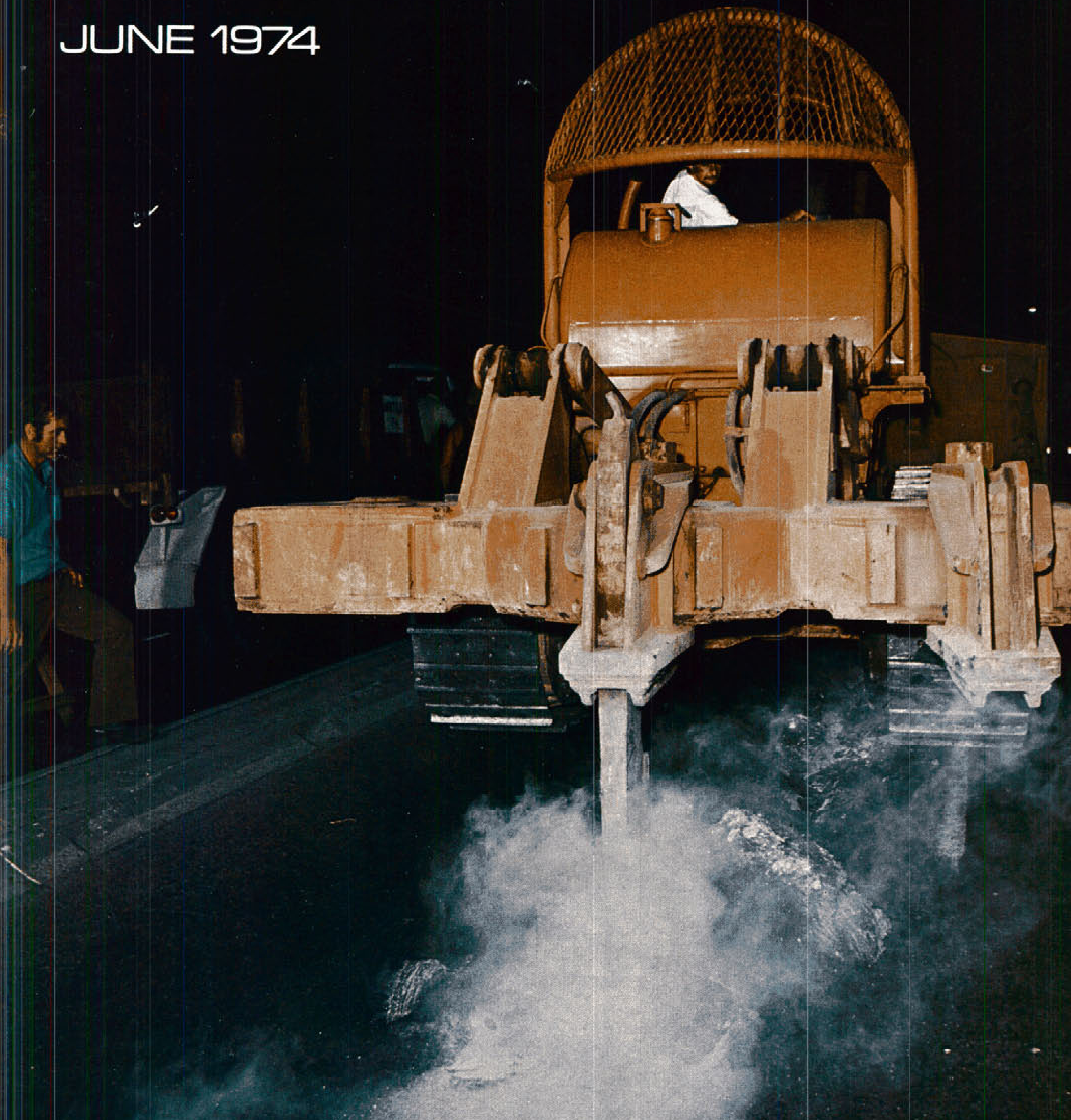
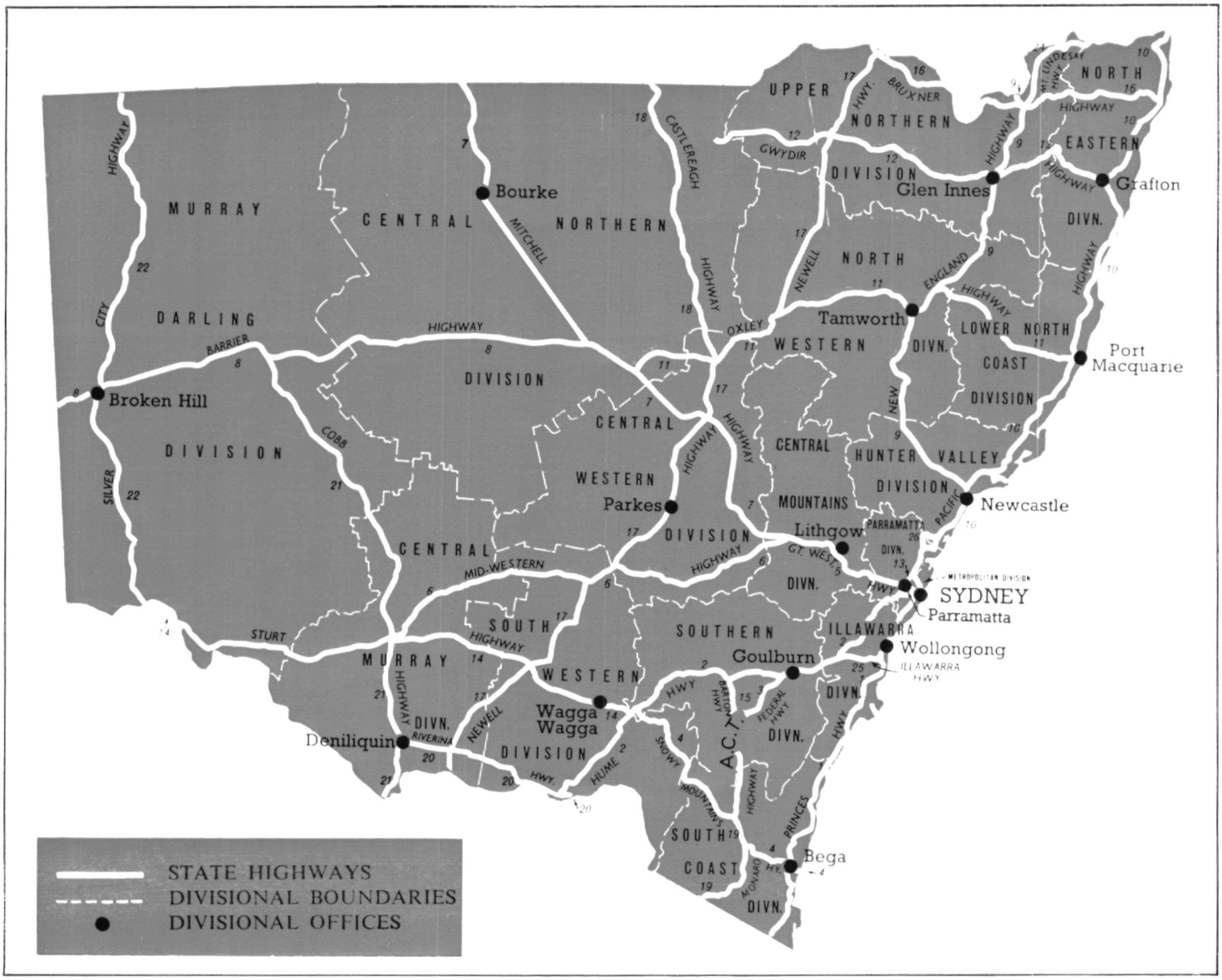
MAIN ROADS

JUNE 1974





New South Wales

Area—801 431 km² (309,433 sq miles)

Population as at 31st March, 1973—4,715,100 (estimated)

Length of Public Roads—208 890 km (129,745 miles)

Number of Motor Vehicles registered as at 30th June, 1973—2,328,037

ROAD CLASSIFICATIONS AND LENGTHS IN NEW SOUTH WALES

Lengths of Main, Tourist and Developmental Roads, as at 30th June, 1973. (Mileage equivalent shown in brackets.)

Freeways	63	(39)
State Highways	10 509	(6,527)
Trunk Roads	7 042	(4,374)
Ordinary Main Roads ..	18 470	(11,472)
Secondary Roads	290	(180)
Tourist Roads	396	(246)
Developmental Roads ..	3 896	(2,420)
Unclassified Roads	2 476	(1,538)
TOTAL	43 142 km	(26,796 miles)

MAIN ROADS

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JUNE, 1974

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Back cover: Working with asphalt

Front cover: On Prince's Highway (S.H. 1), Sydenham, asphalt ripping was done at night to inconvenience traffic as little as possible

ENDURING THE DELUGE

Such projects as sending man into space or transmitting television into every home were once beyond the concepts of the human mind. Now, we even dream of controlling the weather.

Possibly this will remain beyond man's capabilities until his mental development can keep pace with the complexities arising from such an achievement. But in the early months of this year, many inhabitants of southern Queensland and northern New South Wales probably wished that the ability to control the pattern of weather had already been mastered.

As the rain pelted down and the rivers rose, the scene throughout much of the flooded land was of people in small boats or wading through stinking waters, of hands hauling sand bags, of foreheads lined with worry for loved ones, neighbours and valued possessions. For these people modern technology and its promises must have seemed an eternity away as they endured the experiences, the sights and feelings of man in floods for ages past.

But modern technology was at hand, as illustrated by the extensive use of aerial communications to supply isolated towns with essential items and radio communications to co-ordinate relief activities.

In New South Wales some form of catastrophe resulting from extreme weather conditions occurs every few years, bringing financial loss and heartbreak to a section of the community. Several years ago a prolonged drought affected much of the western region of the state and periodically, climatic factors produce conditions ideal for the monstrous horror of fire.

However, during floods, the roads themselves frequently fall victim to the swirling waters. The damage to roads from the January-February floods in northern and north-western New South Wales will take months to repair and considerably deplete the funds available for the planned construction and maintenance of roads in these areas. At the same time, engineers will learn a little more about the effects of floods on roads and bridges and how to apply this knowledge to new roads and bridges.

It has been policy in the Department of Main Roads for many years to locate, design and construct new roads and bridges to reduce or completely eliminate the possibility of closure due to floods. Some locations, for example the section of the Barrier Highway which crosses the Talyawalka Anabranch, would involve long, costly roadworks on a route with a relatively low traffic density where flooding is a generally infrequent occurrence. All these factors must be taken into consideration in the design and cost of proposed roadworks.

Looking ahead in an optimistic fashion, we can anticipate the day when weather control could be a reality. For the present, however, reality means working in many ways to mitigate the effects of flooding. High priority is being given to improving roads and bridges in this State and where feasible to a safe, flood-free standard which will endure even the most catastrophic deluge.●

Opening Ceremony

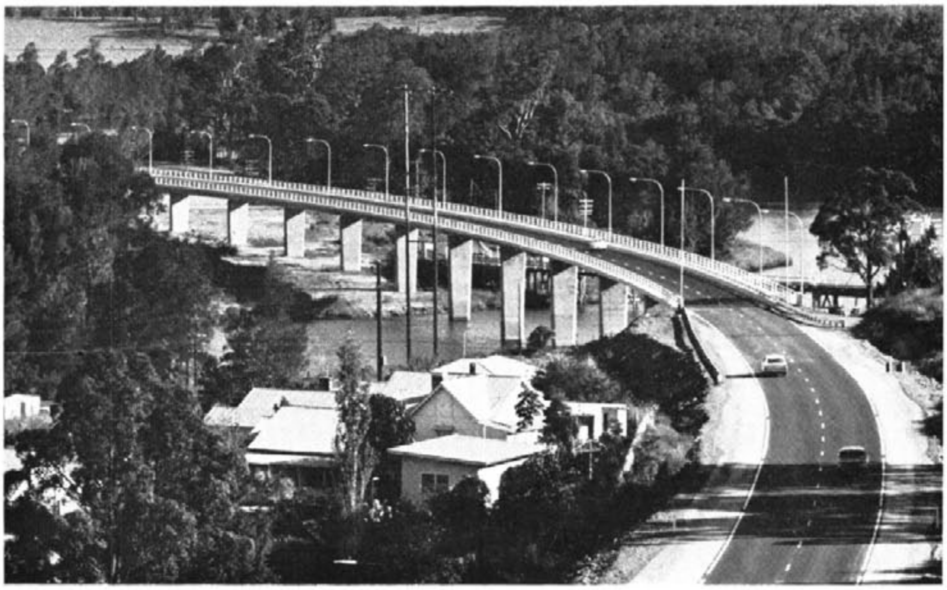
NEW BRIDGE AND DEVIATION AT Telegraph Point

This new bridge over the Wilson River at Telegraph Point was officially opened to traffic on Wednesday, 17th April, 1974, by the Deputy Premier and Minister for Highways, The Honourable Sir Charles Cutler, K.B.E., E.D., M.L.A.

