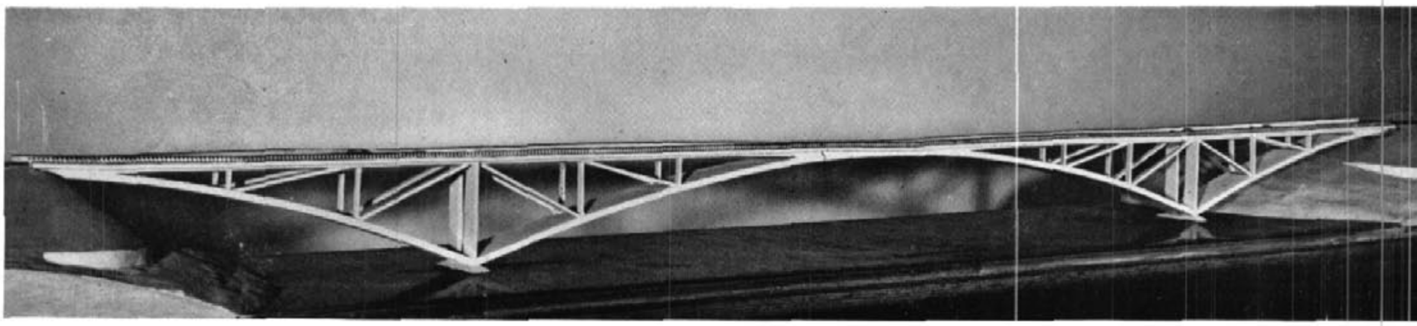
The construction of the Sydney-Newcastle Expressway has been planned so that as each section of the work could be built and completed it would be brought into service and so alleviate traffic conditions on the Pacific Highway.

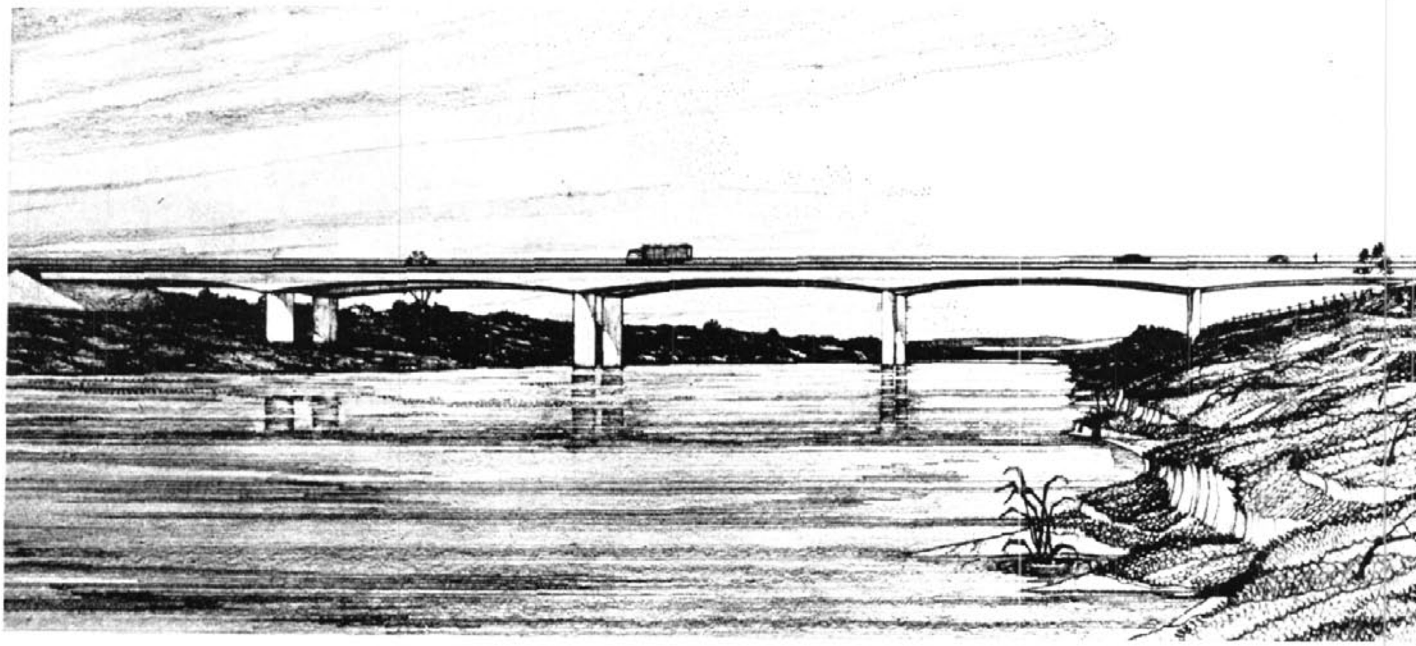
Two sections north of the Hawkesbury River extending to Calga, have already

Left: Artists impression of new railway overbridge at Bankstown

Below: The bridge now under construction at Forbes







been completed and brought into service while the third section, extending southwards from the Hawkesbury River towards Berowra, will be in use by traffic at the end of 1968.

In order to cater effectively for expressway traffic the Department has decided that the next and most obvious step in the construction of the Sydney-Newcastle Expressway will be to link the sections north and south of the Hawkesbury River by constructing a new bridge for the exclusive use of the expressway traffic. The existing three lane bridge will not be adequate for the continued use by increasing volumes of traffic likely to use the Pacific Highway and the Expressway.

To this end plans for a new bridge are now being prepared by the Department's staff with a view to the bridge being completed in 1972.

It is proposed to locate the new bridge at an average distance of about 130 feet upstream from the existing bridge. It will be of steel and concrete construction, 1995 feet long, with two three-lane carriageways separated by a median. Footways will not be provided. The pier positions on the new bridge will be co-ordinated with the piers on the existing bridge. The spans will be considerably shorter than the long steel trusses on the present bridge.

Top: Model of proposed bridge at The Rip

Above: Sketch of how the bridge at Regentville will appear when ultimately completed

Until the new bridge is built the existing bridge will be required to serve both the Pacific Highway and the Expressway.

BRISBANE WATER

The proposal to bridge Brisbane Water at "The Rip" will provide a crossing connecting the Ettalong-Woy Woy area with the peninsula on the eastern side of Brisbane Water. When completed the bridge and approach roads will provide a more direct access to the central coast beaches and greatly improved access for residents on the peninsula.

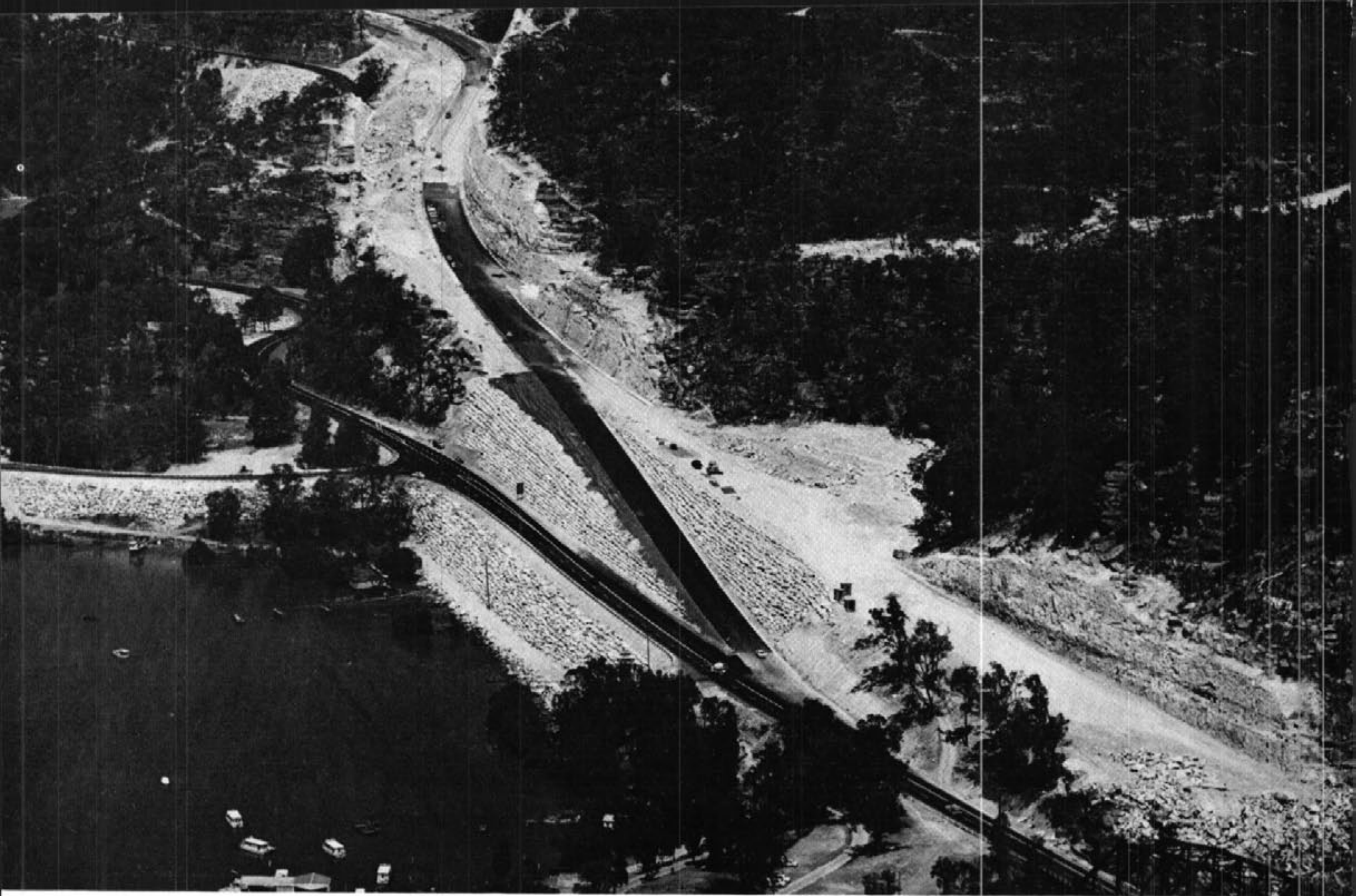
The Department is currently preparing a design for this new bridge with a view to commencing construction early in 1969 and completion by late 1970.

A concrete cantilever bridge of arch-like shape is proposed for this site. It will have an overall length of 1,080 feet and its centre span of 600 feet will cross the "Rip" channel without intermediate piers. The bridge will have a 28 feet wide carriageway and a 5 feet wide footway. The vertical clearance for yachts will be more than 50 feet.

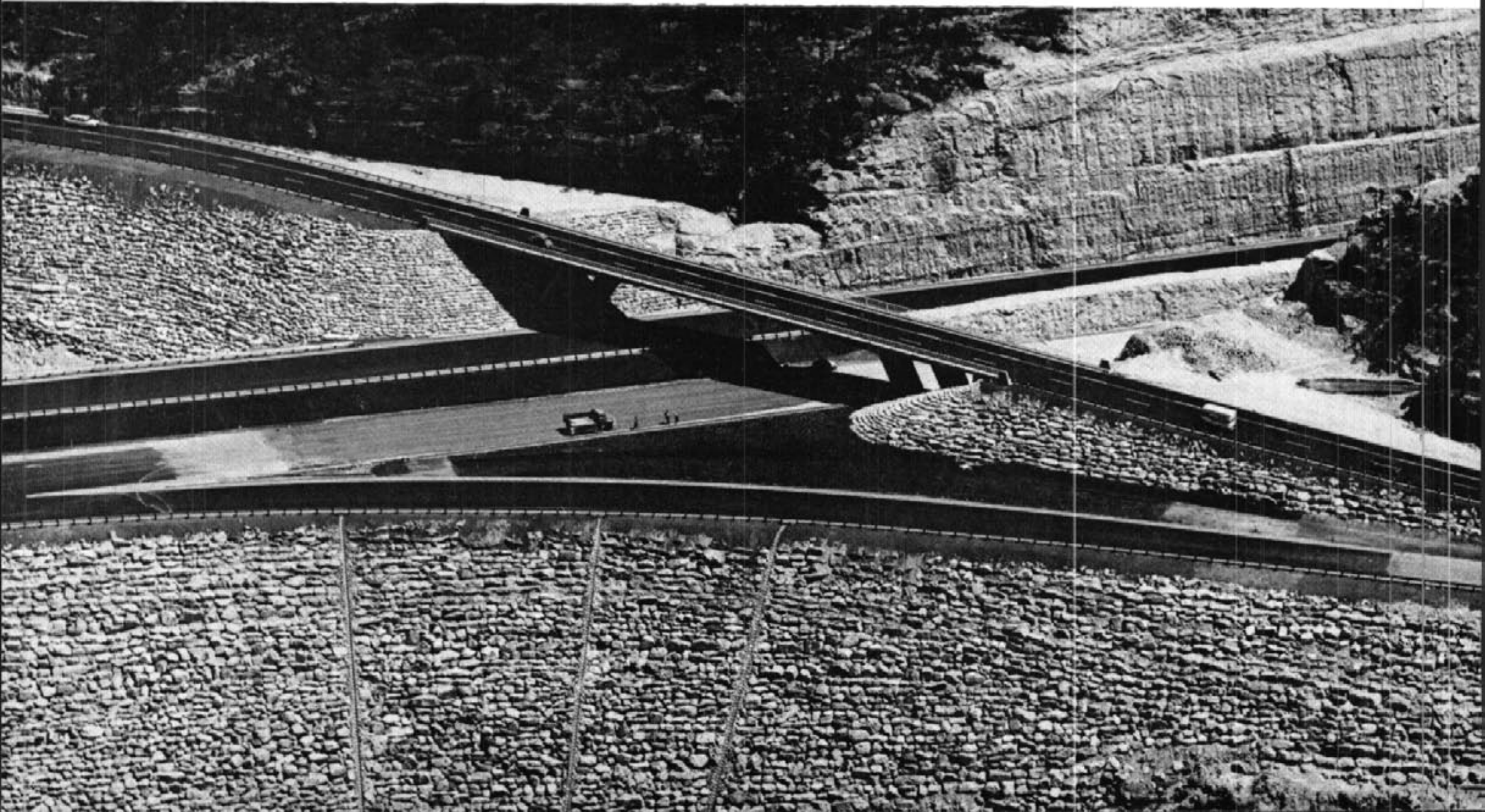
The cost of the bridge and associated roadworks will be shared by the Department and the Gosford Shire Council. At the present time the route of the bridge and approach roads does not form part of the Main Roads System and its future status will be considered when the project is completed.