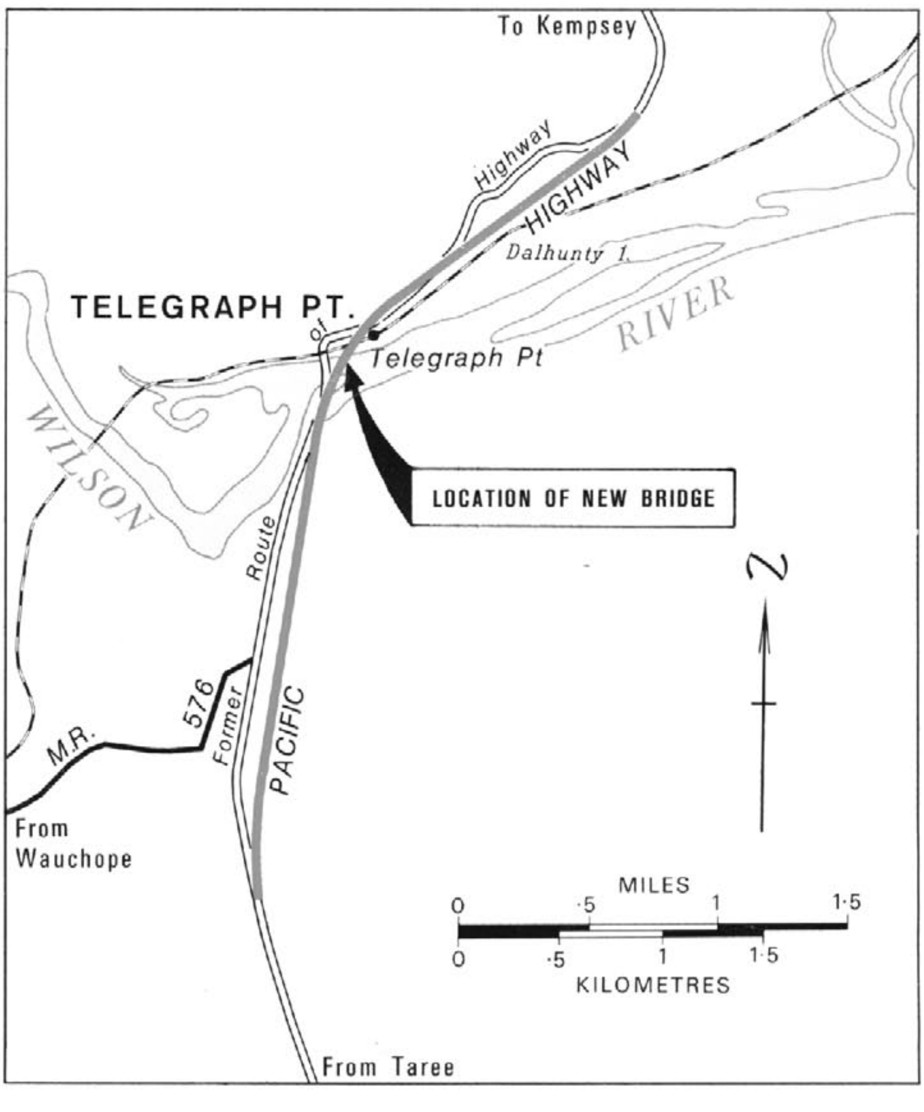
In a lovely setting of deep green hills sweeping down to the valley of the Wilson River, several hundred people watched the 11 a.m. ceremony under perfect blue skies.

Onlookers in the official party attending the ceremony included Mr J. H. Brown, M.L.A., Member for Raleigh and The Hon. I. L. Robinson, M.P., Member for Cowper. Also watching as Sir Charles cut the ribbon were the Commissioner for Main Roads, Mr R. J. S. Thomas and the Assistant Commissioner, Mr A. F. Schmidt. Schoolchildren and residents from the town of Telegraph Point added to the crowd of official guests.

This beautiful 555 m long bridge curves across the Wilson River on a 372 m radius. Its 15 spans rise on a grade of 2% from the southern side of the river. The bridge and approaches form part of a 6 km deviation. The deviation replaced a narrow, winding section of the Pacific Highway and also eliminated a railway level crossing.



Above right: The newly opened bridge over the Wilson River at Telegraph Point, looking south.



THE NEW BRIDGE—WHERE AND WHY

The new bridge over the Wilson River at Telegraph Point was constructed in conjunction with a 6 km deviation of the Pacific Highway to the south of Kempsey. The new bridge and deviation form part of a multi-million dollar, multi-stage plan for reconstruction of the Pacific Highway (State Highway No. 10).

Extending from Sydney to the Queensland border near Tweed Heads the Pacific Highway is the major coastal route and carries large volumes of commercial and tourist traffic travelling both within New South Wales and interstate. Numerous long distance hauliers use this route to transport goods between the large manufacturing centres of Sydney, Newcastle and Brisbane and to deliver the produce of the North Coast to city markets. As well, the Highway provides access to the many popular beach and fishing resorts scattered along this section of the coast.

Telegraph Point is a small settlement with a permanent population of less than 200 persons who derive their livelihood in the main from small-scale grazing and timber cutting. The annual average daily traffic volume at this location during 1973 was 3,640 vehicles.

The old bridge at Telegraph Point is a narrow single lane timber structure built in 1902 and situated on a poor alignment. The vehicle congestion created at this site by the old bridge was compounded by the level crossing of the North Coast railway line which crossed the Highway on the immediate northern approach to the bridge. The Department, aware of the undesirable features associated with railway level crossings such as existed at Telegraph Point, is continually striving to secure their elimination. The relocation of the new bridge on an improved alignment provided a further opportunity to eliminate yet another level crossing from the Main Roads System.

The old bridge was above flood level but the southern approach was subject to regular flooding. The deck of the new bridge has been constructed to a minimum height of 2·4 m above the highest recorded flood level of 4·25 m, which occurred in January, 1968. Of the 15 spans in the bridge only four are required to cross the main channel, the balance of 11 spans being over dry land, except when the river breaks its banks in times of flood.

The completion of the new bridge over the Wilson River and the deviation of the Pacific Highway have contributed greatly to providing safe, fast and comfortable motoring conditions on the Pacific Highway. No longer will lines of vehicles be forced to queue across the bridge and along the northern approach road waiting for the numerous trains to cross the Highway.

EARLY CROSSINGS OF THE WILSON RIVER

The Wilson River was named after William Wilson, a Scot who arrived in the Colony of New South Wales during 1822. He formed an expedition in 1826 to retrace the route of Surveyor-General John Oxley's 1818 expedition to the North Coast when the Hastings River and its outlet Port Macquarie had been named. On Wilson's journey the river which carries his name was discovered and he also named an adjacent one, the Maria River, after his wife.

For many years the crossing of the Wilson River was restricted to the use of small punts which ferried all manner of traffic across the river.

Early in April, 1899, a local newspaper reported: "The movement now on foot to urge for the construction of a bridge across the Wilson River at Telegraph Point should be one to meet with general approval and support from the residents in this and the Macleay districts, seeing that it is on the main thoroughfare for traffic of all kinds along the north coast rivers."

To further substantiate the case for construction of a bridge, the report continued " . . . the fact must not be overlooked that this district is not the old out of date place that it used to be when any means of transit would answer but it is daily developing and progressing in many ways but more particularly in its dairying and farming industries . . . "

At a public meeting held on 22nd April, 1899, the residents of the area urged the Government to construct a bridge to " . . . make communication more rapid . . especially in times of flood . . a loan vote having already been passed in 1892, for the construction of the work."

Work began on the construction of a bridge in September, 1900. It was designed and constructed by the Public Works Department, the Resident Engineer being a Mr W. F. Burrow under the supervision of the Engineer for Bridges, Mr E. M. De Burgh. The bridge was formally opened to traffic on 9th April, 1902, by the Hon. R. Davidson, M.L.A.

A newspaper account of the opening ceremony gave the following description: "The work of christening the bridge was appropriately left in the hands of Mrs H. L. Wilson (perhaps the oldest resident in the district) and Miss E. Rowsell (daughter of Mr W. Rowsell). As the bottles of champagne were broken both ladies distinctly named the bridge 'Telegraph Point Bridge' ".

The bridge, which was constructed by day labour, comprised one iron span, one timber truss span and seven timber beam spans. The timber deck had a minimum width of 4·3 metres and a total length of 11·4 metres.

Because of the timber cutting industry established in the area, the design included an opening span to allow for the passage of timber barges. This opening span was on a bascule type, counter-balanced on a principle which had not previously been applied in Australia.

The total cost of construction of "Telegraph Point Bridge" was £8,500 ($17,000).

Responsibility for this bridge passed to the Department of Main Roads in 1928.

DESIGN AND CONSTRUCTION DETAILS

The foundations supporting the superstructure of the bridge are comprised of piles driven to rock level. The piles were designed for a maximum load of 305 t and consist of hollow 0·9 m diameter steel casings bored into rock at a depth of 25 m and filled with reinforced concrete. Underwater concrete placing techniques were used as difficulty was experienced in sealing off the casings from ground and river water. There are 4 piles under each pier, 15 under the anchor abutment and 3 under the expansion end abutment.

To enhance the appearance of the bridge, the design allows for the caps of piles, which support the river piers, to remain beneath water level at all times. Construction of the pile caps below water level was undertaken using the "coffer dam" technique by which a steel box form was floated into position, sunk to the required level, sealed at the base and pumped out to provide a dry working chamber.

The piers and abutments are reinforced concrete. The piers consist of single columns tapering from a rectangular section at the top to an octagonal section at the base and vary in height from 4·3 m to 15·3 m.

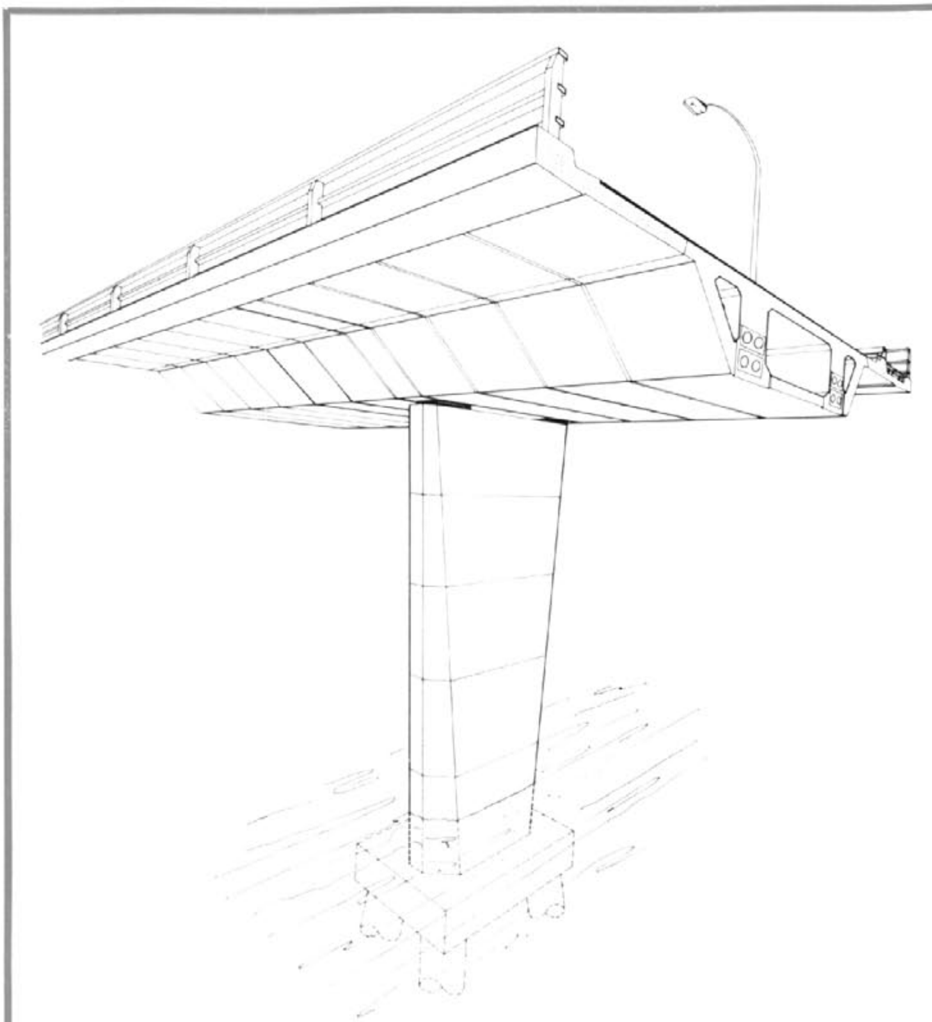
The bridge consists of 15 spans, 13 intermediate spans of 38 m and 2 end spans of 30·5 m, giving a total length between abutment bearings of 555 m.

A feature of the bridge is the 1 372 m radius curve which presents a sweeping perspective of the structure to travellers. The bridge also rises on a grade of 2% from the southern side of the river.

The superstructure comprises a box girder (spine beam) made up of precast concrete segments tied together by steel stressing cables located in ducts within the segments (see diagram). The segments, which are 6·3 m across the top flange and 3·7 m across the bottom flange, vary in length from 1·1 m to 2·3 m and have a maximum weight of 30 t. A total of 235 segments was required for the construction of the spine beam and a casting yard was set up on the southern approach to the bridge for their manufacture.

The superstructure was constructed on temporary driven timber pile trestles erected along the bridge centreline. These trestles supported 2 large steel beams which in turn carried the weight of the segments until they were tied together by the steel stressing cables. The segments were pushed out from the casting yard on a cradle mounted on rail tracks laid along the completed spans of the deck. On reaching the end of the tracks the segments were lifted off the cradle by a hydraulic jack, mounted on a special frame and lowered into place on the supporting steel beams, where they were jointed (using cast-in-situ concrete) and stressed together. On completion of each span the rail tracks were extended, the lifting frame moved forward and the operation repeated for construction of the next span.

Stressing of the superstructure involved the application of a jacking force of 4 000 kN to each of the eight cables incorporated in the bridge. These cables were made continuous over the length of the deck by couplers located in each span.



Pier and superstructure arrangement, Telegraph Point Bridge

After completion of the spine beam, 8·5 m long cast-in-situ reinforced concrete deck slab cantilevers were joined to both sides of it using travelling formwork. The deck was then sealed with a layer of rubberised bitumen before laying the asphaltic concrete running surface.

With a total width of 11·6 m the deck of the bridge provides a 2–lane carriageway 8·6 m wide, a single footway 1·7 m wide and a safety kerb 0.6 m wide. Space has been provided beneath the footway to house public utilities.

To permit movement in the superstructure due to thermal effects, long term creep and shrinkage, a 330 mm wide expansion joint has been provided at the northern or uphill end of the bridge. "Sliding pot" bearings with maximum load capacities varying from 459 t to 153 t allow the superstructure to move on the supporting piers and abutments.

At the southern or downhill end, the superstructure is anchored to the abutment by seven high-strength bars, each 35 mm in diameter. To permit periodic inspection of these bars, the design provided for this anchorage abutment to be a cellular construction.

The quantities of the principal materials used during construction were:

Concrete	5 150 m³
Reinforcing steel ..	930 t
High tensile cable ..	97 t

The bridge was constructed under contract to the Department by Pearson Bridge (N.S.W.) Pty Ltd. Time for completion of the contract was 180 weeks. The total cost of construction of the bridge was $1,600,000.

NEW DEVIATION OF THE PACIFIC HIGHWAY

In conjunction with the erection of the new bridge over the Wilson River, the Department has constructed a 6 km deviation of the Pacific Highway, including the approaches to the new bridge.

Prior to the construction of the deviation, this section of the Pacific Highway was narrow and winding. The relocation of the Highway on an improved alignment and with a maximum grade of 2·3% has ensured safer and easier motoring conditions and has also provided a flood free by-pass to the village of Telegraph Point.

The deviation crosses the flood plain of the Wilson River for a distance of almost 2 km and then passes through mountainous terrain to the north of Telegraph Point. The new road is 0·4 km shorter in length than the previous route of the Highway.

The railway level crossing and old bridge at Telegraph Point, contrast with the elegant design of the new bridge, seen here under construction

The pavement on the deviation, which has been constructed to motorway standards, is 7·4 m wide with 3 m wide shoulders and has been constructed of two layers of shale stabilised with lime to a total thickness of 200 mm and flush-sealed with one coat of bitumen. Turning lanes have been provided at junctions to allow for the free flow of through traffic.

Of the material moved during earthwork operations undertaken on the deviation, approximately one half, equivalent to 1 000 m^3, resulted from the excavation of a 30 m deep rock cutting behind the village of Telegraph Point on the northern approach to the new bridge. This material was won using a combination of drilling and blasting equipment. Up to four track mounted drills were employed on drilling works at any one time during excavation of the cut.

To provide adequate drainage of the deviation, four large reinforced concrete box culverts were required. Three culverts were constructed on the section of the deviation which crosses the flood plain to the south of the new bridge and the fourth was erected on the northern approach to the bridge.

Access to Telegraph Point village and the railway station will be by way of the old route of the Pacific Highway which will be joined to the new route in the village itself. The new route will be carried over the old highway at the northern end of the village by way of a 36 m long prestressed concrete bridge which is set at a 55° skew. This bridge was constructed under contract to the Department by Transbridge Pty Ltd.

Principal quantities involved in the construction of the deviation were:

Earthworks	..	200 000 m^3
Box culverts	..	87 m
Base and surface course area	..	94 000 m^2
Sealed area ..	..	54 000 m^2

Construction of the deviation was carried out over a two year period and all work was performed by the Department's own forces attached to the Port Macquarie Works Office. On average 45–50 men were employed on the project.

The cost of construction of the deviation has been approximately $1,300,000 or $218,000 per km. Of this, the overbridge and culverts cost in the vicinity of $200,000.

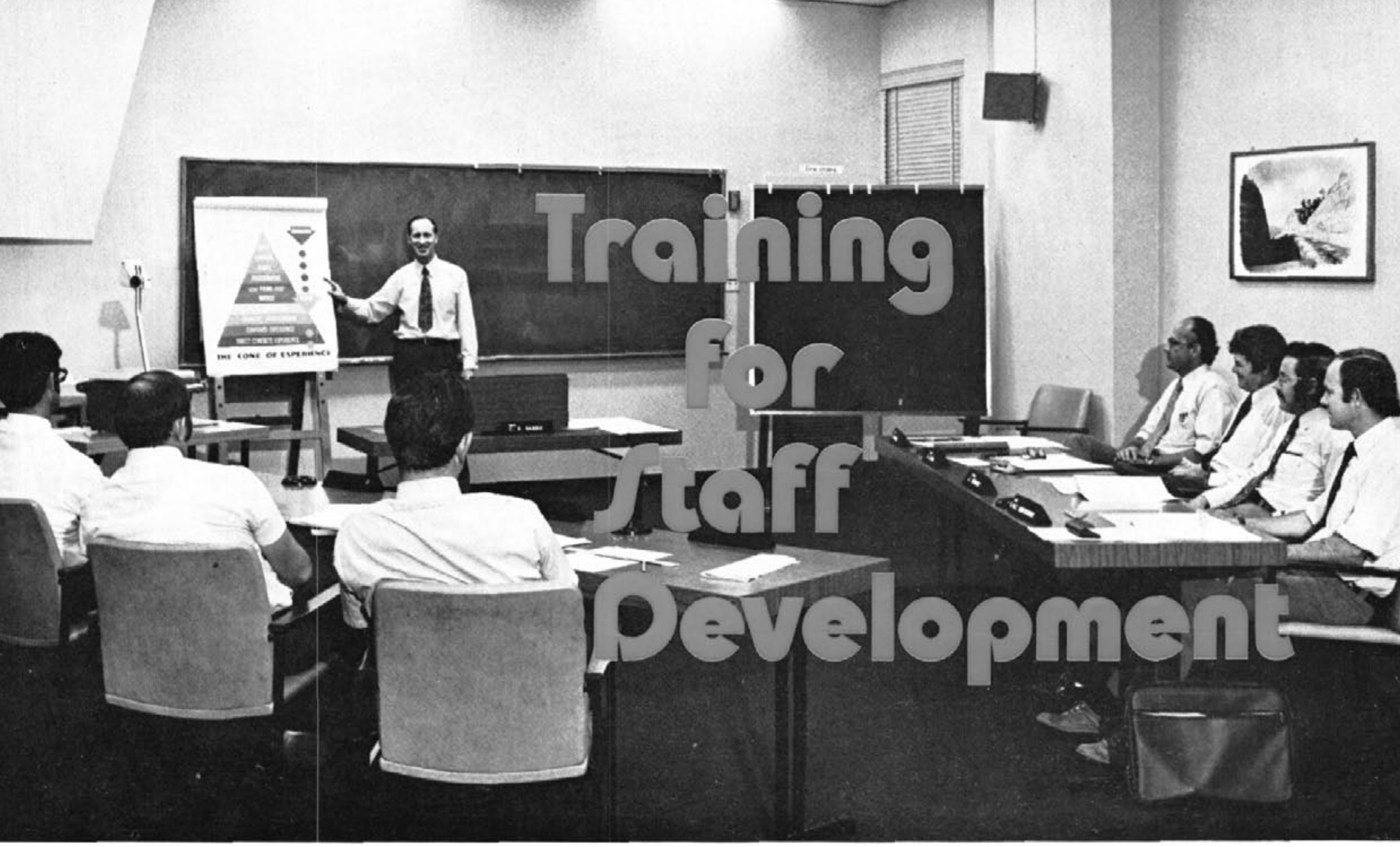
COOPERABUNG CREEK BRIDGE

Further progress in the plan for reconstruction of the Pacific Highway in the Telegraph Point area was made in March this year when a tender was accepted for a new bridge over Cooperabung Creek. The contract was awarded to Pearson Bridge (N.S.W.) Pty Ltd, at a tender price of $61,350.

The 32 m long bridge will be a 3 span flood-free prestressed concrete structure, 8·5 m between kerbs. Like the new bridge over the Wilson River, this bridge will be located on the new deviation of the Pacific Highway which will extend from 86 km to 105·5 km north of Taree.

The new bridge over Cooperabung Creek is expected to be completed later this year, after which Hastings Shire Council will take over the existing narrow bridge.●

Training for Staff Development



A class in progress at the Staff Training Section of the Department's Head Office

Today's emphasis on increased productivity recognizes the importance of fully developing the talents of employees.

For maximum effect, staff development schemes require systematic programming which includes training people in their present jobs, developing them for higher positions while encouraging the acquisition of appropriate educational qualifications.

Training courses can supplement, intensify and condense experience which would otherwise take many years to accumulate. At the same time it must be acknowledged that practical experience gained on the job is the best means of developing an individual's talents.

A CO-ORDINATED APPROACH

Since its inception, the Department has used numerous methods to train its officers to carry out their functions in the most efficient manner. In recent years instruction given "on-the-job", that is instruction given by an employee's immediate superior, has been supplemented by the formal training of staff in group sessions. However, such formal training arrangements, either technical or clerical in nature, were organized and conducted by sections of the Department largely independent of each other.

In 1972 the Commissioner for Main Roads appointed a Steering Committee on Training, comprising the four Assistant Branch Heads with the Deputy Engineer-in-Chief as Chairman. This Committee advises on and implements the Department's training policy and co-ordinates all training activities.

In determining a training policy the Committee recognized that tuition should be, as far as possible, practical instruction on the job under the guidance and supervision of the officer's immediate superior. Formal training off the job should be provided only where on the job instruction is impracticable, inadequate or uneconomical.

THE TRAINING SECTION

A Training Section, headed by the Principal Training Officer who is responsible to the Steering Committee was established in early 1973.

The Training Section acts as a consulting management service giving specialised assistance in programme development and training technique. Through it the Steering Committee is in a position to oversee all training activities within the Department.

The establishment of a central training unit does not encroach on the responsibilities of managers and supervisors in the Department, neither does it relieve them of their obligations towards the training and development of their subordinates. The Commissioner's policy is in fact based on the philosophy that the main responsibility for staff training and development rests with all officers directly in charge of staff. Preparation for advancement within the Department, however, remains an individual's own responsibility.

THE ANNUAL PROGRAMME

In late December, 1973, a booklet detailing the Department's Training Programme for 1974 was issued to all Divisions and Sections of the Department. The programme was compiled using a survey of training needs and evaluation of previous training courses as a guide. It shows the dates of courses that are already scheduled plus details of their venue, duration, objectives and broad content as well as courses to be conducted during the year for which dates could not be determined in advance.

The programme, which is published annually, enables all staff in the Department to be informed in advance of formal training activities to be undertaken during the year. It is also an indicator to the emphasis being placed on the development and training of the Department's staff.

Courses conducted by educational institutions such as the Australian Administrative Staff College and the University of New South Wales Institute of Administration, to which staff are sent, are also listed in the programme.

The training programme is flexible and its publication does not prevent the implementation of activities to cope with needs arising at short notice during the year. Rather it should facilitate these activities by giving a clear picture of the disposition of training resources at any time. As a ready reference the programme is valuable for managers and supervisors in planning the development of their subordinates.

It is expected that by adopting this planned, co-ordinated approach to the training of staff, better use will be made of training facilities and equipment and that the release of trainees and session leaders for courses may cause less inconvenience in the work situation.

NEW EMPHASIS IN TRAINING

A feature of the Department's training from 1973 is the introduction of courses in human relations and communication skills for supervisory officers from all areas of the Department. This training is seen as a stage in the development of executives to fit them for the responsibilities of senior positions.

Next year will see the commencement of Departmental residential management training to fulfil the need for the training of more senior staff, and be an adjunct to external training of this type which has been used for some years.

USING THE TRAINING PROGRAMME

Training courses should be regarded as complementary to instruction and experience gained in the practical work situation. Supervisors should assess the needs of their staff for training and where appropriate utilise the courses available in the training programme. Where necessary, special training for particular staff groups can be arranged and it is in this area that the consultative services of the Training Section may assist.

INSTRUCTING THE INSTRUCTORS

Many officers throughout the Department have developed over the years into specialists in their particular field. These officers form the majority of session leaders at training courses. The use of these specialist speakers with their background of practical experience ensures that formal courses, although conducted mainly in the classroom, retain the "down to earth" atmosphere essential for best subsequent value.

In order to capitalize on the knowledge and skills of specialist session leaders, provision has been included in the programme for courses in instructional techniques. To date, approximately fifty-five officers have attended these courses all of whom have been or will be called upon to conduct sessions in various courses.

IN REVIEW

By keeping supervisory officers informed of scheduled training activities and indicating courses suitable to certain designations and grades of staff, the programme is expected to encourage more participation by them in the training and development of their subordinates.

Integration of all training by means of a training programme should assist in meeting the Department's continuing needs for a competent, well-informed workforce throughout the State.●

ESCAPING FROM A SUBMERGED CAR

When severe and sudden flooding occurs along main roads, such as that recently experienced in the north and west of New South Wales, there is increased danger of vehicles being plunged into deep water with possible loss of life. Even at times of normal driving conditions, a vehicle going out of control or involved in an accident could be propelled into a creek or river with little escape warning for the occupants.

In this moment of panic, the knowledge of a few basic survival rules could save lives.

THE RULES

1. When impact with water seems imminent, switch on both inside and outside lights.
2. Release seat belts immediately after hitting water.
3. Open door windows, movable roof or back window and leave the car as soon as possible. Do not wait until the car rests on the bottom. While still floating, the pressure of water from the outside will make opening doors difficult.
4. If escape from the car is not possible while floating, doors will usually open underwater where pressure will be reduced.
5. Should the car be too badly damaged for these methods of escape, use the feet or shoulders to remove the front or back window, remembering that this can be done more easily by pushing at the corners.