There is no doubt that the completion of this bridge and the ready access it will provide will give added impetus to the development of this part of the coast which is already a very popular resort for holiday makers and tourists.

sydney-newcastle expressway



sydney-newcastle expressway



Previous page: A long view of the expressway showing the winding Pacific Highway

Top left: The new section of expressway merging with the Pacific Highway at the southern end of the Hawkesbury River bridge

Bottom left: New bridge carrying the Pacific Highway over the expressway. Note the deep cuts and high fills

Top right: Construction work at the southern end involves the relocation of the main northern railway line and provision of a toll plaza.

Bottom right: The expressway and the Pacific Highway near the top of the climb from Hawkesbury River.

These recent photographs illustrate the progress being made on the construction of the section of the Sydney–Newcastle Expressway south of Hawkesbury River. Extending from the river towards Berowra, it will link with the widened Pacific Highway, providing greatly improved conditions for travellers especially during peak periods. This section will be opened to traffic at the end of 1968.

Computer For Technical Use

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The routine use of a computer for work in the Department's technical branch, was first undertaken in 1960 when survey traverse data was prepared and computed using the facilities of a computer service bureau operated by a commercial organization.

Following these early trials and subsequent developments, it became evident that a considerable amount of the Department's technical work could be effectively carried out by computer. In consequence, the Department installed data processing equipment in 1962. This consisted of a card punch, verifier, and sorter which facilitated the preparation of data for service bureau computers, which were used to an increasing degree for survey and road earthworks computations, traffic surveys and accident analysis.

By 1967, sufficient work was being undertaken by computer to justify the installation of one in the Department to carry the existing workload and to facilitate widening the range of the work still further. An I.B.M. 1130 model was installed on a hire basis in December, 1967. An article in the June, 1968 number of *Main Roads* refers to this equipment. It is now being used extensively on a variety of work associated with the technical branch.

Head Office land survey checking staff and surveyors in the field use the computer for land survey computations. Programmes written specifically for the Department's requirements solve and adjust traverses and compute areas and co-ordinates. In the statement of problems there is provision for back reference to lines and co-ordinates so that an entire survey with unknowns can be computed in one run.

Many of the more tedious processes in bridge design have now been taken over by the computer. General structural analysis problems are solved by the well known computer programme "STRESS". Other programmes compute Influence Lines for bridge decks and analyse prestressed beams. A bridge geometry programme computes setting out plan measurements and levels for bridge decks curved in plan and/or elevation. A bridge pier and girder programme computes girder lengths and bearing levels for any configuration of skewed piers on curved or straight bridges. Section properties of complicated structural sections are also being calculated by the computer. A recently developed programme prints reinforcing bar schedules for which the bridge designer specifies the bar numbers and sizes, shape numbers, and number off each bar. The programme computes the total length and weight of each bar, making allowances for hooks and bends and prints a completed bar schedule which is then reproduced by photographic means for inclusion in the bridge drawings.

Slope stability analyses of bridge approach embankments in unstable ground are being carried out by the computer by the Swedish slip circle method.

Without a computer it would be impossible to anlayse in detail the huge volume of traffic count data being collected every day throughout the State by hundreds of recording and other types of traffic counters. The bulk of the data comes from 120 recording traffic counters which punch traffic counts into paper tape. The information on the tapes is translated into standard 80 column punch cards for processing by the computer to obtain traffic volumes such as hourly, quarter hourly, and 5 minute volumes, hundred highest hourly volumes and estimation of traffic at temporary counting stations by reference to permanent station counts. Intersection traffic counts are transformed by the computer into printed diagrammatic summaries of the traffic movements through various types of intersections.

A special system of traffic counting on the Sydney Harbour Bridge is used in conjunction with the computer to get daily summaries of traffic volumes on every traffic lane. The computer is also used to analyse travel time surveys, number plate surveys, delay studies, and accident records.

Future traffic volumes in the Newcastle area have been estimated by the use of

screen line counts and computer gravity model analysis. The computer was also used to find minimum paths through the future road network and for traffic assignment to the various links in the network. The Newcastle network required the full capacity of the computer which would need additional storage for a larger network of roads.

The New South Wales part of the 1969–1979 Road Needs Survey undertaken for the National Association of Australian State Road Authorities for which over 100,000 data cards have been punched, is being edited and summarized with the help of the computer. Lists and summaries of Unclassified Road and Bridge Inventories and Needs in each Local Government Area are being printed in duplicate by the computer for despatch to councils which co-operated in the needs survey. With the resources available it would have been impossible to analyse the survey data without the computer.

In the field of road design two of the most laborious tasks, namely calculation of earthwork volumes and pavement formation peg levels are being done by computer. The earthworks programme has been continuously developed since 1962 when it was written for simple rural roads. Further development will enable computation of earthwork volumes of dual carriageway roads with independent grade lines on each carriageway. The main use of the earthworks programme is in rural road investigation for comparing alternative routes or designs. The pavement formation peg level programme was developed in conjunction with the Sydney-Newcastle Expressway south of the Hawkesbury River.

Control of construction of the Expressway was assisted by critical path analyses of construction activities, which were printed out in bar chart form to a time scale by the computer using the project control programmes provided by the computer manufacturer. The project control programmes have also been used for the widening of the Pacific Highway at the southern end of the Expressway.

Calculations associated with the formation of photogrammetric strips by the Department's recently installed Stereometrograph are being performed by the computer which will soon play an essential part in aerial mapping operations when observations from the stereometrograph are punched directly into cards for input to the computer.

Statistical analysis by computer has been useful for the forecasting of vehicle numbers and Departmental revenue and is now being used to analyse accident statistics. It is also used for producing statistics of bituminous surfacing work.

Data processing has been a feature of the records in the Department's Library for some time. A stock taking and borrowers' reminder system is based on punched cards; book titles and numbers are punched into short lengths of paper tape which are used on record loans; and a recently established computer based periodical system keeps a file of all periodicals and their circulation list. At 4-monthly intervals the periodical system punches about 10,000 cards which are used to record the receipt of periodicals and control their circulation.

During the first full month following its installation the computer was worked for a total of 77 hours while in September last this had been increased to 133 hours, or approximately $6\frac{1}{2}$ hours per working day.

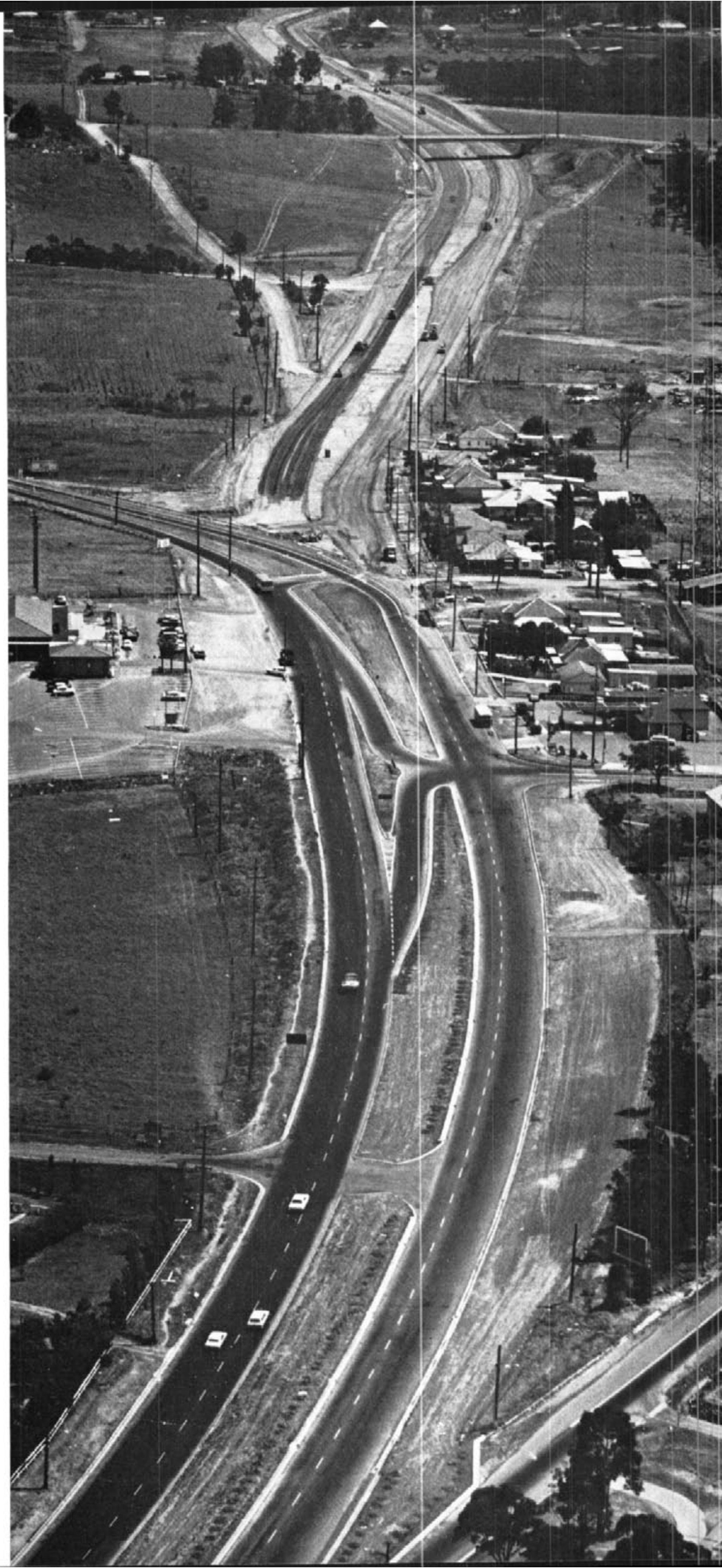
Taking the hire charges into consideration and salaries of personnel involved it is estimated that there has been a saving in excess of $5,000 per month in the work performed by the computer.

In less than a year it has become clear from the point of view of economy and variety of use, that this computer will become even more useful and in fact indispensable. Its future use will no doubt encompass other fields such as pavement research, annual works programmes, job costing, aerial mapping, and automated drawing of plans. In fact the Department has already invited tenders for the installation of a co-ordinatograph (plotter) to be driven by the computer and when this is installed consideration may have to be given to extending the hours of operation.

PROSPECT DEVIATION

A new section of the Great Western Highway (State Highway No. 5) is being constructed near Prospect to eliminate a winding narrow section of road. This deviation, about 2.75 miles long, will have two 24-feet wide carriageways separated by a central median. It will be an extension of the dual carriageway road being provided from the City and which will ultimately extend to Penrith.

It is expected that the new section will be ready for use by traffic by the end of 1968.



Left: Work at the eastern end of the deviation showing Blacktown Road in the right foreground

Centre: A section of the new work including a bridge which carries Church Lane over the route of the highway

Right: The new work at the western end


Divisional Engineers Conference

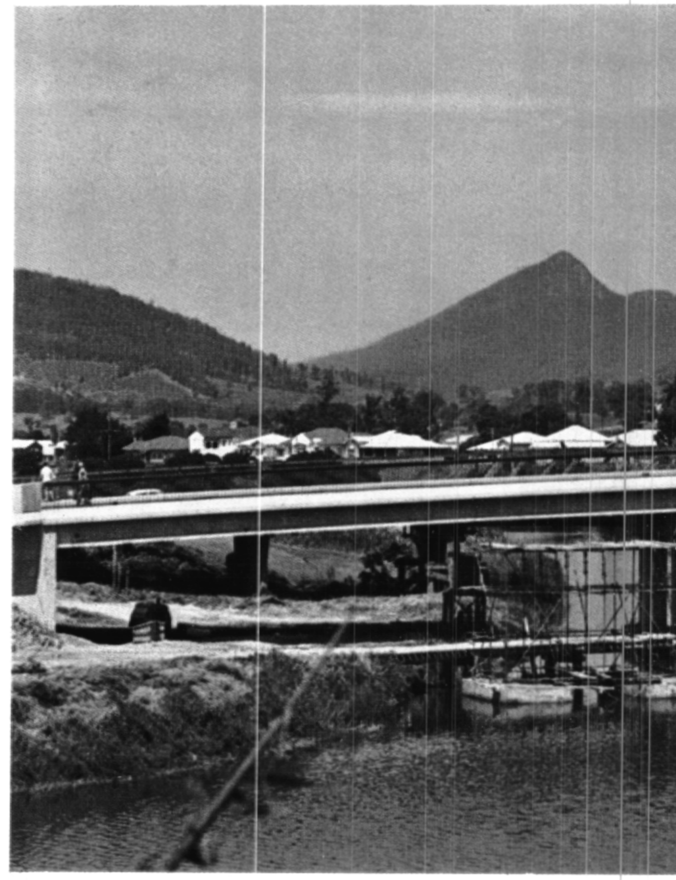
Each year the Department's Divisional Engineers meet in Head Office to discuss and exchange ideas on administrative and technical matters between themselves and senior Head Office staff. This photograph shows the Engineer-in-Chief, with the Divisional Engineers when they recently met for the 1968 Conference.

NEW TWEED RIVER BRIDGE

Above Traffic using the new bridge

Left Night view of the bridge and the glow from bush fires behind Mount Warning

Below The Hon. P. H. Morton, M.L.A., cutting the ribbon to officially open the bridge



A new bridge over the Tweed River at Murwillumbah was officially opened by The Hon. P. H. Morton, M.L.A., Minister for Highways, on Saturday, 26th October, 1968. The ceremony took place in the presence of Parliamentarians, civic leaders, and prominent citizens representing a wide cross section of the local community.

Murwillumbah, situated 20 miles from the mouth of the Tweed River is the centre of a thriving pastoral and agricultural district mainly devoted to dairying and growing sugar cane and bananas. The cane is processed at the nearby Condong sugar mill.

The township of Murwillumbah was first surveyed in 1872. In 1907 it suffered a severe setback when fire gutted the business section of the town. Since then however, there has been considerable development and it is now a busy and important town with a population in excess of 7,300. It is the central headquarters of the Tweed Shire Council.

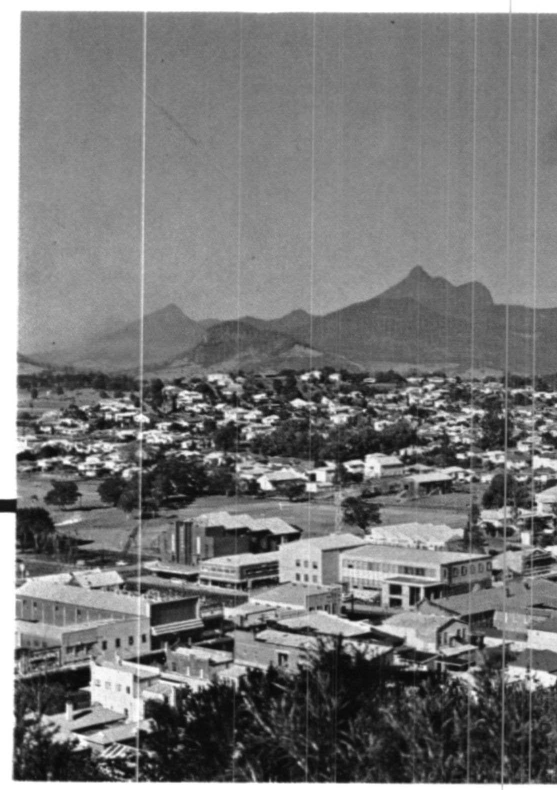
Early settlers and travellers in the area had to cross the Tweed River by a punt. The punt was replaced in 1901 when a new bridge was first brought into use which has served the area to the present time.

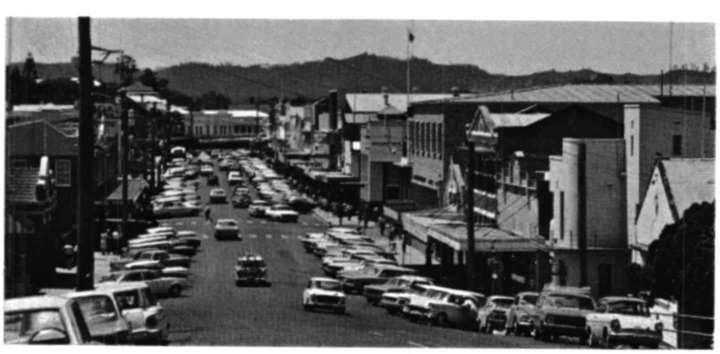
The new bridge is 513 feet long consisting of five spans of prestressed concrete construction. The carriageway is 28-feet wide and there are two 8-feet wide footways. The new bridge is adjacent to the old structure it replaced, providing access to the centre of the township from the Pacific Highway.

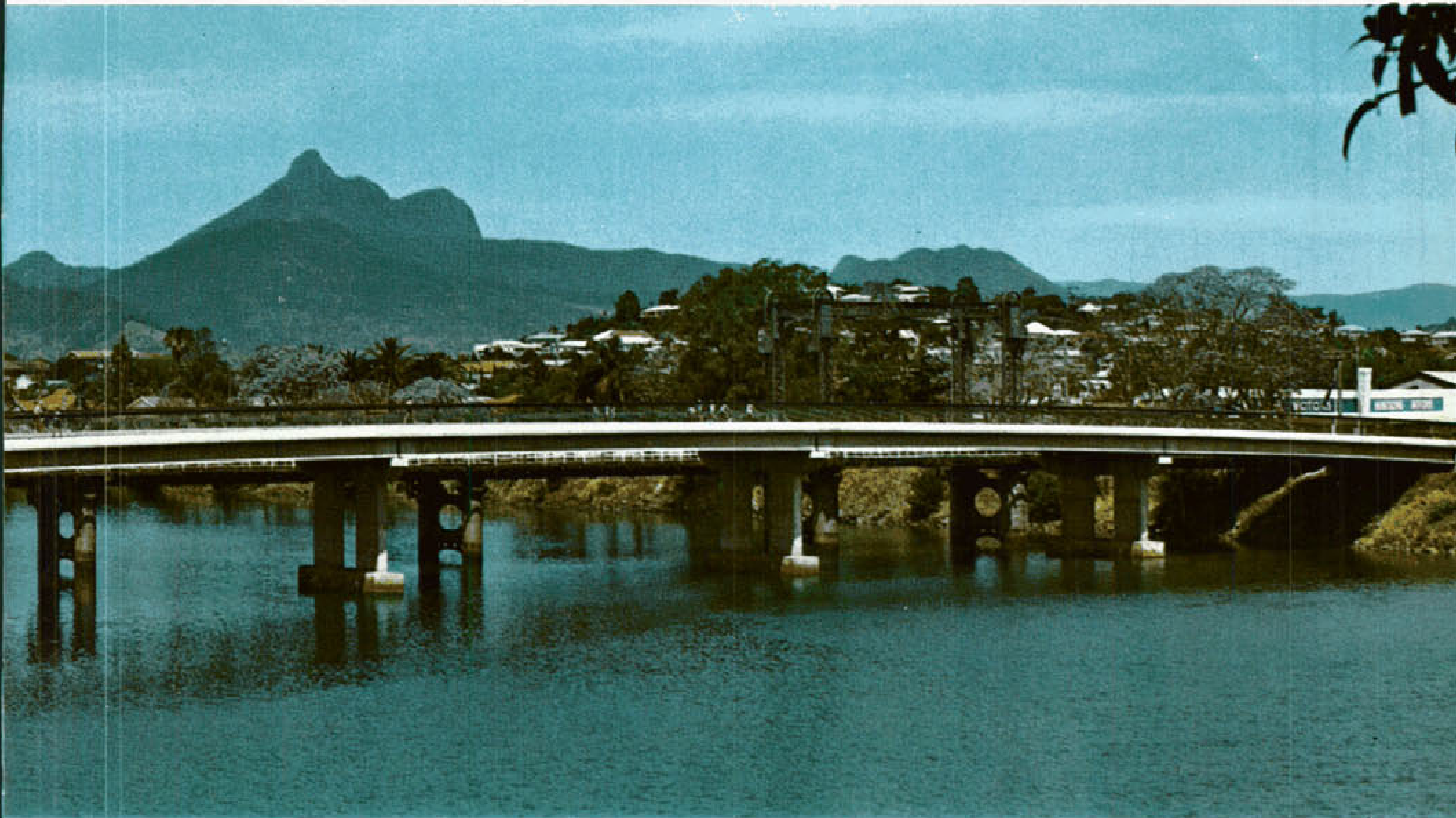
The usual light standards have been eliminated from this bridge and in their stead the bridge lighting has been incorporated in the handrails. The absence of the light standards enhances the appearance of the bridge, while at night the illumination over the river is quite spectacular. The new bridge will serve the district well and faithfully for many years to come.

The Department of Main Roads engaged Messrs Rankine and Hill, consulting engineers of Sydney, to design the bridge which was built by the Queensland firm of Evans Deaking and Co. Pty Ltd. The Tweed Shire Council carried out the necessary roadworks.

The cost of the entire project was about $636,000.