RESEARCH

These rules were devised, after extensive tests, by Holland's Society for Scientific Research in Traffic Safety. The Netherlands, with its predominance of canal-crossed roads, has yearly records of about 1,200 vehicles falling into the water, in which a total of 80 to 100 occupants are killed. The Society carried out its investigations using a number of divergent types of private cars and delivery vans, sometimes manned by humans or dummies, and driven, as realistically as possible, into the water under various conditions.

Conclusions from these tests emphasised that lights switched on lessen the confusion in the vehicle and make location easier from above. It was stressed that car occupants who wear seat belts have more chance of escaping because they are less likely to be hurt at the time of impact with the water. Seat belts would have reduced their chances of injury in any prior accident, while the average impact with water can also be compared to a reasonably severe front collision.

Another finding of the investigation was that in most cases the submerged vehicle will retain no air-bubble. Therefore calm and swift escape is essential to survival.

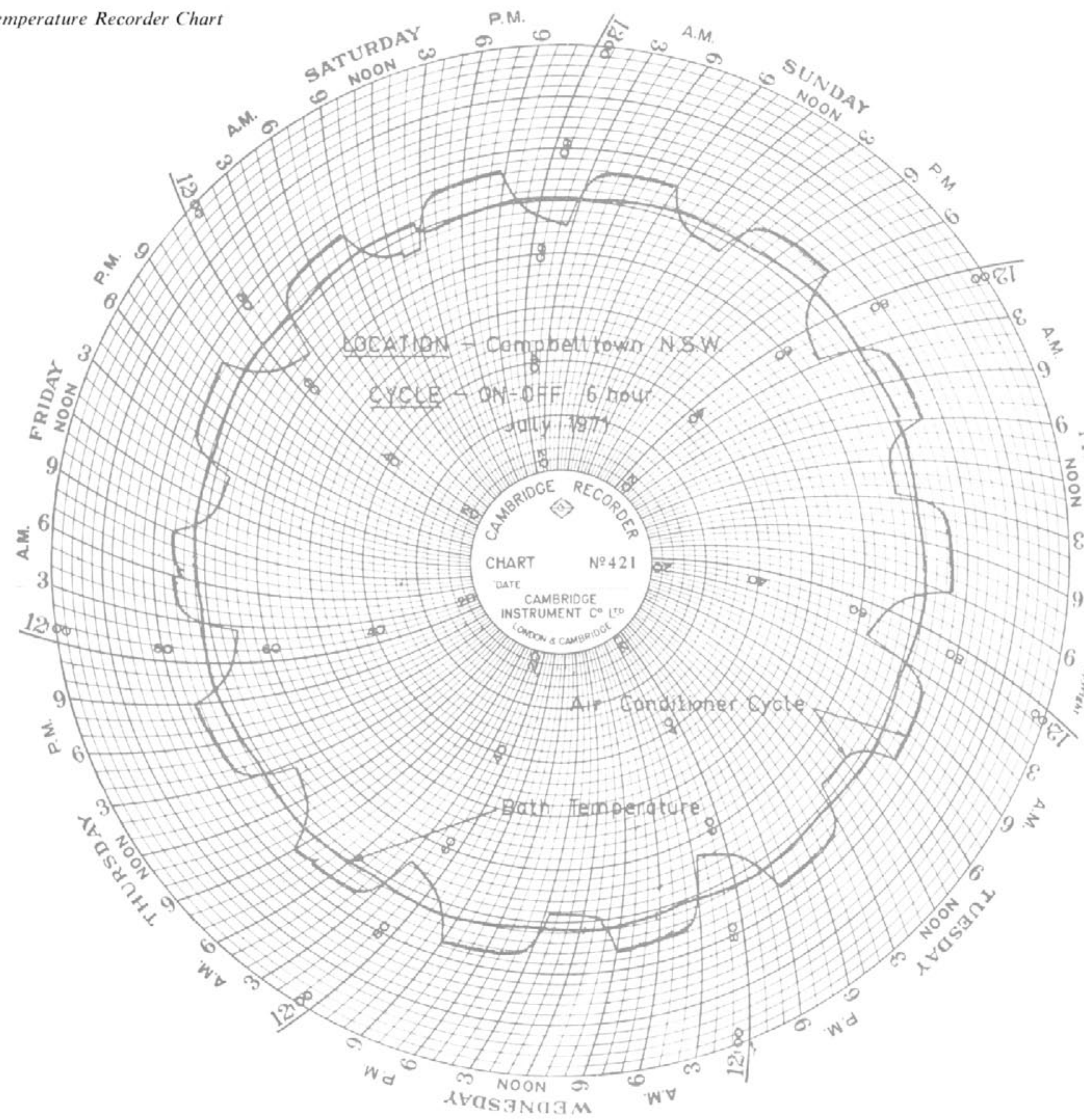
FIELD CURING FACILITIES FOR CONCRETE TEST SPECIMENS

The Department's testing laboratories process and determine by physical test the compressive strength of a substantial number of concrete specimens made from samples of concrete used on works throughout the State.

Usually the purpose of the tests is to verify compliance with specified requirements of the concrete used or supplied. For this purpose, specimens must be subjected to standard curing conditions during their strength development stage.

Standard curing conditions require close control over temperature (23° ± 2°) and humidity (at least 95%) for the first twenty-eight days after casting, and are detailed in the Australian Standards A 103 and 1012 Part 8, "Method for Making and Curing Concrete Compression, Indirect Tensile and Flexure Test Specimens in the Laboratory or in the Field". Specifications for the supply of concrete for the Department's works stipulate compliance with these requirements.

Traditionally, humidity requirements were usually achieved by immersing the



Temperature Recorder Chart

specimens in water or in wet sand, however, temperature control by this method was always a problem particularly on small works.

The first significant attempt by the Department to exercise some measure of control over temperature in a field situation was the construction by the Metropolitan Construction Organisation, at Rosehill in 1957, of a curing bath with water circulation and thermostatically controlled heating. This resulted in somewhat more favourable curing during hot weather because there was no provision for cooling the water in the bath.

Subsequently, the Department's first "fog room" was designed and erected at the site laboratory built for testing materials used during construction of the Gladesville Bridge. This "fog room" had a nominal capacity of 600 standard sized concrete specimens and with refrigeration equipment and heating devices the temperature was maintained within the specified tolerances.

Fog rooms have been constructed at other sites but the complex controls and vapourizing units are costly to install and maintain. Moreover, the large storage capacity available in a fog room is seldom required for field installations.

A related problem concerned the difficulty of complying with curing requirements when transporting concrete specimens, particularly over long distances, to the testing laboratory or to controlled curing facilities. A standard system of wrapping specimens in at least five layers of wet paper, sealing in a plastic bag and consigning in a specially made corrugated cardboard carton was initiated within the Department in the early 1960's.

It was recognized that satisfactory field curing of concrete specimens could be achieved most economically if portable curing facilities could be installed temporarily at the work site and relocated when the demand diminished.

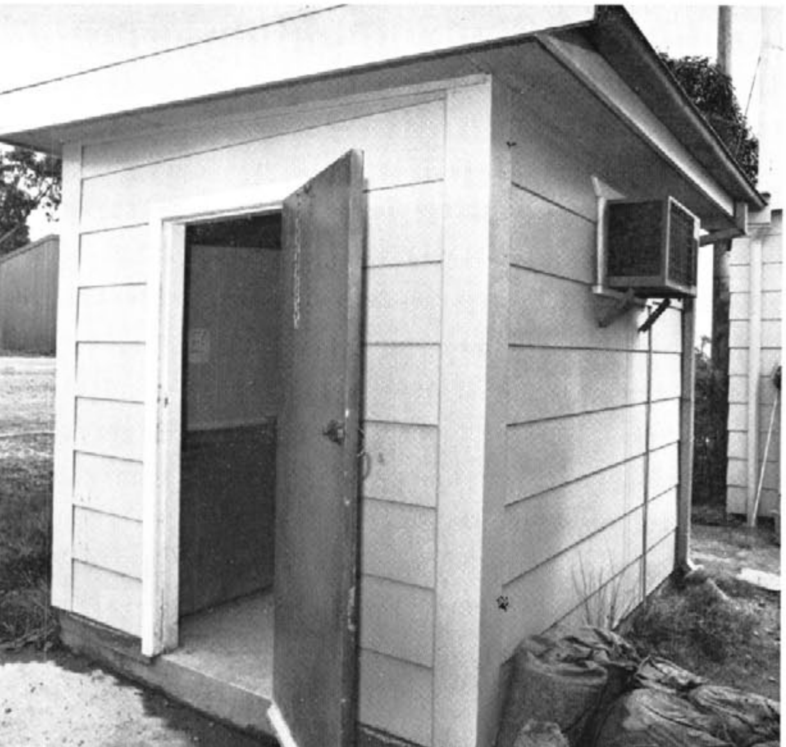
The Department has now developed a prefabricated, readily transportable curing room which can be set up on a prepared concrete slab base. Its internal dimensions are 2·3 m wide by 2·7 m long. The external wall cladding is of asbestos cement weatherboards, with internal lining of asbestos cement sheeting. Cavity insulation is provided by bats of mineral wool, 50 mm thick. The room is delivered complete with internal plumbing and electrical wiring. The site requirements consist of access to a 240 V, 50 Hz electrical supply, a water supply and facilities for periodical drainage of water from the baths.

Three stainless steel tanks, each with its own water inlet and drainage with a total capacity sufficient for 180 standard 150 mm diameter by 300 mm long specimens are located within the room so that there is air circulation to all surfaces. To reduce condensation within the room, the tanks are fitted with removable covers. For initial filling and refilling in areas where the temperature of the water supply is relatively low, a portable immersion type heater can be used.

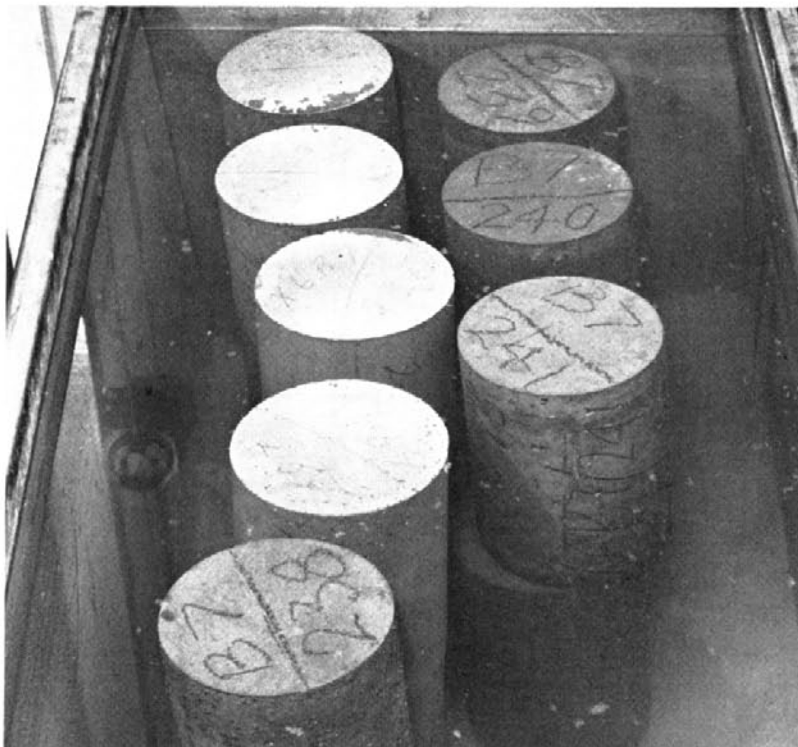
The curing bath temperature is maintained within the specified limits by means of a window mounting type air conditioning unit. The unit is a recirculating type fitted with a thermostat which will permit adjustment to give a temperature differential of $\pm$ 4° C. The capacity of the unit is determined by the climatic conditions in which it will be used. For average conditions a unit rated at 1·12 kW with 11 660 kJ cooling capacity and 7 420 kJ heating capacity has been found to give satisfactory performance.

To reduce maintenance and running costs and to provide for regular servicing, the operating time of the air conditioner is controlled by a synchronous time switch with duplicate on-off levers. Temperature recorders monitor the actual performance of the air conditioning unit and two programmes of on-off cycles are selected to suit the local ambient temperatures. Although the air temperature within the room may fluctuate within a range of $\pm$ 4° C the inertia type effect of the large volume of water in the tanks reduces the temperature differential of the water to within the specified range of $\pm$ 2° C. A typical record illustrating this phenomenon for a 6 hours ON followed by a 6 hours OFF cycle is reproduced in this article.

A number of these portable curing rooms are in service and performing satisfactorily.●



Portable curing room on concrete slab with air conditioner mounted to window-type opening in the wall



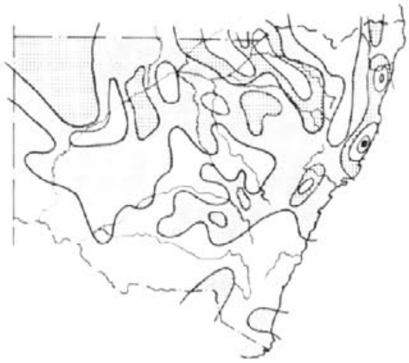
Concrete specimens in the water bath

FLOODS

STORM RAINFALLS AND MAXIMUM RIVER HEIGHTS RECORDED DURING JANUARY—FEBRUARY 1974

Right: Storm Rainfall for 8 days ending 9 a.m. 14th January, 1974 (millimetres).

100 - 200
200 - 300
300 - 400
400 - 600
> 600



Below: Dates and maximum river heights shown in metres recorded from the storm events that occurred during January 1974.

Flood Height

Murwillumbah	*2.1 m*
Lismore	*5.5 m*
Grafton	*3.0 m*
Tamworth	*4.9 m*
Gunnedah	*5.8 m*
Wee Waa	*4.6 m*
Moree	*7.0 m*
Collarenebri	*6.1 m*
Brewarrina	*6.1 m*
Bourke	*9.1 m*
Louth	*7.9 m*
Wilcannia	*7.6 m*

Flood height is the height at which landholders would need to be alerted for removal of stock, etc.

JANUARY-FEBRUARY, 1974

Early this year, large areas of New South Wales and Queensland experienced floods equal to, and in some places exceeding, the worst ever recorded. The damage to many public facilities was enormous and the hardships and suffering of the people reached a toll which can never be reckoned.

Many main roads were severely damaged and, although temporary repairs were carried out as soon as the waters receded, reconstructing the damaged sections will take many months to complete.

Information for this article has been collected from several sources, but principally from material prepared by the New South Wales Civil Defence Organisation for publication in the Summer 1974 edition of the State Emergency Services "Bulletin". Assistance was also received from the Bureau of Meteorology.

WHY THE FLOOD?

Heavy, widespread rain commenced about October, 1973, over the areas of the Central Tablelands, Riverina, Western, and Darling Districts. This continued until the end of the year, maintaining soil water content at high levels in most areas of the State. The majority of river catchments therefore had very little absorption capacity—perfect conditions, in fact, for rapid flooding.

In the far north of Australia the normal "wet" season commenced in December which was earlier than usual. This "wet" advanced to abnormal southerly extremes and humid, moisture-laden air covered much of the continent. There was a lack of strong upper winds to disperse the atmosphere so these conditions persisted for a long period and flooding occurred in many areas.

In early January, an inland low pressure system moved from Northern Australia and centred in the south-western region of Queensland. The meteorological report of this event stated—

"Computations of the atmospheric moisture available in depth for condensation into raindrops (precipitable water) are made daily from upper air observations and the Precipitable Water Analysis for 7th January showed high values over eastern Australia. During the period 5th–9th January Cobar and Moree upper air stations indicated a near saturated atmosphere to 11 000 m. Although the strong convergence pattern had collapsed by the 9th January, thunderstorm rains continued over the area with the persistence of the trough until 12th January. The monthly rainfalls for the Western and North-Western Plains Districts were the highest for the 60-year period since commencement of instrumentation, while new records for January were created over large areas of the North West Slopes, the North Coast and Tablelands and the Manning Districts".

Cyclone "WANDA" moved into south-western Queensland and Northern New South Wales on 24th January bringing more heavy rains which aggravated flooding. This was the most devastating meteorological event which, coming as it did after floods were already in progress,

Sandbags feature in similar scenes of flood battle, but many miles apart. On the right, Castlereagh Highway, 22 km south of Walgett. On the far right, 8 km north of Bourke on the Mitchell Highway

A LAND IN DISTRESS

set the conditions for a record-breaking flood over many thousands of miles.

FLOODED LANDS

Major flooding occurred along the Macintyre, Gwydir, Barwon, Namoi, Mooki, Peel, Castlereagh, Darling, Culgoa, Birrie, Bokhara, Narran, Paroo, Warrego, Bulloo, and the lower Macquarie and Bogan Rivers. An area of 466,200 sq km, more than half the total area of New South Wales, is drained by these rivers.

In many districts, record river heights were established. Water reached heights never seen or known of before in some areas of the far West, particularly the Bulloo and Paroo basins. The Central West and South West river systems, including the Lachlan, Belubula, Murrumbidgee, and Murray were also subjected to moderate flooding.

For the Northern and North-Western areas of the State, however, the floods were the largest since the destructive floods of 1890 and 1955-56.

In the six days between 4th and 9th January, heavy rain totalling between 200 mm and 380 mm fell over wide areas of the north and far west river catchments. Some rainfall stations reported falls of 250 mm–350 mm in a 24-hour period. Soon after the commencement of this rain, it became obvious that flooding of a serious nature would occur on many rivers and the Bureau of Meteorology issued warnings of major flooding for all streams west of the Namoi River. Rain was most heavily concentrated in the Barwon, Culgoa, Bokhara, Paroo, and Bulloo basins and the lower and middle reaches of the Namoi, Gwydir, and Macintyre Rivers. These areas suffered the greatest flood damage and possibly the most prolonged period of inundation since flood records have been kept.

Right: Floodwaters from the Darling/Barwon River system surround the town of Brewarrina, near the intersection of Trunk Roads 68 and 70.

Below: A sea of floodwaters was a familiar sight for the inhabitants of Bourke early this year as it was 84 years ago when these photographs were taken during the mammoth flood of 1890.

Mid-January saw thousands of square miles of land in the west submerged. Towns affected by flooding included Gunnedah, Breeza, Carrol, Tamworth, Narrabri, Wee Waa, Moree, Pallamallawa, Walgett, Mungindi, Collarenebri, Rowena, Pilliga, Burren Junction, Lightning Ridge, Goodooga, Weilmoringle, Wanaaring, Louth, Tilpa, Wilcannia, Merindee, Coonamble, and Gilgandra.

Possibly the worst affected centres were Narrabri and Wee Waa on the Namoi River, which were isolated for almost a week. About 300 mm of water covered the road in the business section of Narrabri at the peak of the flood and many houses were inundated.

Wee Waa was submerged for over six days when water up to 1·5 m deep entered practically every home in the town. All road and rail links to Wee Waa were severed, the only access being by aircraft. During the emergency about 200 evacuees were airlifted to Tamworth where they were cared for by State Emergency Services, Youth and Community Services and Salvation Army personnel. The RAAF flew over 200 tons of food and supplies to the Wee Waa airstrip from where supplies were ferried to town in flood boats operated by the Water Police Flood Rescue Squad. To do this the boats crossed raging flood waters for almost two miles. Part of the sewerage system in Wee Waa collapsed and added to the health hazard. Snakes, mice, spiders, and insects, unable to find higher ground, sought refuge in houses, making conditions most uncomfortable for residents.

As well as extensive damage to homes and possessions, stock, fence, and crop

losses in the Narrabri-Wee Waa area were severe. Damage to the cotton crop was estimated at $20 million. Road damage in the valley was enormous.

Flooding in the towns of Moree and Gunnedah was not as severe as in 1971. Floodwaters entered the towns and it was necessary for about 200 people to be evacuated from low lying areas. Complete evacuation of a population of approximately 100 was necessary at Carrol.

The intensity of local rain brought additional problems for rescue because many people were stranded when properties were so quickly isolated, remaining so for almost a month—the only means of transport to these centres being by aircraft. The same position applied to the smaller centres of Goodooga, Collarenebri, Lightning Ridge, Louth, and Tilpa. Water did not enter Walgett, Brewarrina or Bourke because of levee systems constructed or improved prior to the flood.

In towns protected by levees, the atmosphere of battle was all around as a 24 hour watch was maintained and the levees strengthened or repaired whenever necessary. During a critical stage of the Barwon flood, a part of the levee at Brewarrina was breached. To assist the local organisation with recovery and strengthening of the system, a contingent of Army personnel, including vehicles, was flown into the town, as were thousands of sandbags.

Isolated towns received a total of 1,500 tons of food, equipment and medical supplies flown in by RAAF Hercules and Caribou aircraft, while 2,750 people were either carried or evacuated by fixed wing aircraft and helicopters. Missions such as these are estimated to have involved 2,000 RAAF flying hours. Included in the essential supplies were flood boats, motors, vaccines, drugs, blankets, disinfectants, bread, flour, tents, vehicles, radios, sandbags, air drop containers, milk, canned goods, cereals, vegetables, napkins, baby food, cleaning materials, and welfare and water purification items.

BOURKE

Floodwater from the Darling River isolated the town of Bourke for several weeks. All supplies were brought in by air and it was vital that the road from Bourke to the airport at North Bourke remained open. This allowed supplies to be brought to Bourke from the airport and from Bourke by air to other isolated centres and station properties.

Levee banks were constructed along the road formation to keep the route open. The Department's indoor and outdoor staff, as well as contractors to the Department, put extensive effort into this task.

The Mitchell Highway (S.H. 7), passing through Bourke, was affected by floodwaters at various points extending from about 21 km south east of Bourke, towards Nyngan and about 30 km north of Bourke, towards Barringun. On the Highway towards Nyngan the Department strengthened the road shoulders and formation at points 3 km and 9·5 km south east of Bourke prior to arrival of the flood, in an attempt to reduce the extent of damage which might occur at these locations.

Before the flood reached its peak, the Department graded a side track on the western side of the highway from 21 km to 32 km north of Bourke in anticipation of water cutting the road at the depressions 22·5 km and 29 km north of Bourke. At the peak of the flood the road was covered to a depth of almost one metre at these points. For a short period, heavy rain closed this side track, but it was repaired and opened to light traffic soon after.

OTHER PLACES

Similar stories of the work done by the Department's staff to reduce road damage and keep communication routes open were repeated in many areas. As flood waters receded, work commenced on restoring broken road surfaces to trafficable condition. Temporary repairs were made immediately with the view to

Above: The Mitchell Highway leading into Bourke was subject to flooding at this point 3 km south of the town.
Below: At Grawan Creek on the Gwydir Highway, 8 km east of Collarenebri, a bridge standing above the flood level became the temporary home for beehives.

repair and reconstruction of a permanent nature at a later date when conditions returned to normal.

WILCANNIA

The Talyawalka Anabranch of the Darling River crosses the Barrier Highway (S.H. 8) about 11 km east of Wilcannia. The floodwaters from the north reached this area on 23rd February, 1974, and forced the closure of the Barrier Highway to through traffic for nearly two weeks. The road pavement was under water for just on six weeks.

A stretch of highway approximately 2 km long was covered by water which reached out on all sides to form a huge inland "sea". Wilcannia was almost surrounded by the brown swirling mass which carried with it the distinctive stench of floodwaters. To add to the unpleasantness, swarms of mosquitoes breeding in the swampy waters descended on the area.

Some homesteads near Wilcannia were surrounded by the floodwaters, but property damage appeared minimal generally because levee banks had been constructed in anticipation of the coming flood. Knowledge of the flood's approach also helped to keep stock losses down by allowing graziers to move their animals (predominantly sheep at Wilcannia) to higher ground.

MARCH, 1974—A NEW FLOOD DISASTER

Heavy rains from a low depression which developed into cyclone "Zoe" began falling over the Northern Rivers area of New South Wales on 9th March. The deluge (in some places between 500–700 mm over a period of a couple of days) was so intense that flooding in the rivers was an almost immediate result.

Towns particularly affected by floodwaters included Tweed Heads, Murwillumbah, Lismore, Coraki, Ballina, Maclean, Grafton, and Kempsey. The main commercial areas of several towns were badly flooded and retail businesses suffered heavy losses. Coraki and Woodburn were isolated for a period and the floodwaters at Lismore were described as the worst the district had ever experienced. There were extensive rescues by air and boat in the Richmond Valley where floodwaters stretching for many miles on either side of the river marooned hundreds of people and thousands of cattle.

Highways in the north were severely damaged and closed at some locations. The Pacific Highway (State Highway No. 10) was closed just north of Kempsey, 60 km north of Grafton and between Murwillumbah and the Queensland border; the Gwydir Highway (State Highway No. 12) at several locations north west of Grafton; the Bruxner Highway (State Highway No. 16) at several locations between Lismore and Tabulam; a section of the Oxley Highway (State Highway No. 11) between Wauchope and Mt Seaview. Many trunk roads and main roads were also closed for varying periods.

* * *

Highways are the principal avenues of road communication throughout the State and they connect with highways in adjoining States.

The widespread flooding in the north and northwest has indicated that there is a need for the State's highways to follow flood-free routes. However, the degree of urgency in this work is tempered by the resources available to the State.

Where possible, bridges and road pavements are constructed above lesser regularly recurring floods, it is the exceptional floods as occurred in 1890, 1955-56 and again in 1974 which point to the vast sums of money which would be required to provide a network of highways trafficable under all sorts of circumstances.

In providing highways with fully sealed surfaces over their entire length with adequate waterways at bridges and culverts, a major step forward has been taken towards providing the ultimate in a highway system.●

Flood damage to the Castlereagh Highway. Left, just north of Walgett where a box culvert has been washed out. Above, 6.5 km south of Walgett where temporary repairs have been made to sections of road adjoining a bridge. Right, a typical example of eroded pavement, located at 35 km south of Walgett.

Training in progress on the construction and operation of the air portable ferry

The Chapel at the School of Military Engineering, Casula

SOLDIERING ON

The 21st Construction Regiment (SR) RAE was formed in 1951 and is jointly manned by personnel from the Department of Main Roads, the Metropolitan Water Sewerage and Drainage Board and the Public Works Department.

The 23rd Annual Camp for the 21st Construction Regiment was held this year from 9th to 22nd March. The camp was held at the Headquarters of the School of Military Engineering at Casula, near Liverpool, for 101, 102, and 103 Construction Squadrons and 108 Plant Squadron (Heavy) which comprise the Regiment, together with attached SR Units 201 Works Section, 1 PC and R Group and CMF Unit 56 EWPS.

Supplementary Reserve (SR) Units were established by the Army to supplement Regular Army Units. The Reserve Units are composed of skilled people who during the year carry out their special trades or professions but during an annual camp and at other times between annual camps apply their civilian skills as soldiers.

Supplementary Reserve Units can encompass any profession, medical, dental, engineering and so on. The 21st Construction Regiment (SR) RAE is an engineering unit and as such employs the skills of the engineering professions, civil, electrical, and mechanical together with the skilled trades associated with those professions.

A total of 293 serving personnel attended the 1974 Camp and 55 recruits were given basic training. The camp, held over a period of 14 days, provided training in the use of small arms on the rifle range, engineer corps training and project work. The project works were of a permanent nature for the improvement of amenities for training at the School of Military Engineering.