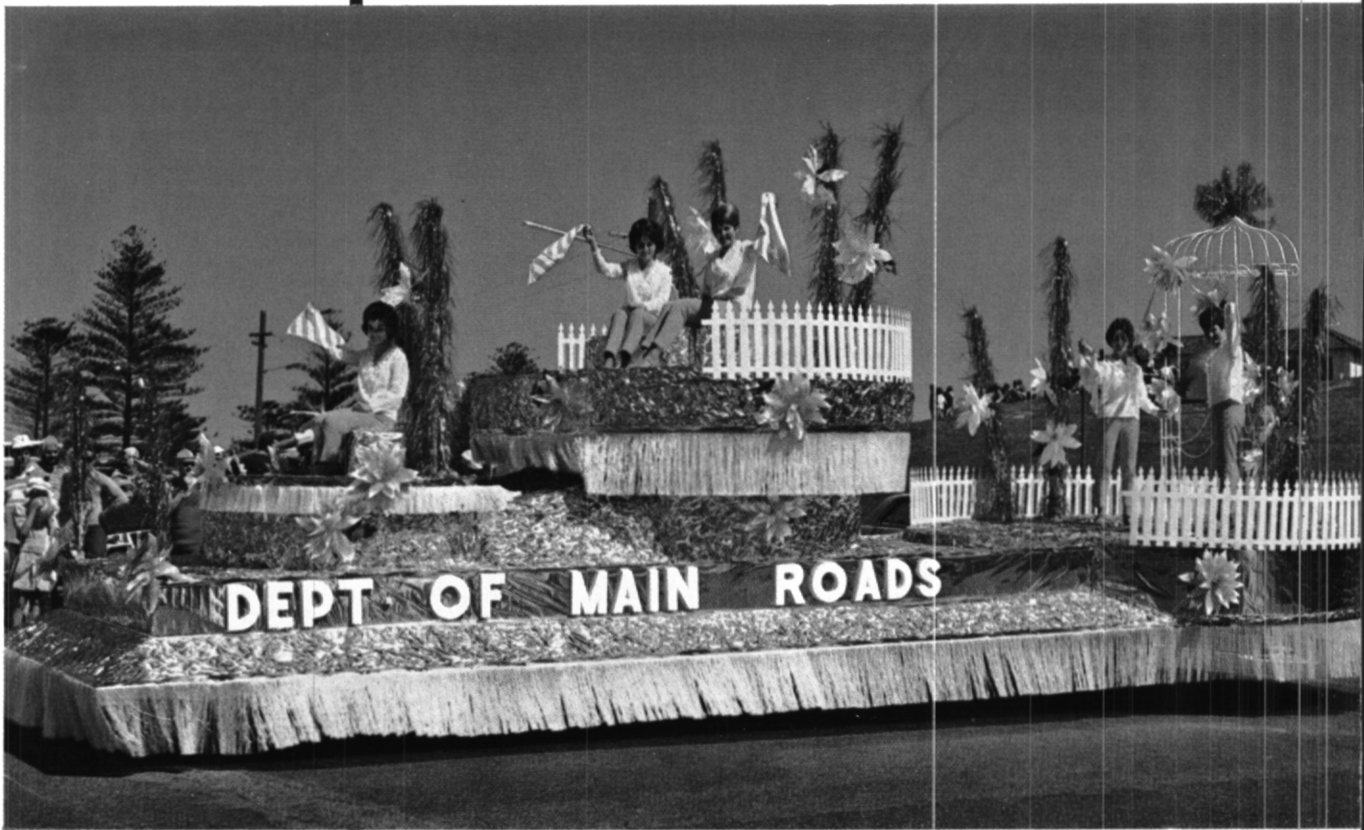


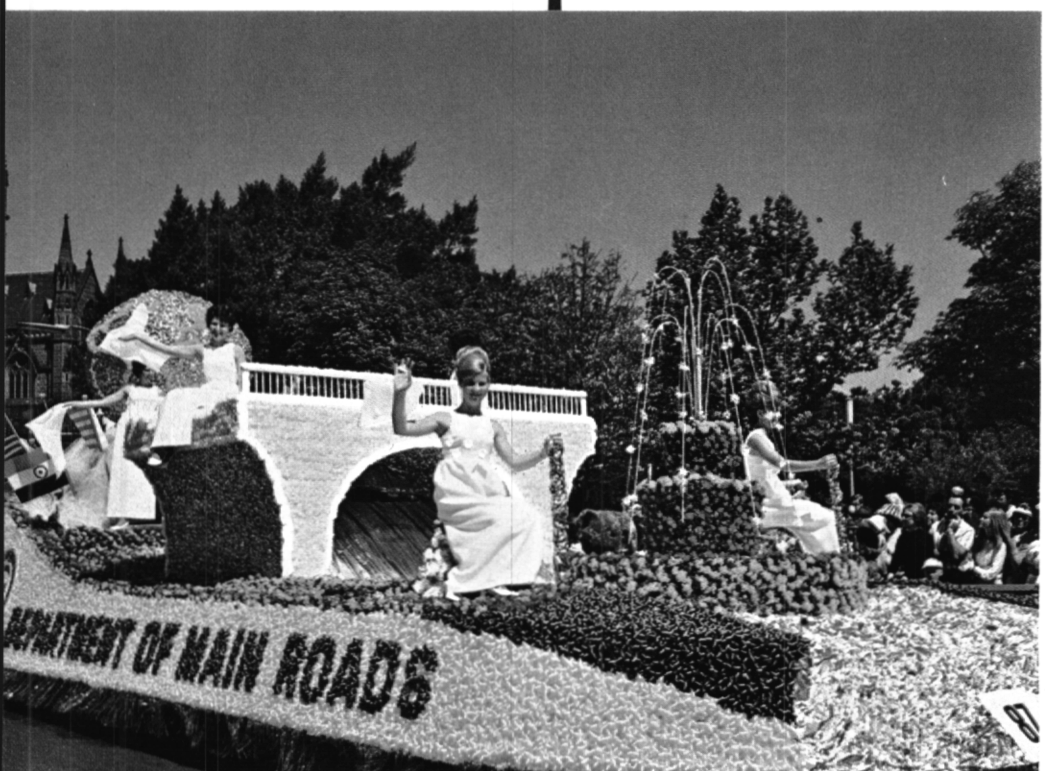
Above New bridge

Right Unveiling the plaque to commemorate the opening

Left The town of Murwillumbah with Mount Warning in the background

Far left Part of the shopping centre

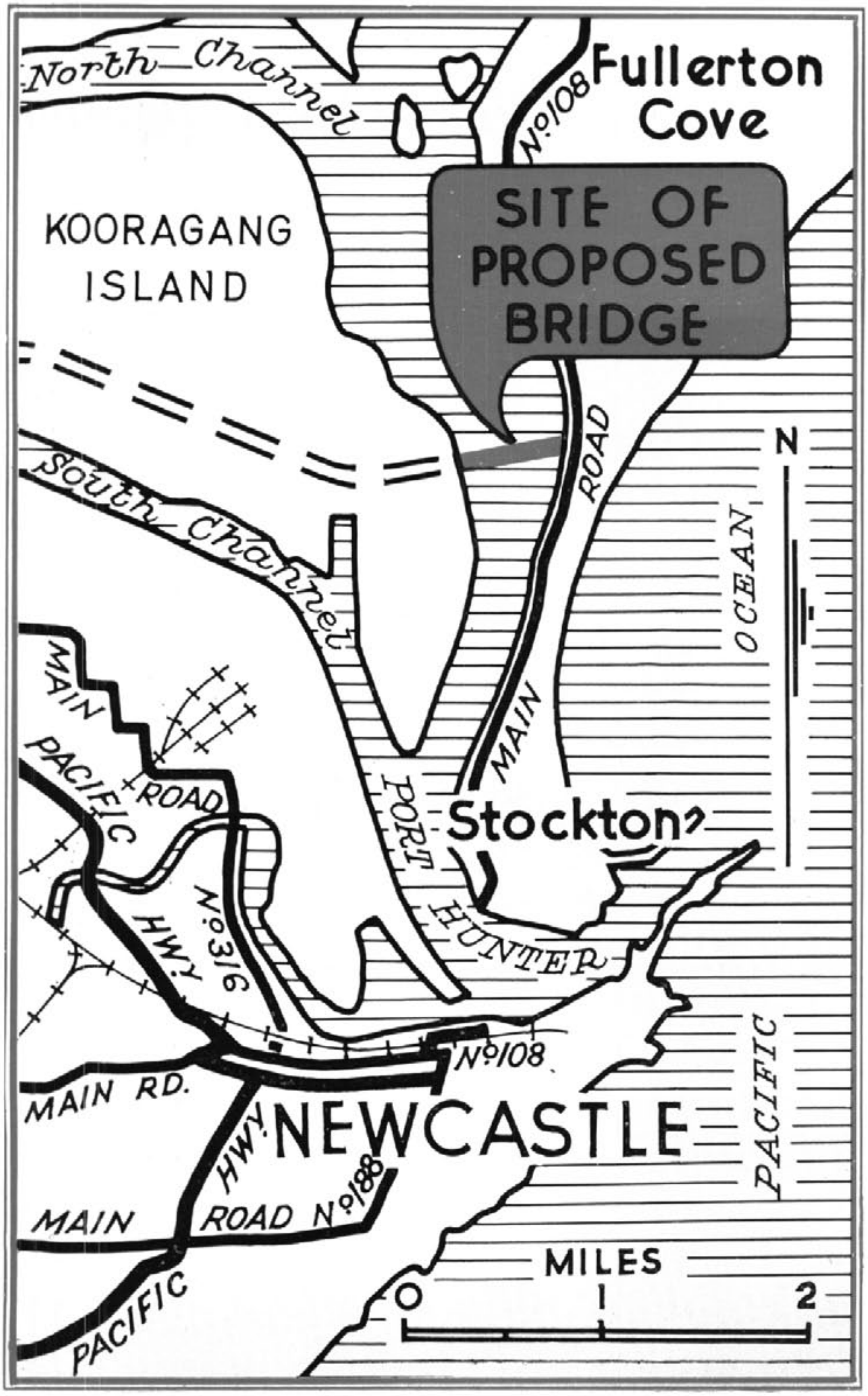




festivals

Recently the Department arranged for decorated floats to take part in the pageants for the Newcastle Mattara Festival and the Sydney Waratah Spring Festival. The float which took part in the Mattara Festival (top) was awarded first prize in its class. Both floats were designed to capture the spirit and gaiety of the occasion. The attractive young ladies are members of the Department's staff.

Hunter River Bridge — Newcastle



There are, at the present time, fifteen vehicular ferry services operating on the Main Roads System in New South Wales. Since 1925, the Main Roads Board and later the Department of Main Roads have programmed for the elimination of these services and so far, thirty have been replaced by bridges.

One of these services now operates on Port Hunter (Newcastle Harbour) between the City of Newcastle and Stockton, on Main Road No. 108.

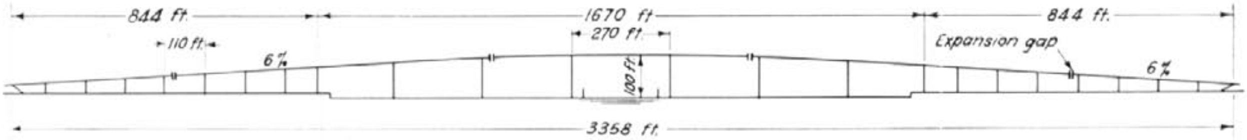
Although two large steam vessels operate on this service there are frequent delays during peak periods because of the large volume of traffic. The annual average daily traffic at this point increased from 3,450 in 1963 to 3,818 in 1968. With the growing importance of the City of Newcastle and the rapid industrial development in the area, the traffic volume will no doubt increase significantly in the near future.

Siltation on the stream bed at the ferry approaches and other reasons cause stoppages to the service with serious inconvenience to the travelling public.

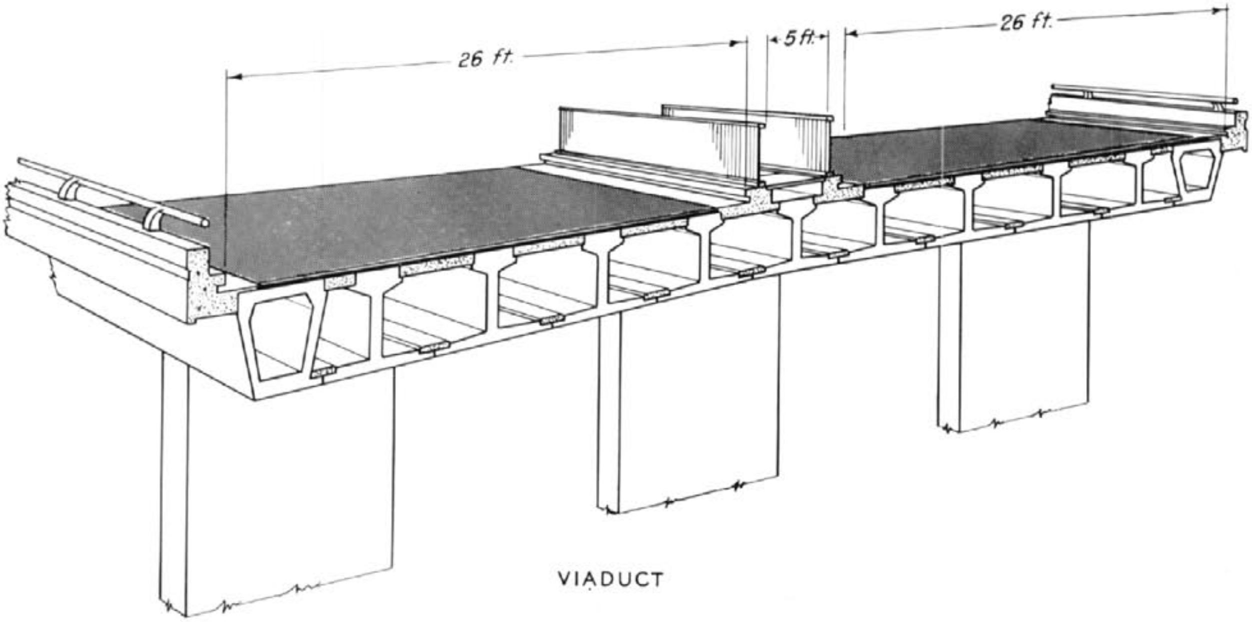
The annual cost of maintaining this vehicular ferry service is in the order of \$500,000, so that the construction of a bridge at this site will result in considerable savings in addition to vastly improved travelling conditions. With all of these factors in view, the Department, for some time, has been giving consideration to the elimination of the ferry service at this site by the construction of a bridge.

The Public Works Department has been engaged on a reclamation scheme on the islands between the North and South Arms of the Hunter River. The islands were separated by narrow channels which have been filled and now form one island named Kooragang. The reclaimed land is being developed for industrial purposes and already extensive use has been made of the area.

It was decided some time ago that a new crossing of the Hunter River should serve this area and at the same time eliminate the ferry service. In consequence,



ELEVATION



VIADUCT

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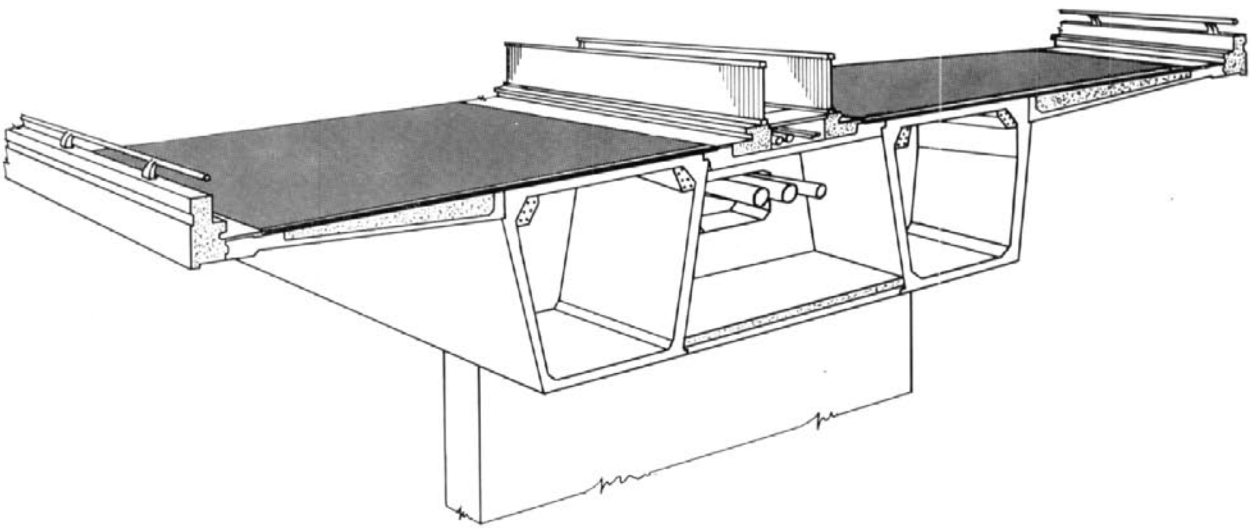


MAIN BRIDGE

a new bridge over the South Arm at Mayfield was constructed and opened to traffic in February, 1965 providing access to the reclaimed land from the western area of Newcastle City. It was proposed that a road across the island will link this bridge with another to be built over the North Arm of the River, thus completing the road connection to eliminate the ferry service.

In addition to linking the residential suburb of Stockton with the City of Newcastle and with the fast developing industrial areas on Kooragang Island the new road route will also improve access to the seaside resorts in the very popular Port Stephens area north of Newcastle.

Following the completion of survey investigations and preparation of design, the Department invited tenders and recently awarded a contract for the construction of the North Arm Bridge to Dillingham Constructions Pty Ltd for the tendered price of $3,669,293.

The site of the new bridge is on the North Arm of the Hunter River about 2½ miles upstream from the existing ferry crossing.

The Maritime Services Board determined that shipping on the river requires a navigational clearance of 100 feet vertical and 200 feet horizontal. Accordingly, a high level structure will be built as the needs of road traffic precluded the provision of a low level bridge with an opening span.

To achieve the required clearances the design provides for 844 feet long viaducts on each side of the main river channel, rising from 20 feet high abutments on a 6 per cent grade. The bridge over the main channel will be 1,670 feet long and the overall length of viaducts and main bridge will be 3,358 feet. The viaducts are curved in plan to link with the newly designed road system on the Island and with Main Road No. 108, on the Stockton Peninsula.

The deck will provide for two carriageways each 26 feet wide separated by a central footway, 5 feet wide, which will also act as a median to separate the carriageways. Each carriageway will provide for two lanes of traffic. Concrete wall barriers topped by steel pipe rails will form the outer sides of the carriageway while vertical bar grille railing will separate the carriageways from the footway. Lamp standards, 25 feet high will be placed in line with the outside barriers. Pedestrian access from ground level to the bridge footway will be provided under the bridge by a stairway through the superstructure near the abutments.

The quantities of the principal materials to be used in the bridge construction are—
Concrete:
22,700 cu. yd
High tensile steel:
592 tons
Reinforcing steel:
2,510 tons

The whole structure will be founded on rock. The piles will consist of hollow 3-feet diameter steel casings bored into rock at depths of 70 to 140 feet and filled with concrete. The bridge piles are designed for 260 tons maximum load. Two test piles, loaded with up to 600 tons of pig iron, showed no appreciable settlement. The Department constructed the piles in the approach piers prior to calling tenders for the bridge construction which includes the piles to be built in the river channel.

The design calls for the piers and the superstructure spans to be joined together to form continuous concrete units or rigid frames able to absorb the longitudinal forces on the bridge. There will be five such units in the full length of the bridge, separated by "finger plate" expansion gaps to permit free variations in length caused by temperature changes and creep of the bridge materials. Stainless steel roller bearings will be placed at expansion gaps.

The continuous rigid frames will contribute to an appearance of graceful lightness in the structure since they will permit the individual members to be made quite slender. At the same time they will retain a large strength reserve inherent in rigid frame construction. Since the continuous frames will transfer most of the longitudinal wind and braking forces to the abutments and selected piers, all the other "flexible" piers will be freed from these loadings with resultant savings in construction materials.

Precasting is specified to minimize the need for form work and falsework for this tall structure. To reconcile this technique with the requirements of the rigid frame structure, "temporary hinges" will be used extensively. The precast elements will be lowered to rest on steel bearing plates and these hinged joints later "frozen", i.e. fixed against rotation, by packing them with concrete and providing continuity through overlapping steel reinforcement.

The use of rigid frames, which could be very sensitive to uneven settlements of the supports, is possible because the whole structure will be founded on bed rock, a firm white sandstone.

The viaducts will be similar in construction to two bridges recently completed by the Department of Main Roads, namely, the Roseville Bridge over Middle Harbour and the De Burghs Bridge over Lane Cover River.

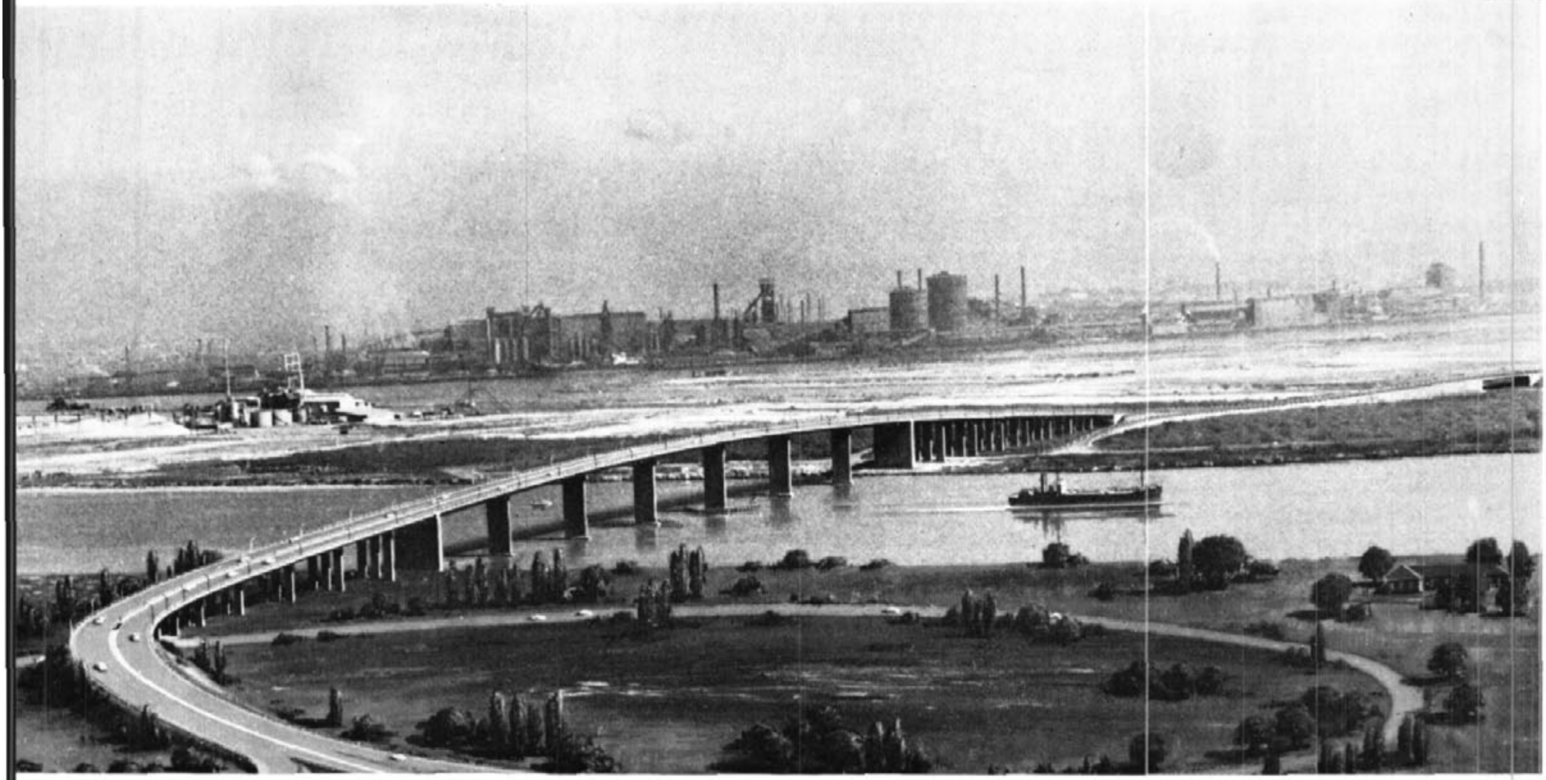
Each viaduct will consist of six 110 feet spans between shorter 90 feet end spans. They will be subdivided, by a nearly central expansion joint, into two rigid units anchored respectively to the abutment or to the large box piers which will connect the viaducts to the main bridge.

The viaduct deck is designed as a hollow slab constructed by concreting the joints between top and bottom flanges of precast prestressed concrete girders. The bottom flanges will butt against each other to eliminate the need for suspended formwork for the in-situ concrete. The girders will be 4 feet deep and post-tensioned with 4 or 5 cables, designed for a jacking force of up to 220,000 pounds each.

The girders will be placed either on the abutment (for the end spans) or on the cantilevered end of the preceding girder and cantilevered out from the next pier.

The joints between girders will be located at such a distance from the piers that the final positive and negative bending moments in the girders will be balanced and resisted by the same prestressing cables, suitably draped up and down along the girder webs.

Girders will be placed directly on the pier columns thus avoiding cross heads projecting below the continuous bridge slab. Those girders situated between the columns will be supported by a cross-girder built into the bridge slab and



Artist's impression of new bridge

post-tensioned by six cables designed for a jacking force of 420,000 pounds each.

The piers will consist of three prismatic 10 feet by 2 feet columns concreted in-situ. The supporting pile caps will be below surface and there will be two vertical bored piles under each column.

The abutments will be buried in embankments constructed to about 20 feet high. They will be stabilized by concrete anchor beams supported on bored piles.

The main river bridge consists of five spans of varying lengths from 210 feet to 270 feet. It will be subdivided by two expansion gaps.

The deck heights and spans provided in the design of the main bridge are considerably greater than in the approach viaducts. However, the width remains the same. It would therefore not be appropriate to provide three columns in each pier and single column piers have been designed for the main bridge.

These tall single columns will be rigidly framed into a narrow box girder, from which the deck slab is to be cantilevered. This "spine beam" construction will suit the conditions existing at the Hunter River site, namely, construction at great height over a navigable river. The spans will have to be constructed on a falsework truss supported from the bridge piers as formwork support from surface level and erection of whole girders in one piece will be impracticable. The spine beam has been designed as a composite structure consisting of two box girders and connecting slabs which will make possible the greatest number of uses of the expensive erection truss.

The box girders will be erected independently in segments. The falsework truss will only carry the weight of one box girder and can be moved on after concreting the segmental joints and post-tensioning the box girder. Precast connecting slabs will then be placed between the box girders and a second stage prestress will be applied when the spine beam is completed. The jacking force will be 860,000 pounds per cable with twelve cables to each girder. The cables will be external to the walls of the segments and encased in concrete after stressing is completed.

After completion of the spine beam, 12-feet long precast deck slab cantilevers are to be attached to both sides of it by post-tensioning.

The extreme edges of the cantilevers are to be stiffened by a cast in-situ reinforced concrete fascia beam which will include the concrete wall barrier as an active structural part. It will assist in spreading traffic loads over a greater width of cantilever. For the same purpose a steel shear joint, which can transmit shear forces in both directions, is to be inserted at the extremity of the two cantilevers adjacent to the expansion gap.

The single pier columns under the main spans are to be in reinforced concrete cast in-situ. They will be 3 feet 9 inches thick and 30 feet wide. They will stand on pile caps cast in a coffer dam built of precast concrete slabs over piles of which some are battered parallel to the bridge and some across the bridge.

A large box pier 59 feet wide and 13 feet thick will create a visual separation between each of the sleneder approach viaducts and the deeper main spans. These piers will be of reinforced concrete skeleton frame with a cladding of precast concrete slabs.

Service pipes are to be carried across the river spans below the central footway and between the box girders and then taken down through the separating box piers, to an underground location along the approaches.

Steel fenders will protect the piers in the main shipping channel. The fenders are designed as rigid frames to absorb the energy from ship collisions by forming and yielding through plastic hinges.

Development Of Some Roadmaking Equipment

THE evolution in earthmoving equipment leading up to the modern equipment of today, could be said to have begun about a century or so ago. In the years that have followed roadmaking plant has continued to develop abreast of other engineering fields and to-day, the civil engineer has available to him, precision equipment which is fast, efficient, and capable of a high production output.

The once rather crude tractor, excavator, grader, etc. have been refined considerably, particularly since World War II.

☐ One of the earliest forms of earthmoving equipment, the hand operated dredge, was first available in 1420. This was later horse operated, but it was not very successful until the development of the steam engine.

☐ One of the first steam excavators was produced by William Otis, in the United States of America, in 1835.

☐ Thomas Aveling, in 1865, produced a steam roller by converting one of his 12 horsepower steam traction engines. It weighed 30 tons.

☐ A horse drawn wheeled scraper was produced by the Western Wheeled Scraper Company, Iowa, in 1877.

☐ The first screw-type air compressor was patented in 1878, but it was not seriously developed until 1934.

☐ From the first "successful" two cylinder petrol traction engine (then called "tractor") of 22·45 horsepower, produced at the turn of the century, has developed the modern wheeled tractor of up to 60 tons weight and up to 700 horsepower.

☐ Continuous track chains were first used on horse drawn carriages in England in 1770 to prevent bogging.

☐ The first "practical" track laying tractor was the Holt 40 horsepower steam tractor of 1904, a year after the Wright brothers flew the first self-powered aeroplane. The front steering wheels of the early crawler tractor were replaced by track steering by the Best Tractor Company in 1912.

Although earthwork jobs such as dams, quarries, open cut mines, etc. have scope for very large machines, road building equipment is restricted in size and weight by the very nature of the work on which it is used. The construction of expressways and wider roads in recent years has allowed the use of larger machines due to the greater formation widths on which they are called to work and where greater quantities are to be handled; thus it is economical to hire or invest in more costly and specialized equipment.

Each type of plant has gone through its own period of development and some of the more common items are referred to here.

ROAD GRADERS

The first horse drawn grader was made in 1879, and this type of light weight grader continued in use up to World War I. At about this time heavier graders were being made. Initially they were drawn by crawler tractors, and emerged as grader blade attachments mounted under wheeled or crawler tractors.

In 1910 Holt made a blade attachment for his crawler tractor and by 1919 the Russell "Motor Patrol Maintainer" (Patrol grader) was produced. 1931 saw the introduction of the auto patrol grader with power controls and engine at the rear as in conventional graders to-day. These graders had a petrol engine of about 28 horsepower. To-day the most popular road graders are in the 10-12 ton range with over 100 horse-power diesel engines and fitted with hydraulic or mechanical powered controls, power or power assisted steering and capable of travelling speeds of up to 25 miles per hour. The heavier graders range from 20 to 29 tons in weight and fitted with 200 to 250 brake horsepower engines with power boost to all operating controls. Most graders are fitted with scarifiers as well as the grading blade, which are available in lengths up to 14 feet, the most popular being 12 feet.

Various wheel arrangements are available including the six-wheel grader with oscillating tandem drive wheels at the rear and leaning front (steering) wheels which give more stability when leaning toward the direction of the load exerted transversely by the blade when cutting. There is also a unit which drives and steers on all four or six wheels.

Graders can be fitted with electronic blade levelling controls which allow the operator to dial the required slope of the cutting edge which is accurately maintained irrespective of any transverse ground irregularities.

Many special attachments have been developed to diversify the use of the grader. These include a dozer blade, snow plough, elevating grader, rear mounted ripper, scraper, roller, etc.

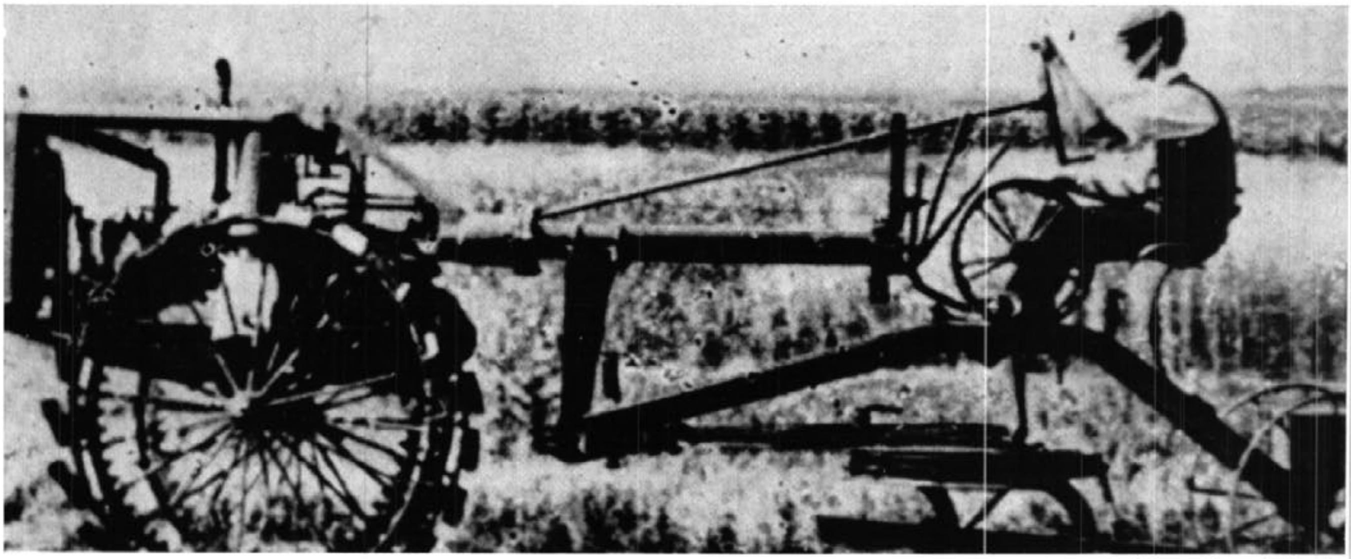
One large grader reported to have been built overseas had a blade mounted between two prime movers, with centre pin steering. This grader weighed 45 tons.