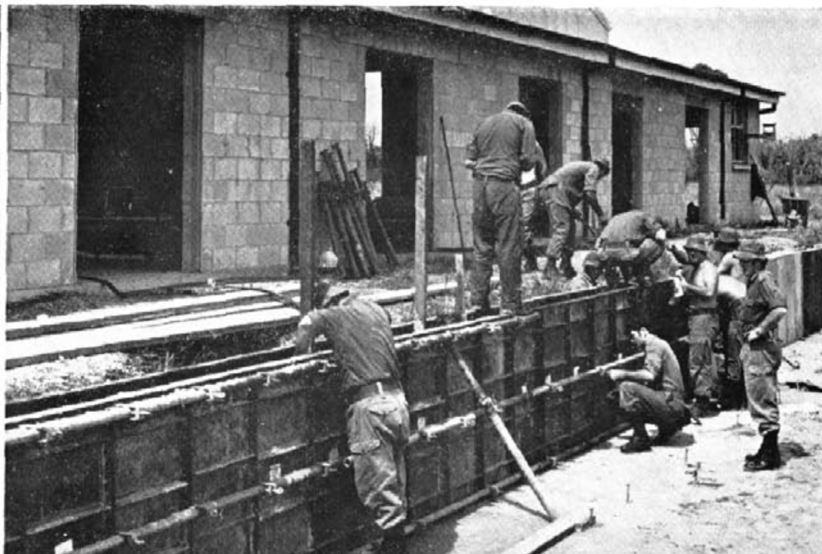
The routine of army training is varied from year to year. One year is devoted to training in individual type army skills, another year to engineer corps work, and the third year is given over to a field exercise.

The work of sappers in the engineer corps is not entirely a matter of building roads and aerodromes, bridging streams or providing water, buildings and the like. Many skills are required in the use of explosives for demolition work. There is also a need for an appreciation of the use of explosives by the enemy in mining roads and fields with both anti-tank and anti-personnel mines.

An interesting aspect of training at the 1974 camp was the instruction given in methods of defusing anti-personnel mines. In this exercise a replica of a jungle village built to actual scale was booby-trapped and the sappers were required to find the traps and make them safe. The ingenuity of the enemy in setting traps was appreciated as was the excitement experienced when an unwary sapper trod on a hidden mine or inadvertently shifted some material which immediately created an explosion. To add realism clouds of smoke were released with each explosion.●

Mine warfare demonstration in progress at the Model Asian Village established at the School

Building of a concrete retaining wall and aprons at the new Field Engineering Wing Store



WHEN THE WATERS GO DOWN

Flood Damage in North-Western and Western New South Wales

January–February 1974

(Above): The break in the Castlereagh Highway was soon rectified by Bailey bridging until more permanent repairs could be made.

(Below): The Castlereagh Highway was damaged at many locations as on this section just north of Walgett.

(Below): Where water crossed the Highway, such as here, 14½ km north of Walgett, investigation for possible undermining of the road pavement was necessary immediately the water subsided.

focus on freeways

South Western Freeway — Yerrinbool to Yanderra

In May, 1974, tenders were invited for construction of a section of the South Western Freeway 8 km in length between Yanderra and Yerrinbool. The work involves earthworks, bridgeworks at four locations and associated drainage works.

This section of the South Western Freeway is an extension of the 5 km length from Aylmerton to Yerrinbool on which construction began in October, 1973. The first section of this freeway to carry traffic was the 10 km, opened to traffic on 26th October, 1973, from Cross Roads near Liverpool to near Raby Road, Minto. The adjoining 5·6 km section to Camden Road (Main Road No. 178) is expected to be opened this year.

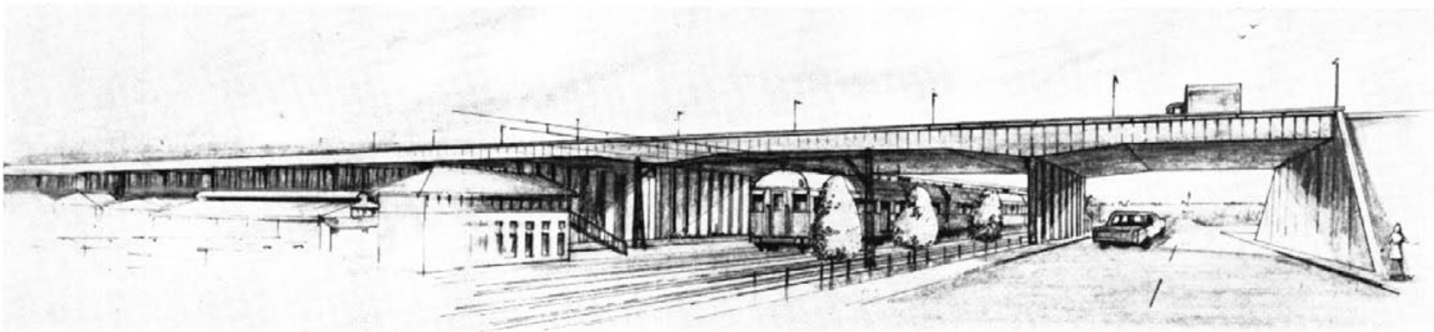
The steady progress being made with construction of the South Western Freeway shows in practice the intention to up-grade the main routes from Sydney to Canberra and between Sydney and Melbourne. Complementary to this freeway construction, dual carriageways are being constructed and planned on extensive lengths of the Hume and Federal Highways.

Progress on the North Western Freeway

Further progress on the construction of the North Western Freeway will be made following the calling of tenders in May, 1974, for work across the Darling Harbour Railway Goods Yard. The successful tenderer will be involved in the building of structures from Harris Street, Pyrmont, over the Goods Yard to Day Street. The work will comprise the construction of piers, abutments, retaining walls, composite steel and concrete superstructure, tensioned concrete box superstructure and reinforced concrete pavement.

This part of the North Western Freeway is to be built in two sections—firstly the viaduct across Darling Harbour Railway Goods Yard, after which a contract for the roadworks between Pyrmont Bridge approach and Day Street will be let. The work schedules have been arranged so that both works will be completed together.

Because the railway marshalling yards at Darling Harbour operate continuously, particular construction problems occur and the Department undertook the driving of piles and other foundation work, co-operating closely with the Public Transport Commission of New South Wales to suit their requirements. This type of co-operation will be necessary throughout construction.



Freeway Bridge over the Railway at Strathfield

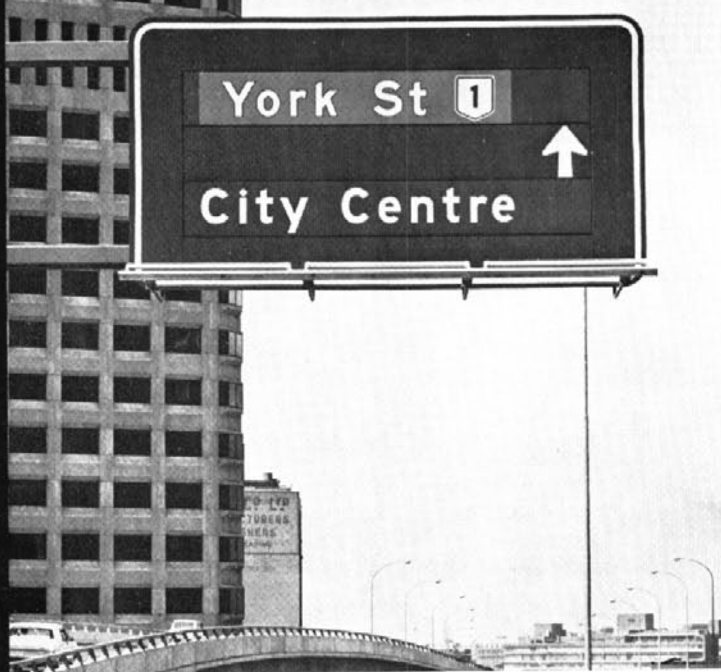
Left: The graceful lines of the Telegraph Point Bridge crossing the Wilson River on the route of the Pacific Highway seen to advantage from the banks of the river

The Department expects to call tenders later this year for a new bridge over the railway line at Strathfield to cross the Hornsby railway line between Strathfield and North Strathfield stations. It will parallel the northern side of Parramatta Road, spanning Queen Street, the railway, Railway Street and Powells Creek stormwater channel.

The bridge will form part of the Western Freeway (F4) and will consist of four lanes, two in each direction, separated by a temporary median. At a later date an identical bridge will be constructed adjacent to the first structure to form the eastbound carriageway of the freeway.

The bridge will be 363·92 m long and 22·3 m wide with eleven spans of variable length, the longest being a 45 m span over the railway.

This artist's impression shows the location of the bridge looking along Queen Street.●



Above and below: Another example of the rotating message sign is located across the approach to the Western Distributor. The centre sign is fixed while the other two, which rotate into the desired position, can show a choice of messages.

Above: This structure about 300 m (1,000 ft) from the Miller Street overbridge on the [illegible] carries signs bearing two [illegible] legends. Signs slide behind the blank centre [illegible] panel when not in use. The three photographs here show the two legends of the sign and an intermediate stage when the panels are in the process of change, which takes about 40 seconds.

Movable Traffic Devices

When called upon to assert their ingenuity to solve perplexing traffic problems, engineers in the Department of Main Roads have developed several traffic devices with a unique versatility for their particular road location. All the devices mentioned in this article are designed to move in some way and to guide traffic into improved flow conditions. The devices encompass Changeable Message Signs, Movable Toll Booths and Movable Median Strips.

The need for these devices usually arises on roads or bridges subject to reversible traffic ("tidal") flow. There are six bridges around Sydney where traffic tidal flow normally operates at peak periods although such an arrangement is often adopted temporarily at other sites while roadworks are in progress. However, the Sydney Harbour Bridge is the busiest of the bridges and the devices described here have been developed for use there and on the adjoining Warringah Freeway, also subject to reversible traffic flow, although they may later be used at other sites.

In 1962 *over* 33 *million vehicles crossed the Sydney Harbour Bridge and by* 1972 *this number had increased to approximately* 50 *million or almost one million per week.*

Such a volume creates tremendous control difficulties and these difficulties become intensified when considered in conjunction with traffic tidal flow, or the change of direction of traffic in certain bridge lanes to suit various peak conditions.

Engineers have met the challenge of these problems by providing unique or "one of a kind" control devices which regulate, warn or guide the traffic. This article describes some of these devices.

CHANGEABLE MESSAGE SIGNS

As the name implies a changeable message sign is one which is capable of displaying different messages at various times to advise the motorist where to go and what to do: "Form One Lane" changing to "Form Two Lanes" being a simple example.

One of the largest structures of this kind erected by the Department of Main Roads extends over five lanes of the Warringah Freeway approximately 300 m south of the Miller Street Overbridge.

Two sets of signs bearing different legends are employed, one set being displayed, the other stored behind those being displayed or behind a special blank storage panel.

In the morning and off-peak periods the legends direct southbound traffic into lanes leading to Sydney by either the Cahill Expressway or the Bradfield Highway. When traffic direction is altered, the stored signs are moved into the relevant positions to ensure that all southbound traffic is channelled into the easternmost lanes. Northbound traffic passing under this particular sign is restricted at all times.

The signs are electrically operated by a pushbutton control on the structure and complete changeover is obtained in 40 seconds.

The sign described above may be loosely defined as a sliding type of changeable message sign. Numerous other signs have been installed using different methods of operation to enable the various legends to be displayed. Some rotate, others pivot, some show one message only, which can disappear as required, others bear two, three or four legends as conditions dictate.

A large sign which has been erected on the southern approaches to the Sydney Harbour Bridge displays its legends on rotating synchronous prisms.

Generally, each movable sign carries a single message and is designed individually with actuating mechanism and support structure built to suit the site and the traffic situation. From all aspects a sign of this nature can be truly considered as being the "one of a kind" type.

MOVABLE TOLL BOOTHS

On the Sydney Harbour Bridge, One Way Toll was introduced in July, 1970, and since then tolls have been collected from southbound traffic only.

In the planning stages of the introduction of the system engineers in the Department were confronted with the problem of providing booths for toll collection from this traffic and, when traffic flow was reversed, providing a clear roadway over the same area. The obvious decision was that the booths would have to be movable and the problem then became the manner in which to obtain the movement practicably and economically.

Six collecting lanes were required and were provided by the erection of seven booths with five of the booths being movable.

The choice of motive power was limited to a unit compact enough to be housed within the eastern fixed booth of the group and possessing the ability to manoeuvre within one lane in the unstacking operation.

Subsequently an electrically operated battery tractor was purchased and placed into service. It can make a complete turn within a 5 m circle and with its available drawbar pull of approximately 1 100 kilograms can tow a load of 25 tonnes on a level surface at 4 kilometres per hour.

Operators with techniques and experience can move the toll booths from the stacked to the unstacked position in less than two minutes.

A further need for the provision of movable toll booths was created by altered traffic arrangements following the progressive opening of the first stage of the Western Distributor between September and December, 1972. Prior traffic studies had shown that for the most efficient traffic flow, the two eastern booths of the southern toll plaza would be needed for toll collection in certain peak periods only and moved clear of traffic at other times.

These booths were installed in a similar manner to the One Way Toll booths but in this instance motivation was achieved by using one of the toll booths as the prime mover. Drive to the wheels of the towing booth is achieved electro-hydraulically, the power supply being obtained from cables running in tracks in the roofed area above the cabins. When necessary, the booths can be locked in position by retaining pins.

A previous article outlining the functions of the One Way Toll systems and the operation of the movable toll booths was published in Main Roads, September, 1970.