TRACTORS

Progress in the manufacture of tractors has been considerable since the turn of the century when Hart Parr produced the two cylinder 22·5 horsepower petrol engined wheeled tractor.

Tractor manufacturers have always produced a light tractor which is ideally suited for agricultural use while the large tractors have grown in size and capacity to the present machines such as the twin crawler tractor with a 425 gross flywheel horsepower and a weight of approximately 31 tons. Fitted with a 22-feet wide blade it can also be fitted with ripper shanks of up to 84 inches in length.


Horse drawn grader


Motor Patrol Grader


Special purpose grader of 617 h.p. and 45 tons

The large pneumatic tyred tractors are built with weights up to approximately 60 tons with rated engine brake horsepower of 635 developed from a 16 cylinder V type diesel engine. In spite of their tremendous power and weight they are compact machines and do not approach the dimensions of the steam tractor of the early 1900's when a wheeled farm tractor could be 60 feet wide and over 15 feet high with cylindrical wheels about 15 feet long and 9 feet in diameter.

Although the continuous chain track system was invented in 1770 in England and proposed for horse drawn carriages, it was not used on a tractor until 1904.

During World War I many tractors were used in France to haul guns and supplies and the British Army tanks were based on crawler tractors.

Tractors were built on an assembly line system prior to the end of World War I. They were lighter and cheaper than the earlier models and gave more horsepower per pound weight. This trend has continued through the years of tractor manufacturing and although horse power has increased, the weight (bare) has not increased in the same proportion. Two of the heavy tractors manufactured by different firms have increased in flywheel horse power by 109 per cent and 76 per cent. Their bare weights have increased only by 54 per cent and 42 per cent respectively.

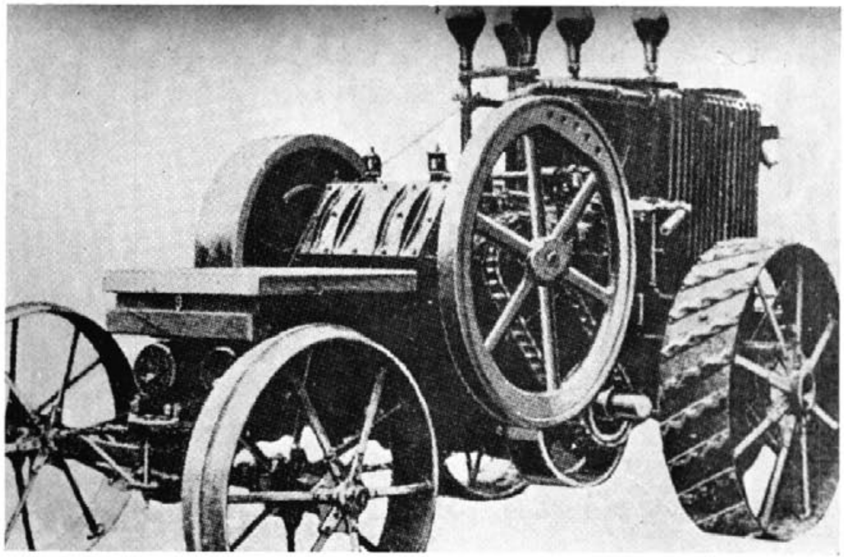
The pneumatic tyred tractor has become an integral part of modern earthworks equipment such as scrapers, rollers, dumpers, and spreaders.

Many attachments are made for tractors, both crawler and wheeled. The most popular is the familiar dozer in its various forms of tilting, angling, or fixed bull blade.

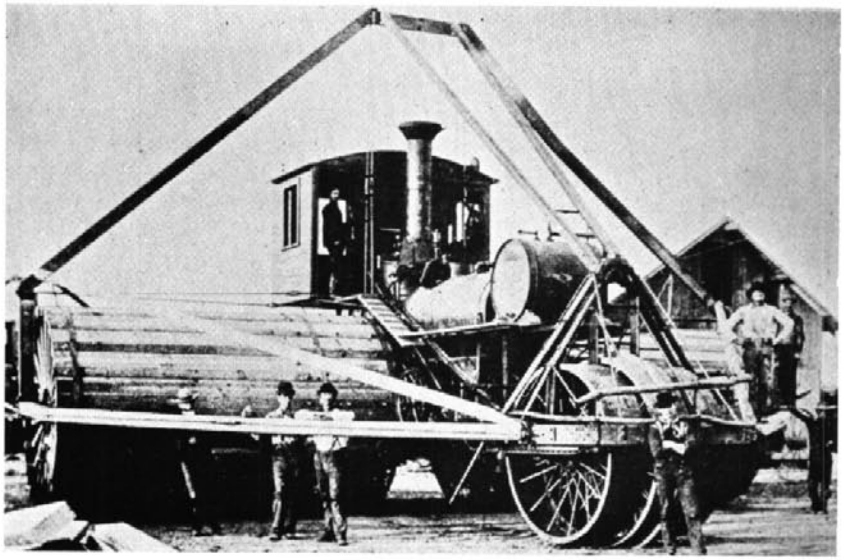
An early type of crawler tractor-dozer of 30 horsepower used on the Razorback Deviation on the Hume Highway, in 1929, required an operator to walk behind to adjust the blade by means of long poles attached to each side of the tractor.

Until relatively recent times rippers were mounted on their own wheels and drawn by tractors. To-day, they are mounted onto the rear of the tractor. Being hydraulically operated, they allow the rear end weight of the tractor to be exerted on the ripper tynes to give better penetration.

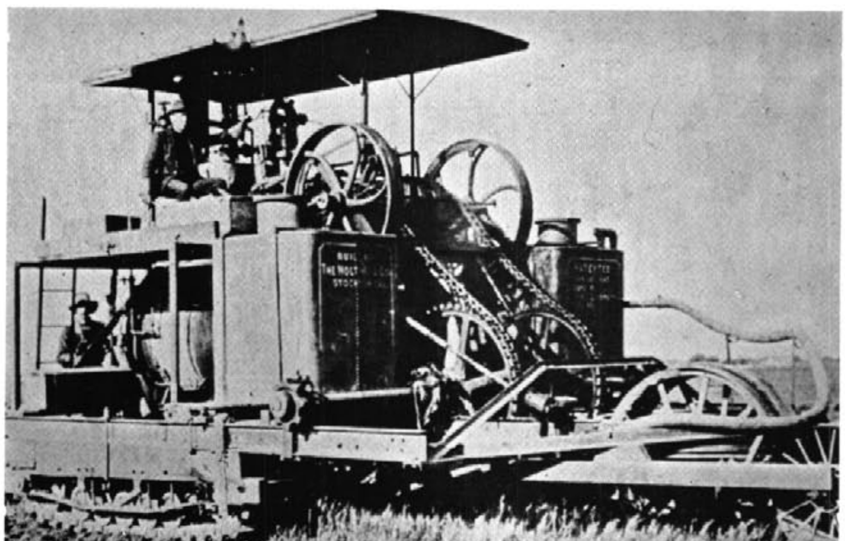
The crawler track section of tractors has been refined in recent years. The life of components has been considerably extended by such improvements as lifetime



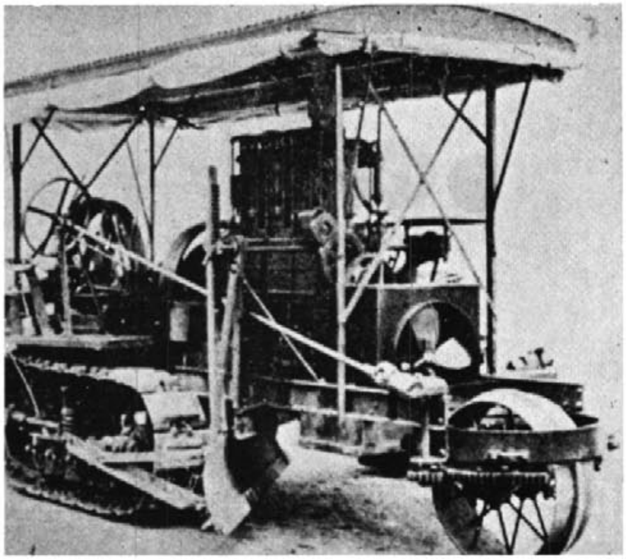
The Hart Parr wheeled tractor—1900



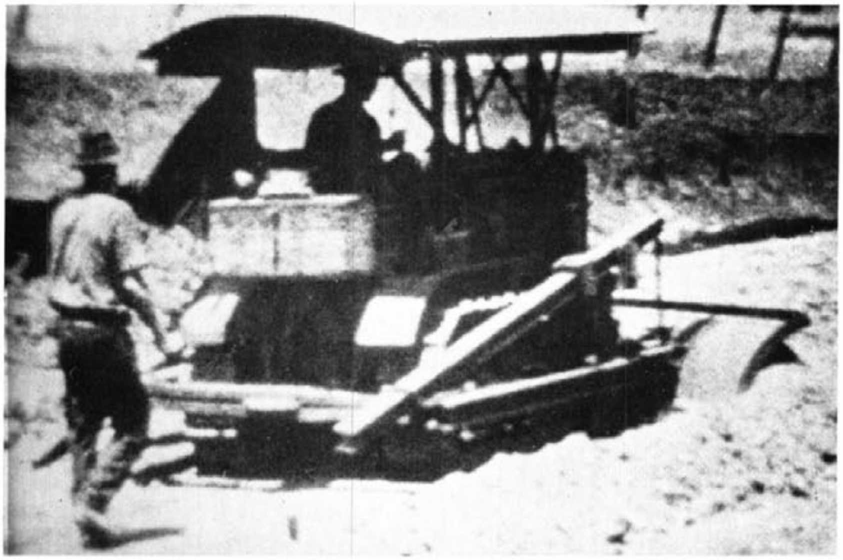
Steam tractor—1900



Steam track laying tractor—1904



1910 *model tractor* (*note blade underslung*)



30 *h.p. tractor*—1929

Modern type 635 *b.h.p. tractor*

lubricated track rollers and idlers, track rollers with antifriction bearings, track pin, and bush sealing and lubrication.

Recently, experimental tractors have been built using a gas turbine engine and also fuel cell (hydrogen oxygen) power giving approximately 20 horsepower from 1,000 fuel cells.

ROLLERS

During the century since road rollers were first invented, they have progressed from steam to the first motor driven (eight horsepower) roller produced in 1904 and the present day group of rolling and compacting equipment.

Nowadays, there are the steel tyred (smooth) rollers, vibrating rollers, pneumatic tyred rollers, and patterned rollers (cleated, sheepsfoot, grid). Each type has certain advantages in different types of work and with different road making materials.

Drawn rollers with an irregular rolling surface are not new and date back to 1880 or earlier. These were sometimes made from sandstone and drawn by bullocks.

Vibrating rollers are a relatively recent development and are now available with variable amplitude of vibration and with a range of vibrating frequencies to suit them for different types and depths of material being compacted.

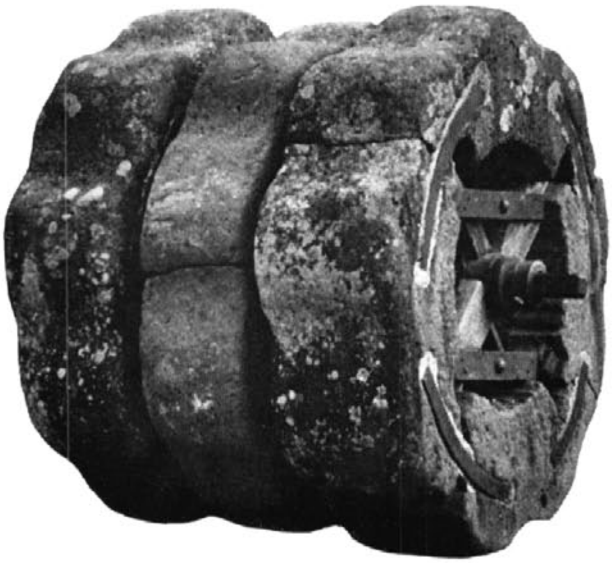
Self propelled pneumatic tyred rollers are available with controls that enable tyre pressure to be varied equally in all tyres whilst in motion, thus varying the ground pressure to suit compaction requirements.

Grid rollers were recently developed to give a crushing and compaction effect. Material in windrows can be reduced in size in-situ due to the knuckle effect given by the high spots on the simulated wover grid drum. High speed operation at 10 to 15 miles per hour is necessary for this work to give the impact necessary for breaking down the material.

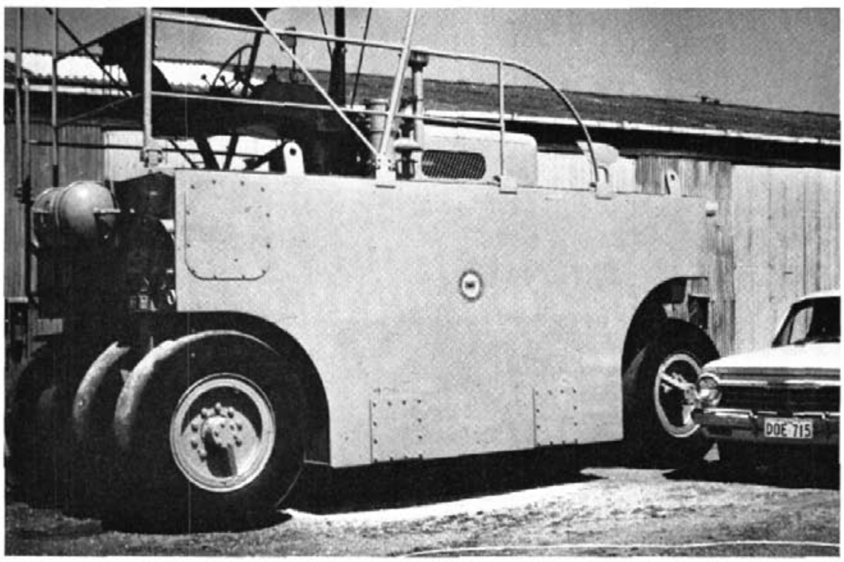
In both steel wheeled and pneumatic tyred rollers a smooth change in direction from forward to reverse is essential for both the life of mechanical components and the road surface. This is achieved by special clutches and transmissions or by using a fully hydraulic drive.