MOVABLE MEDIAN STRIPS

In the centre of many roads the raised dividing strip, the median, has become commonplace to the motoring public. It is a most effective means of dividing traffic and is generally viewed as a barrier by all but the irresponsible motorist.

To the traffic engineer, in his continual search for the most efficient methods of channelisation, a median is a tool for the regulation of traffic but has the disadvantage oı being a fixed part of the road.

This property of fixture tempers the engineer's thinking particularly on heavily trafficked roads where direction is changed at times over the same length. To achieve adaptability it has become the acceptable custom to manually place rubber flaps or flexible posts in lieu of using fixed medians. These devices attain the object to some degree but are time-consuming to place and remove and offer only a token barrier to traffic.

It was due to these disadvantages that engineers within the Department conceived the idea of a movable median strip when initial planning prior to the opening of the Western Distributor revealed that restrictive but removable channelisation barriers would be needed on the southern approaches to the Sydney Harbour Bridge.

Development was carried out at the Central Workshop where timber models were built for preliminary investigation. One of the means considered for moving the medians was air bearings on a hovercraft principle to accommodate omni-direction tracking of wheels and to allow the median to move across its travel path, friction free. In experiments with a low air pressure of 21 kPa to 35 kPa fingertip control of a model was obtained on a smooth surface (sheet metal). However, when tried on a smooth asphaltic concrete pavement no movement at all was possible at these pressures, probably due to air losses caused by the porosity of the surface of the pavement. When the pressure was increased (689 kPa) the slightest movement obtained would cause the model to flutter violently.

The results were similar with a commercial type hover pallet which was very efficient moving on a smooth surface but had

Top left and above: Another movable sign over the southern toll barriers on the Sydney Harbour Bridge is the tilting message board which is raised or lowered to suit the required traffic pattern

Left: A rotating type of changeable message sign in operation at the southern toll barriers on Sydney Harbour Bridge

relatively no movement on an asphaltic concrete pavement, even at high pressures.

This series of experiments was then discontinued and another series of experiments involving the use of adjustable spring loaded wheels adopted. On finalisation of the design, part of the median was constructed and subjected to successful dynamic testing by impact from loaded vehicles.

The median strip consists of a series of fabricated steel modules connected by hinges and adjustable stops. The spring-loaded wheels at the corner of each module are adjusted to carry the initial weight of the module and give sufficient road clearance to allow free movement of the complete median strip across its travel path. When subjected to vehicle impact or loading the wheel springs compress until the module touches the road pavement allowing the additional loading to be distributed around the full perimeter of the module.

Connecting hinges and stops are on opposing corners at either end of each module and their design and construction allows for limited vertical movement to accommodate variations in level in the road pavement.

Adjustments of the stops to predetermined measurements allows any pair of modules to turn independently on their common hinge and form either a straight line or chords of a curve as the stops are reached.

The first module of the complete median strip contains a drive mechanism which gives power to rubber-tyred driving wheels by means of an electro-hydraulic power pack. Electricity to the power pack is supplied through a flexible armoured cable fed throughout the whole length of the median. The final module is attached with a hinge and an adjustable stop to a steel anchor plate concreted into the road.

Right: A small battery operated tractor is used to "stack" toll booths on the southern approach to Sydney Harbour Bridge. The booths are shown being moved and in a "stacked" position. It is possible to complete this manoeuvre in less than two minutes

The principle used in the movable median strips described above was conceived by Mr J. S. Winning of the Department's Central Workshop and developed under his guidance. The Department has subsequently applied for the Australian Patent—on application number PB 5505.

Movement of the median is controlled by an operator from the driving module. As it commences to move in a lateral direction it turns slightly on the common hinge between it and the adjoining module. When the stop between these two is reached both become as one and together continue to move in a lateral direction at the same time turning on the common hinge between the adjoining module and the next one.

This action repeats itself progressively with all modules until the stop between the final module and the anchor plate is reached.

The median has then become rigid in its desired position and is securely locked in that position by steel pins inserted manually through welded sleeves on the modules into cast iron sockets concreted flush with the road pavement.

To give motorists greater awareness of the median strip under night time conditions semi-flexible posts sheathed with retro-reflective material are fixed into the module shells.

The Department has installed two such median strips on the southern approaches to the Sydney Harbour Bridge. One median consisting of fifteen modules, restricts morning and daytime off-peak traffic using lanes 7 and 8 on the Bridge to the Cahill Expressway for access to Sydney. In this position it forms an eastern curve of approximately 100 m radius in its 60 m length.

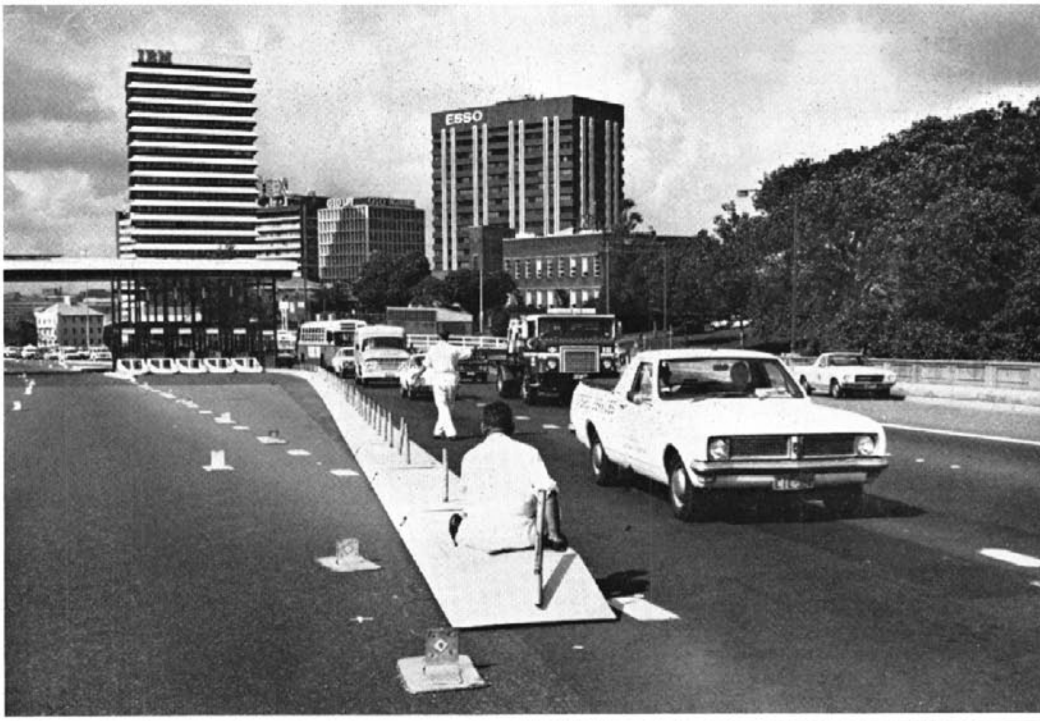
In the afternoon peak, to give this traffic an alternative access to Sydney, the southern extremity of the median is moved takes approximately 15 m to the west and up a straight line position towards the southernmost toll booths. Transition from the locked positions in the two extremes is accomplished within 1½ minutes.

The second median strip 70 m long, was installed on the northern side of the western group of toll booths and consists of seventeen modules.

This median, adjusted so that its northern extremity moves east or west only 3·5 m is used to control merging traffic proceeding north from Sydney via Kent Street or the Cahill Expressway. It is moved frequently during the day at the discretion of traffic controllers according to varying volumes of traffic.

In service the medians have proved extremely reliable and because of their successful application an improved prototype using remote operation has been developed at the Central Workshop. Further installations which are contemplated on the Warringah Freeway will use this principle for control.

The need for efficient control of traffic in the extremely heavy volumes typified by the Sydney Harbour Bridge creates a continuous challenge to the engineers within the Department. In meeting this challenge and providing the most effective possible road system, other inventions of similar versatility are constantly developed in the Department.●



Top right: Another more common type of movable traffic device is the simple traffic flap, placed at intervals along lane divisions to discipline traffic flow Centre and right: Motivation for this median strip which moves across the road surface comes from a drive mechanism in the median, controlled by an operator on the first module. Steel pins lock the median to the road when the correct position has been reached

MECHANICAL REMOVAL OF ASPHALT SURFACING

The heater planer at work a few years ago on Sydney Harbour Bridge

The service life of an asphaltic concrete pavement increases when the void content is reduced, provided that the void content does not fall below a certain critical value. Below this value the stability of the asphaltic concrete decreases, particularly in warmer weather. The void content is dependent on the design of the asphaltic concrete and also on the degree of compaction. Continued heavy traffic, particularly in hot weather, will tend, therefore, to cause deformation of potentially unstable asphaltic concrete pavements by plastic flow. Where the asphaltic concrete has been laid on a smooth rigid pavement such as a cement concrete base there is a particular tendency for longitudinal movement of the overlying asphaltic concrete relative to the base, causing the effect known as "shoving" or "slipping". Movement within the asphaltic concrete layer itself may result in the formation of corrugations. These two effects may occur separately or in combination.

The resheeting of an asphaltic concrete pavement which shows evidence of instability will restore acceptable riding conditions for a period, although there is a tendency for the original imperfections to be reflected in a lesser degree in the new wearing surface. The addition of further material tends to increase the degree of instability, however, and the only long term solution to the problem is the removal of the existing pavement and its replacement with more stable material.

The removal of existing asphaltic concrete overlays is also necessary in some other circumstances. The bitumen binder is subject to oxidation and other effects which, over a period of years, may result in ravelling or "picking out" of the surface. Any movement of the subgrade, such as may occur at public utility service openings, will cause a deterioration in riding conditions. In most cases it will be possible to overlay the old surface with a new wearing course, but in certain cases the level of the pavement or the weight of the pavement is of critical significance and removal of the old wearing surface is necessary.

This article looks at two methods of removing asphaltic concrete pavements. In particular it discusses a mechanical method successfully used by the Department's Metropolitan Division at locations on Victoria Road, Rozelle, and Prince's Highway, Sydenham.

THE HEATER-PLANER

Of the several methods of correcting "corrugated" or "shoved" asphaltic concrete, one used by the Department was the technique of "burning off".

The process was carried out using a large mobile heater-planer which travelled slowly over the pavement. Some of the volatile fractions of the asphaltic concrete were consumed by burning and the top surface of the residue was brought to the condition where it could be graded into windrows and removed by loaders and trucks.

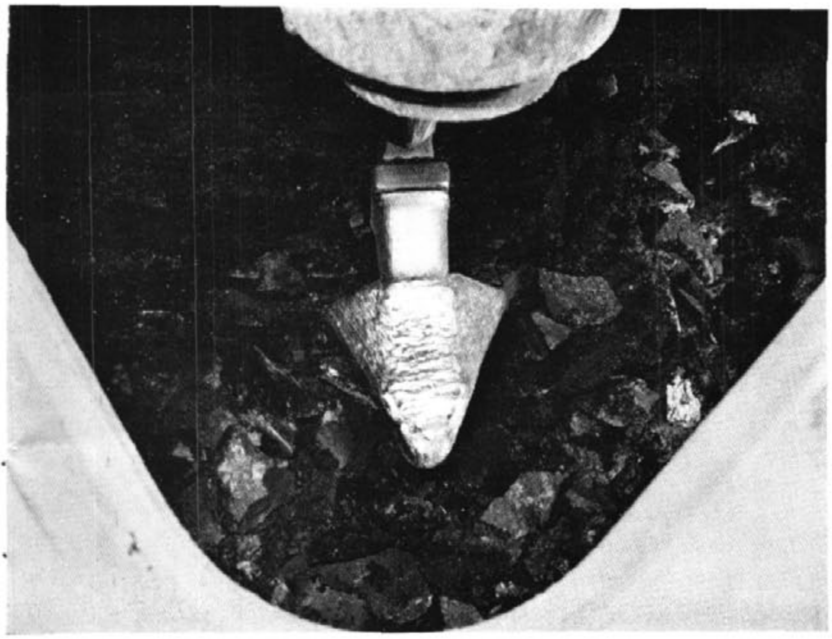
This method has been successful but the costs are high and the use of the heater is undesirable in built-up areas due to the pollution of adjacent buildings by smoke and ash.

This method was used on the Sydney Harbour Bridge and on the Pacific Highway at North Sydney in 1959 and on Parramatta Road between Petersham and Camperdown in 1968. Recently it was used for the replacement of asphalt on King Georges Road (Main Road No. 315) near Blakehurst.

RIPPING EXPERIMENT

At Rozelle and Sydenham the asphalt was relatively thin, in the order of 75–100 mm deep, and had been laid on top of cement concrete pavement.

A loader, scraping asphalt against the median strip with a cleared section of carriageway on its left



Above: The broadened ripper boot on a Cat D6 Dozer. The sharp pointed toe aids entry into the asphalt for ripping. Right: Two loaders blading loosened asphalt by working towards one another

A mechanical method of removing damaged asphaltic concrete pavements was tested on a small area of Victoria Road in April, 1973. A dozer of approximately 180 bhp with a standard ripper gave encouraging results on the test performance which assessed the hardness of asphaltic material, the traction between the dozer and the pavement and the manner in which the asphalt broke away. The test showed that considerable amounts of asphalt could be removed within limited times. Because movement of the asphalt usually occurs where traffic volumes are high, consideration of time was an important factor.

The remainder of the pavement section proposed for removal was sampled by coring at about 6 m intervals to ascertain depth and hardness of the asphalt. Mechanical ripping was then completed over a section of Victoria Road northerly from Roberts Street, Rozelle.

THE METHOD OF MECHANICAL RIPPING

The standard ripper boot on the dozer was broadened to give a greater bearing area on the cement concrete base to prevent scoring. The boot was given a sharp pointed toe for entry into the asphalt and was "V" shaped at the toe to assist in cutting, breaking and lifting the asphalt being removed.