AIR COMPRESSORS

Air compressors used on road construction works are now available in reciprocating and rotary types. The extensive use of tractor mounted rippers has reduced the amount of drilling and blasting and the need for compressors.



Example of a drawn roller



Pneumatic tyred roller—30 ton

Self loading scraper

Reciprocating aircompressors have been developed somewhat in parallel with steam engines and their use probably also dates back to the time of the early steam engines. Considerable development in this equipment has taken place in the past 20 or 30 years during which time relatively light weight efficient units of high speed have been produced.

The demand for lighter but larger capacity mobile units prompted the manufacturers to look to types other than the traditional reciprocating unit. The principle of the rotary vane compressor has been known for some time, but the first major step was taken in 1947 when the oil flooded (or oil cooled) rotary vane type was patented. This had the advantage of oil injection for lubrication, cooling and sealing. Introduced into Australia in about 1958, it is now generally used in mobile compressors of moderate sizes.

Concurrently with the development of rotary vane compressors, the rotary screw type unit was evolved. The rotary screw units were first introduced on larger stationary compressors. Smaller mobile units were introduced in Australia in about 1958.

The first helical lobe compressor was patented in 1878, but it was not seriously developed until 1934.

SCRAPERS

The scraper was one of the early types of earthmoving equipment, possibly related to the old land leveller and originally drawn by horses. Later it was developed as a tractor drawn unit of much larger size (now of approximately 30 cubic yards capacity). During World War II a self-propelled unit employing single axle traction was developed. This type of unit is now available from various makers with bowl sizes of up to 55 cubic yards and 800 flywheel horsepower.

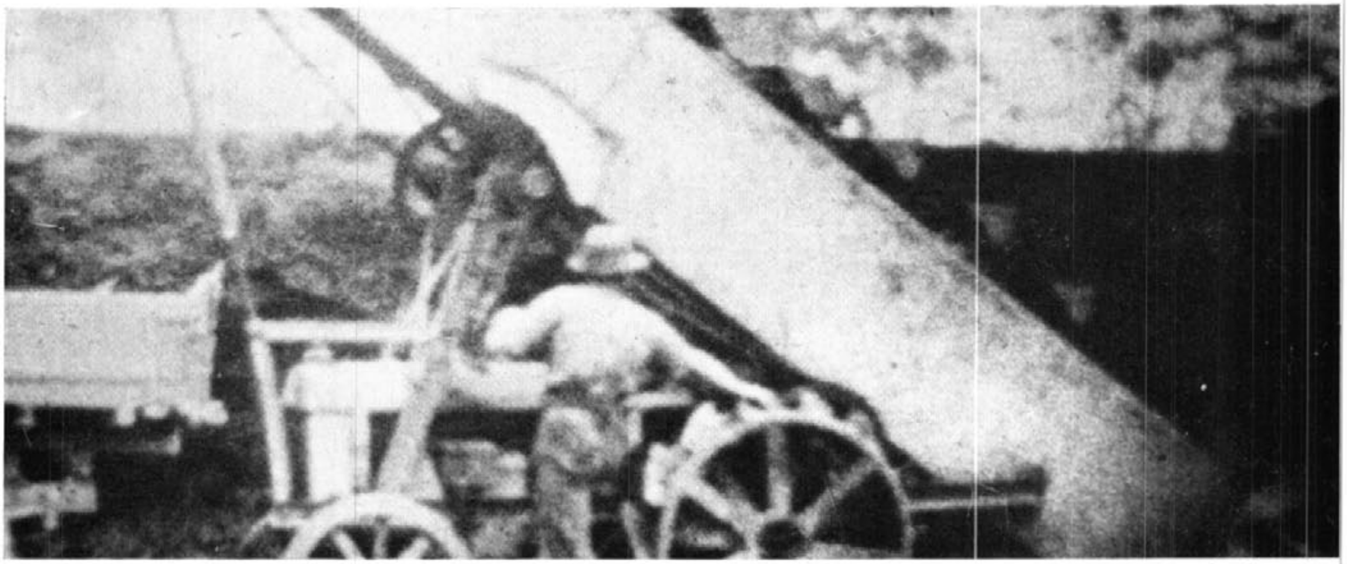
Multiple coupled scraper operation has increased the total carrying capacity to 90 tons per unit. One such unit employs electric motors on its eleven wheels and travels at up to 20 miles per hour.

The self loading scraper was first built in about 1954. In loading it depends upon a bar type elevator, electrically driven or mechanically powered from the tractor power-take-off shaft.

EXCAVATORS AND LOADERS

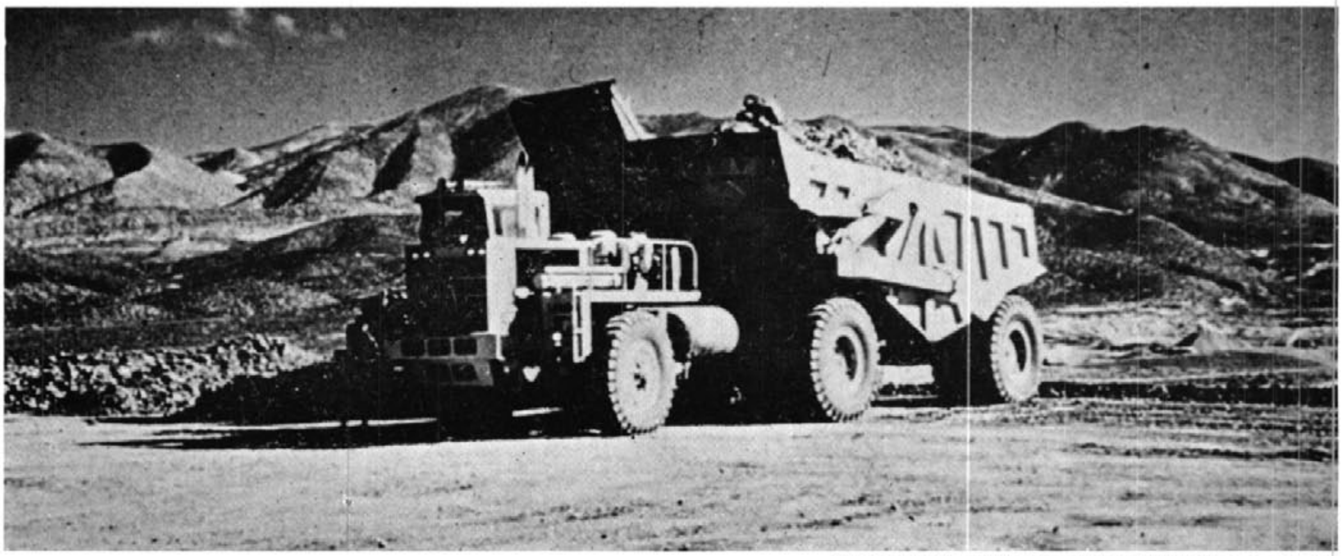
The early type excavators or steam shovels have been replaced on roadworks to a great extent by front end loaders, particularly in the range of smaller bucket capacities.

The first front end loaders appeared in



Bucket loader—1925

Modern front end loader



Dump truck of 79 cu yd capacity 700 h.p. engine

England in the early 1920's. They were built on a 20-horsepower wheeled farm tractor and had a capacity of up to 30 tons per hour.

Early loaders were cable operated but by 1950 cables were being displaced by hydraulic operation. Nowadays, following improvements in sealing devices, oil filters, and metallurgy and with precision production machine tools, hydraulic systems have replaced cables and drive shafts on most types of earthmoving equipment.

There are many other items of road making plant possibly of equal importance to those mentioned. In many cases new types of plant have been produced to meet the greater needs and higher standards of modern road building. These include major items such as soil stabilizing plant, hot mix plant, tamper leveller spreaders, trimmer spreaders, pile boring plant, tunnel borer, etc.

The development of earthmoving plant and components has in the past depended to a great extent upon laboratory experiments and research in the engineering field and this will continue in the future. Consequent upon this research items are produced lighter in weight but greater in strength, by the use of high tensile steels and other alloys. Automated precision machine tools, quality control of raw materials, and heat treatment, together with improved lubricants and fuels, have given greatly extended life to wearing parts.

The design and production of certain component parts and assemblies by specialist firms have simplified the work of the plant manufacturer. Mass production has enabled costs and production time to be kept within reasonable limits.

Many of the present day refinements used on earthmoving plant are improvements or adaptations of age old engineering principles.

Road building equipment is operated in an atmosphere highly contaminated with abrasive dust. Engine intake air cleaners and breathers have undergone considerable change and to-day air cleaners are produced which give efficiencies in the order of 99·9 per cent.

Some manufacturers are endeavouring to standardize on components such as gear boxes, clutches, etc. with a view to their removal as complete assemblies and replacement with exchange units to avoid major dismantling and excessive idle time. Thereby specialists can recondition the replaced equipment under ideal conditions in well equipped workshops and with a minimum of plant down-time.

Modern equipment requires skilled tradesmen to provide adequate maintenance. This is being met by some manufacturers and users by providing detailed training to their maintenance personnel.

At the present time research is being undertaken in various fields. One of note is in the field of engonomics, whereby the operator's position, location of controls and operating loads etc. will be rearranged and improved with a view to reducing fatigue and thus maintaining a high operator efficiency. This is necessary if the advantages of modern engineering techniques and the high purchase price of equipment are to be used efficiently and economically. The control of noise level at the operator's ear and vibration could necessitate many changes in the design of components such as gears, casings, etc. which produce and transmit these undesirable effects.

SYDNEY HARBOUR BRIDGE ACCOUNT

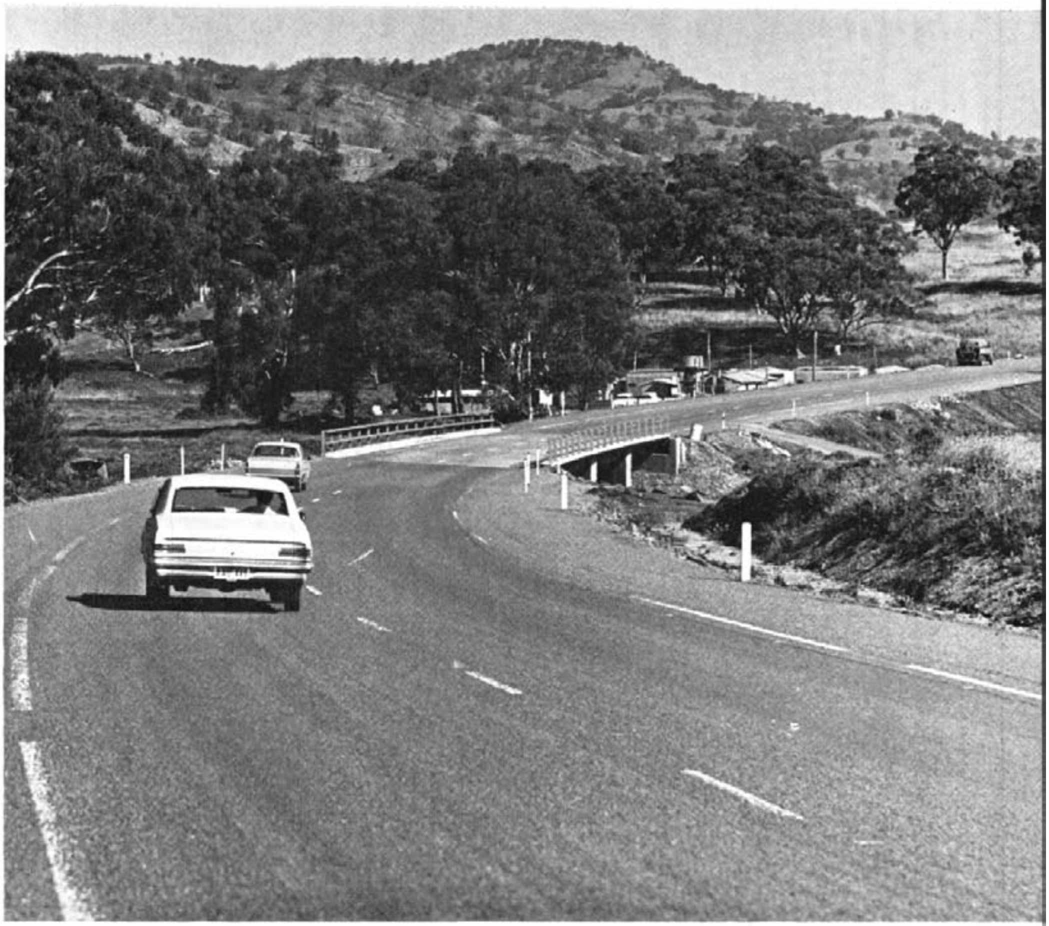
Receipts and Payments for the period 1st July, 1968 to 30th September, 1968

Receipts	$
Road Tolls	1,053,962
Contributions—Railway Passengers	72,896
Omnibus Passengers	6,458
Rent from Properties	33,048
Miscellaneous	..
Loan Borrowings for the Warringah Expressway Approach	..
Total Receipts	**$1,166,364**

Payments	
Cost of Collecting Road Tolls	211,949
Maintenance and minor improvement	140,391
Alteration to Archways	475
Provision of Traffic facilities	23,937
Administrative Expenses	17,781
Loan charges, payment of interest exchange, management and flotation expenses—State Loans	295,570
Interest and provision for repayment Loan Borrowings under Section 7 of Sydney Harbour Bridge Administration Act	178,395
Miscellaneous	2,853
Transfers to Expressway Fund	..
Total Payments	**$871,351**

NEW ENGLAND HIGHWAY DEVIATION

Left and right:
Sections of the completed deviation



Two railway level crossings were eliminated from the route of the New England Highway when a new deviation north of Murrurundi was opened to traffic recently.

The deviation commencing at Kankool, 6.7 miles north of Murrurundi, extends to Willow Tree, 11.9 miles north of Murrurindi. It includes a new bridge, 205 feet long, over Chilcott's Creek.

The new section of road with wider pavement and shoulders and superior alignment and grading provides greatly improved conditions for motorists.

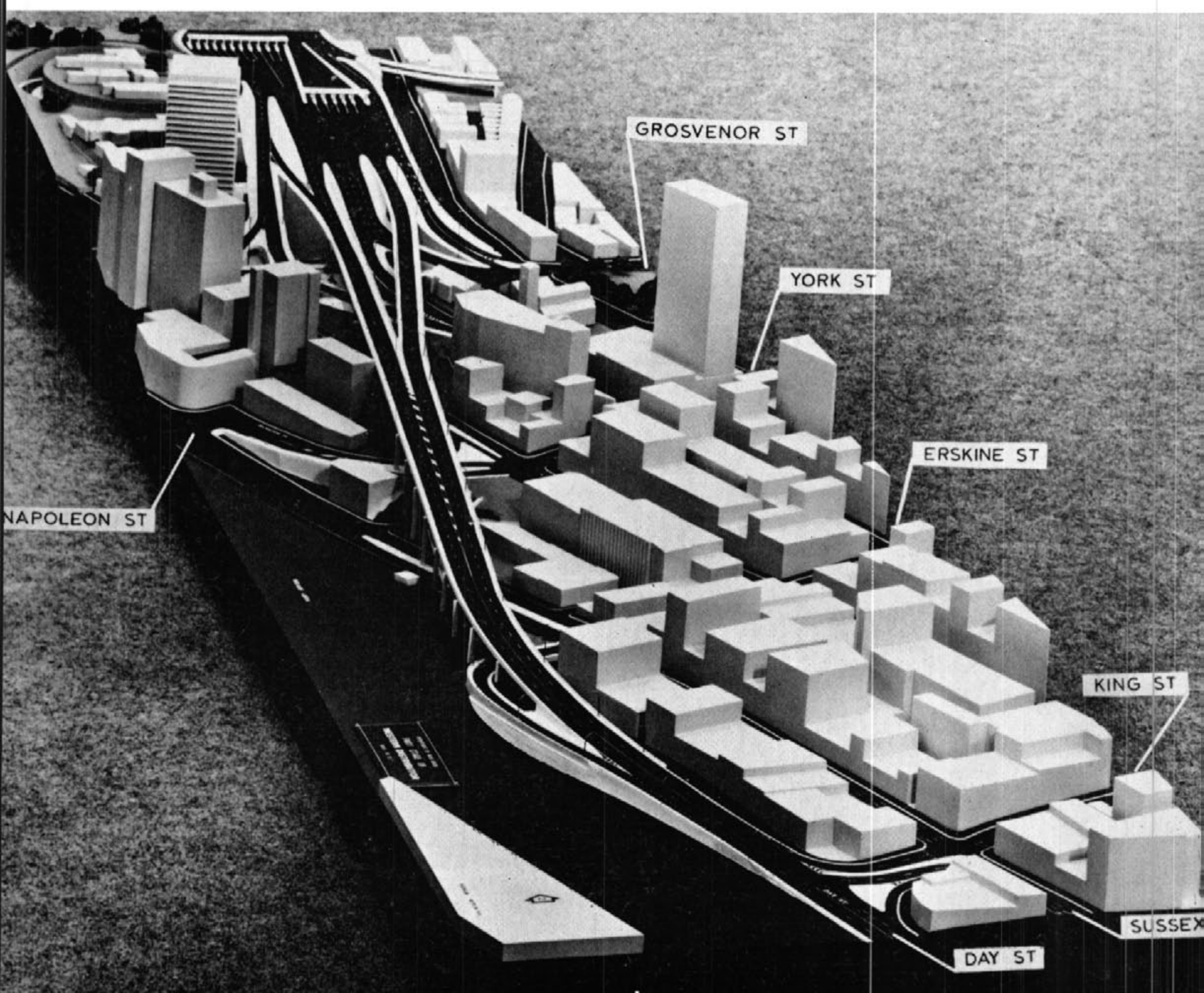
The Department carried out the work with its own forces at a cost of approximately $593,000.

Below:
Bridge over Chilcott's Creek

WESTERN DISTRIBUTOR

The Department of Main Roads, at an early date, will arrange for the construction of the first section of the Western Distributor. This section, which will be generally in structure, will extend from the southern end of Sydney Harbour Bridge to Day Street, near Erskine Street. Ultimately this will be extended to an interchange at Ultimo from which the proposed Southern and Western Expressways will commence. The distributor, a model of which is illustrated, should relieve the central city business area of much of the traffic which now travels through it to and from the Sydney Harbour Bridge.

Model of the first section of Western Distributor



MAIN ROADS FUND

Receipts and Payments for the period 1st July, 1968 to 30th September, 1968

	County of Cumberland Main Roads Fund	Country Main Roads Fund
Receipts	$	$
Motor Vehicle Taxation (State)	1,781,124	7,124,497
Charges on heavy commercial goods vehicles under Road Maintenance (Contribution) Act, 1958 (State)	719,672	2,878,690
Commonwealth Aid Roads Act, 1964	1,404,777	5,480,109
Road Transport and Traffic Fund	..	..
From Councils under Section 11 of Main Roads Act and/or for cost of work	2,837,203	7,445
Other	264,938	304,419
Total Receipts	**$7,007,714**	**$15,795,160**
Payments		
Maintenance and minor improvements of roads and bridges	2,063,932	4,704,938
Construction and reconstruction of roads and bridges	1,838,653	7,517,641
Land Acquisitions	658,756	135,854
Administrative Expenses	464,808	932,751
Loan Charges, Payment of Interest, Exchange, Management, and Flotation Expenses—State Loans	41,250	214,090
Interest and provision for Repayment of Loan Borrowings under Section 42A of Main Roads Act	113,046	17,521
Miscellaneous *	844,388	865,063
Total Payments	**$6,024,833**	**$14,387,858**

* Includes transfer to Special Purposes Account, in respect of finance for Operating Accounts, Suspense accounts and Reserve Accounts.

TENDERS ACCEPTED BY COUNCILS

The following tenders (in excess of $10,000) for Road and Bridge Works were accepted by the respective Councils for the three months ended 30th September, 1968.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
				$
Ashford	D.W. No. 3159	Construction of a 20 cell 6 feet by 3 feet re-inforced concrete low-level box culvert over the Macintyre River at Bedwell Downs Crossing.	K. A. Constructions Pty Ltd	17,853.63
Balranald	T.R. No. 67	Priming and bitumen sealing from 13.12 m. to 17·13 m. north of Balranald.	Emoleum (Aust.) Ltd	10,482.87
Bogan	T.R. No. 57	Construction of a 6 span steel and reinforced concrete bridge 112 feet long at Mulla Cowal, 10·10 m. south of Nyngan.	W. E. Trothe	30,007.65
Central Darling	T.R. No. 68	Construction to gravel pavement stage between 53·51 m. and 55·51 m. north of Trunk Road No. 66.	J. H. Furney and Co.	17,915.34
Coolah	M.R. No. 206	Reconstruction and bitumen surfacing from 2·30 m. to 4·55 m. south-west of Dunedoo.	A. J. Sumner	32,148.76
Murrurundi	M.R. No. 358	Construction of a 5 span reinforced concrete bridge 165 feet long over Millers Creek 15·00 m. from Willow Tree.	S. Turner & Son Pty Ltd	47,799.00
Murrurundi	Blackville Road	Construction of a 3 span reinforced concrete bridge 150 feet long over Pump Station Creek 22·00 m. from Willow Tree.	S. Turner & Son Pty Ltd	24,327.42
Namoi	M.R. No. 127	Construction of a 4 cell 7 feet by 6 feet reinforced concrete box culbert at 18·40 m. and a 4 cell 7 feet by 6 feet reinforced concrete box culvert at 18·50 m. west of the Narrabri-Myall Vale Channel.	C.I.R. Construction	42,245.15
Uralla	M.R. No. 124	Construction of a 2 span composite steel and concrete bridge 110 feet long over Saumarez Creek 5·50 m. from Armidale.	M. R. and E. M. Firth	31,900.60
Wingecarribee	Various	Supply and delivery of 4,875 cubic yards of natural gravel.	Australian Quarries Pty Ltd	13,153.75
Wollondilly	D.R. No. 1302	Supply and delivery of 9,000 tons of fine crushed rock	Readymix Group N.S.W.	32,715.00
Yallaroi	S.H. No. 12 & T.R. No. 63	Bitumen resealing on State Highway No. 12 between 2·93 m. and 3·80 m. east of Warialda and on Trunk Road No. 63 between 7·55 m. and 10·00 m. north of Warialda and bitumen sealing on Trunk Road No. 63 between 24·75 m. and 28·00 m. north of Warialda.	Emoleum (Aust.) Ltd	11,871.33

TENDERS ACCEPTED BY THE DEPARTMENT OF MAIN ROADS

The following tenders (in excess of $10,000.00) for Road and Bridge Works were accepted by the Department during the three months ended 30th September, 1968.

Road No.	Work or Service	Name of Successful Tenderer	Amount
			$
State Highway No. 2	Hume Highway. Shire of Holbrook. Construction of an 11 span prestressed concrete bridge 385 feet long over Billabong Creek, 30·50 m. south of Tarcutta.	Siebels Concrete Constructions Pty Ltd	114,397.40
State Highway No. 2	Hume Highway. Shire of Holbrook. Construction of a 3 span prestressed concrete bridge 105 feet long over Little Billabong Creek approximately 24·00 m. south of Tarcutta.	Siebels Concrete Constructions Pty Ltd	40,170.20
State Highway No. 2	Hume Highway. Shire of Gunning. Supply of bridge plank units to new bridge over Medow Creek at Gunning.	Monier (N.S.W.) Pty Ltd	24,240.00
State Highway No. 7	Mitchell Highway. Shire of Darling. Construction of a 2 span steel and reinforced concrete bridge 196 feet long over Cuff's Creek 82·00 m. north of Bourke.	A. Cipolla & Co.	36,785.00
State Highway No. 9	New England Highway. Shire of Uralla. Construction of a 4 cell 10 feet by 7 feet reinforced concrete box culvert and a 4 cell 10 feet by 8 feet reinforced concrete box culvert at Chilcott's Swamp approximately 49.07 m. north of Tamworth.	Enpro Construction Pty Ltd	21,834.04
State Highway No. 9	New England Highway. City of Maitland. Supply and delivery of 20,000 cubic yards of pavement material between 3·50 m. and 5·00 m. west of Maitland.	Moore's Earthmoving Pty Ltd	13,600.00
State Highway No. 16	Bruxner Highway. Shire of Ashford. Construction of a 6 span prestressed concrete bridge 195 feet long, and a 3 span prestressed concrete bridge 60 feet long over Myall Creek 1·80 m. west of Bonshaw.	Kennedy Bros	64,651.88
State Highway No. 16	Bruxner Highway. Shire of Tenterfield. Construction of a 4 span prestressed concrete bridge 240 feet long over Black Creek 40.00 m. west of Casino.	Central Constructions Pty Ltd	129,526.00
State Highway No. 17	Newell Highway. Municipality of Forbes. Construction of a 9 span prestressed concrete bridge 460 feet long over Lake Forbes at Forbes.	Moy Bros Pty Ltd	247,702.85
State Highway No. 17	Newell Highway. Shire of Bland. Construction of a 8 span reinforced concrete bridge 162 feet long over Mandamah Creek and a 10 span reinforced concrete bridge 190 feet long over Scots Creek, 16·90 m. and 17·60 m. north of Ardlethan.	Danckert Constructions Pty Ltd	59,181.95
State Highway No. 17	Newell Highway. Shire of Boolooroo. Supply and spray cutback R90 bitumen between 18·50 m. and 39·00 m. north of Moree.	Shorncliffe Pty Ltd	13,485.00
State Highway No. 19	Monaro Highway. Shires of Yarrowlumla and Monaro. Construction of a 7 span prestresssed concrete bridge 299 feet long over Michelago Creek at Michelago.	Pearson Bridge Pty Ltd	139,720.00
Trunk Road No. 83	Shire of Copmanhurst. Construction of a 19 span prestressed concrete bridge 665 feet long over Six Mile Creek at Batten's Bight, 23·94 m. south of Casino.	Peter Verheul Pty Ltd	154,493.80
Main Road No. 206	Shire of Talbragar. Construction of a 6 cell 8 feet by 8 feet reinforced concrete box culvert at Fitzeii's Creek, 18·30 m. from Dubbo.	A. Cipolla & Co	30,431.50
Main Road No. 281	Shire of Tumbarumba. Extension to the existing bridge by 5 spans of steel and reinforced concrete 195 feet long over the Murray River at Tintaldra.	J. Evans	53,419.06
Main Road No. 593	Municipality of Botany. Supply of precast segments for bridge at Gardener's Road, Mascot.	Pearson Bridge Pty Ltd	292,428.00
Main Road No. 593	Municipality of Randwick. Construction of foundation piling for a new bridge over Epsom Road at Kensington.	Frankipile Australia Pty Ltd	43,642.19
Warringah Expressway	Municipality of North Sydney. Section 1. Harbour Bridge to Miller Street, Cammeray. Design, supply of equipment and installation of irrigation system for landscaped areas on Warringah Expressway.	Deveson Jahn (A/sia) Pty Ltd	71,841.40
	Municipality of Bankstown. Construction of bridge over the railway line at Stacey Street, Bankstown.	Pearson Bridge Pty Ltd	518,115.00
	Municipality of Botany. Construction of bridge over access to the Lakes Golf Course Club House at the extension of King Street, Mascot.	Wetherill Concrete Constructions	41,993.00