The operation of ripping and blading the asphalt and removing the loosened asphalt in trucks is fairly straight forward. However, there are other complicating factors.

Because of the volume of traffic carried by the two major roads where this type of asphalt removal has been carried out, the work has been performed at night, from about 8.30 p.m. to 5.30 a.m. On the three lane carriageway, a width of about one and a half lanes is ripped and traffic is carried on one lane. When work on the half carriageway has been completed over the length selected for treatment on that night (usually around midnight) traffic is switched to the freshly exposed cement concrete pavement and loosening and removal of asphalt continues on the remaining half of the carriageway.

The half carriageway is prepared for traffic before this, however, by making ramps at the straight cuts at either end of the length, filling any hollows in the cement concrete base and ramping at public utility manholes, etc.

At Rozelle, cold mix material was used for this purpose at night and replaced with hot mix during the day. For the work at Sydenham, arrangements were made for hot mix material to be stored in a hot bin at the mixing plant and this material was then used at night, greatly reducing the amount of double work in the operation. Ramping at cross streets, intersections, and median gaps requires hand work and involves more time.

Just prior to opening for traffic, any remaining small debris is swept up by road brooms.

Because the job is being carried out by machinery working in a fairly confined area, the logistics of loading, moving, and disposing of material is an important factor in the planning and timing. The loosened asphalt is scraped up by two loaders, either working towards one another, or one loosening and loading and one clearing and tidying up. Trucks used for the removal of the ripped asphalt usually stand on the median, if this is of sufficient width, or on the other side of a narrow median when the tractor is ripping on the median side of the carriageway. The trucks stand on the footpath or in the working area when the tractor is ripping on the kerb side of the carriageway. The number of trucks required depends on the rate of removal and haulage distance, but three to five trucks are generally involved.

On Victoria Road, temporary linemarking of stripped areas for peak a.m. traffic was done nightly. At all times, during the ripping process and afterwards, police co-operation is essential.

PROGRESS

Depending on the hardness and depth of the asphalt, a length of about 75 to 120 m and three traffic lanes wide can usually be removed in one night. The quantity of asphalt represented by this range is up to 300 tonnes.

These figures differ, however, with the location. At Rozelle, for example, the asphalt proved relatively hard and ripping in some sections was difficult as the bond between asphalt and cement concrete base was very good and particular difficulties were encountered where the tram tracks had not been removed. The length of carriageway removed each night varied between 30 m and 90 m.

At Sydenham, the asphalt was softer and more easily ripped and output each night varied between 60 m and 120 m. An unexpected problem at Sydenham was a 50 mm deep longitudinal ridge which required ramping with hot mix to allow traffic to travel safely on the underlying concrete surface.

REPLACEMENT OF ASPHALTIC CONCRETE

The pavement stripped each week was relaid on the following Sunday, weather permitting. Working for five nights, an organization using one tractor dozer for removal produces sufficient stripped pavement to do a day's work asphalting, and Sunday is chosen because of lower traffic volume.

COSTS AND CONCLUSIONS

The removal of asphaltic concrete by mechanical ripping has proved more economical than "burning off". It has an additional benefit too, in considerably less atmospheric pollution which is very important to people living near locations where this type of works is undertaken.

The Rozelle work gave an average cost for the whole operation of $4·11 per m². Removal of 2 540 t of material over 18 nights was involved here. It is estimated that if it had been by burning off, the asphalt removal would have cost about $5·85 per m².

There are few locations on metropolitan main roads where asphalt ripping to remove corrugations will be necessary. Most sections of corrugated asphalt surface have been removed, during reconstruction and improvement works. However, there have remained several areas on the main road system which have already been developed to 6 lane standard and further reconstruction for increased traffic capacity is not planned in the near future. These are the locations where the uneven surface must be improved during normal maintenance and improvement work, and it appears that removal by mechanical ripping will be a very practical and economical method where the asphaltic concrete overlies a cement concrete base. ●

MOBILE ASPHALT UNIT

For relatively small asphalt paving works in country areas, the Department has established a Mobile Asphalt Unit which has been brought into operation during the past year.

COMPOSITION OF THE UNIT

The Unit is completely self-contained. It comprises a mixing team, a haulage team and a paving team.

There are four men in the mixing team. The mixing plant comprises three basic units and two ancillary units arranged as follows:

Basic Units:

1. Semi-trailer mounted drying and mixing unit complete with primary dust extractor.
2. Trailer-mounted cold aggregate bin unit.
3. Trailer-mounted binder/fuel storage unit.

Ancillary Units:

4. Trailer-mounted power generating unit.
5. Skid-mounted secondary dust extractor.

The plant is electrically operated throughout with a standard oil fuel burner at the dryer. The plant is of the batch mixing type with a pugmill capacity of 908 kg and an output of 30 to 40 tonnes of asphalt per hour. The power unit comprises a diesel engine driven alternator of 225 KVA capacity with a 27 KVA auxiliary alternator set for stand-by heating. A front end loader is used for moving the four separate aggregates from stockpiles to the cold aggregate bins.

The haulage team consists of five 8-tonne trucks and drivers.

The paving team has a ganger and eight men who operate an asphalt paving machine, a steel tandem roller, a pneumatic multi-tyred roller and ancillary plant such as road broom, tack coating sprayer and truck. The paving machine is pneumatic tyred, fitted with a tamping and vibrating screed and an automatic level control system to ensure the production of good quality riding surfaces. The machine is capable of paving a width of up to 4·3 metres in one pass.

The whole unit is under the control of a Works Engineer assisted by a foreman, a testing operator and a clerk. The testing operator works from a mobile laboratory.

Accommodation for the men is provided in caravans making use of local caravan parks wherever possible.

Mobility is a primary consideration. The whole plant can be dismantled, moved and re-erected within a few days. Normally 2,000 to 3,000 tonnes of asphalt or about two to three weeks work from a single mixing site would be sufficient to justify a move.

USE OF THE UNIT

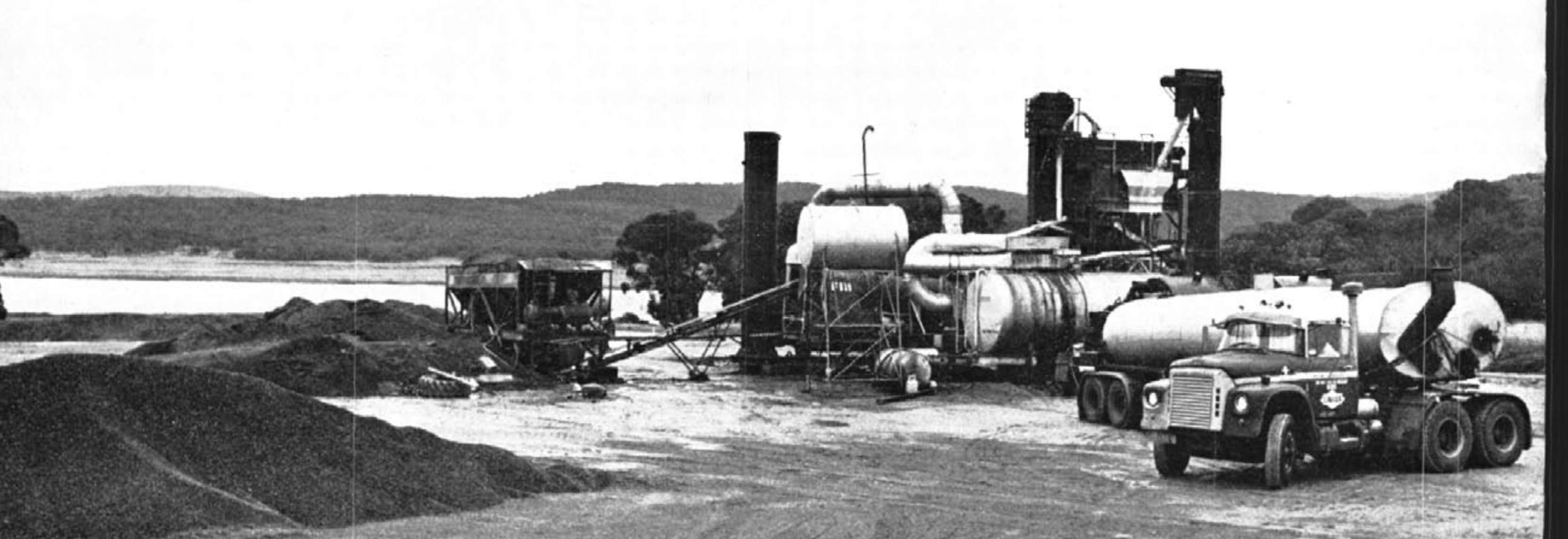
Having regard to the high cost of asphalt paving in comparison with sprayed bituminous surfacing and to the limited funds available, the use of asphalt should be considered only under certain circumstances. Such circumstances would include sections of heavily trafficked highways on permanent alignment where sprayed surfaces have proved unsatisfactory, intersections where extensive pavement marking is necessary, overlaying cement concrete pavements to improve riding qualities and prolong life, shape correction of otherwise sound pavements or bridge decks and strengthening of pavements when asphalt can be shown to provide the most economical satisfactory treatment.

Planning for the supply of materials is necessary well in advance of moving the unit to a new site and extensive testing is usually required on pavements to be overlayed with asphalt. For these reasons, and to ensure continuity of work for the unit as well as avoiding unnecessary travelling, the aim is to work the unit on a programme prepared in advance to extend over about two years and to do all available work in a particular area whilst the plant is there. The plant is, of course, also available to depart from its programme to do any special or urgent works which may become necessary.

Costing and transfers of accounts are finalised in the Asphalt Section of the Department's Head Office from information made available by the Mobile Office. The cost of asphalt production from each site is averaged and distributed on a weight basis in order to share the cost of establishment and transfer. Actual costs of aggregates, haulage and paving are charges directly to each job.

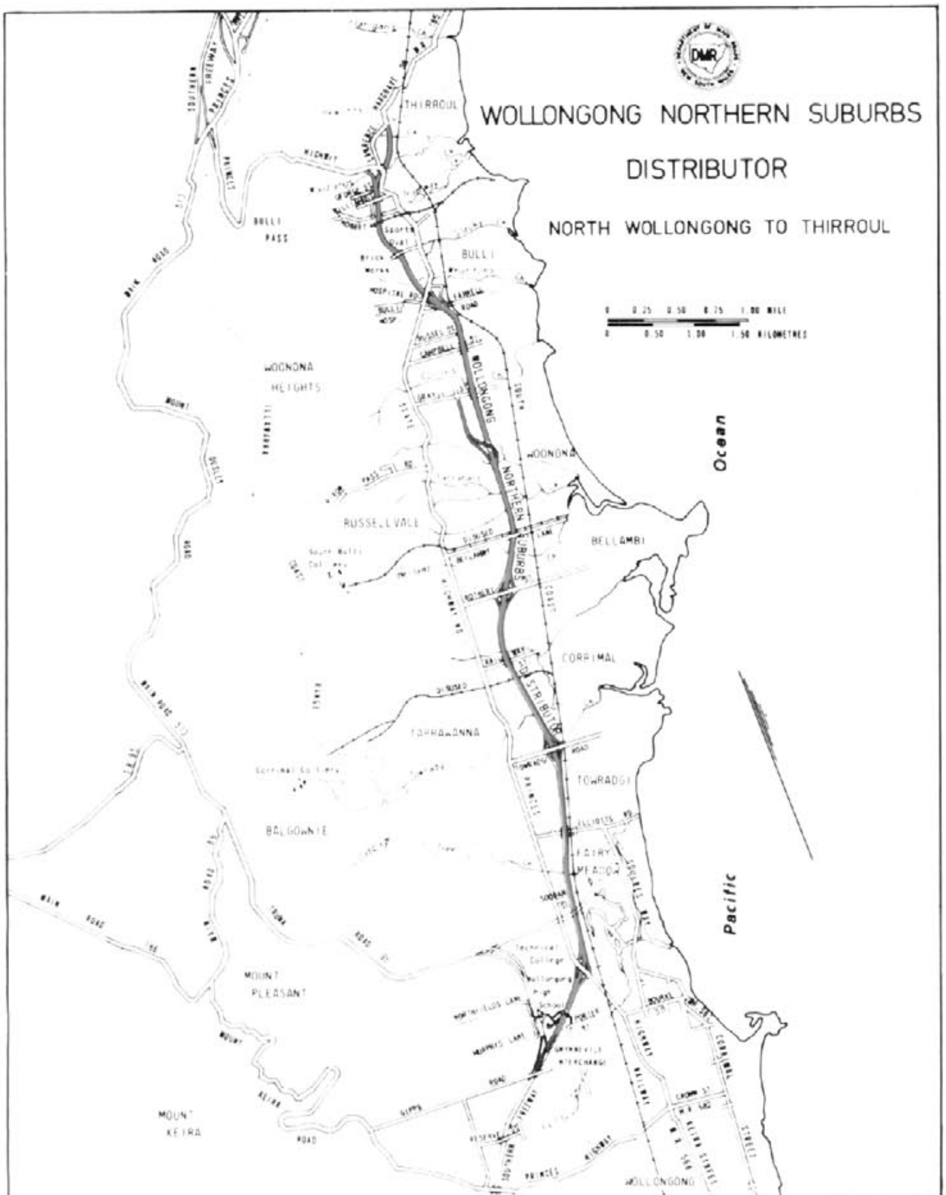
With this unit in operation, the benefits of the higher standard of road pavement provided by asphalt can be brought to locations which were previously beyond the practical and economical haulage range from fixed sources of supply of asphalt. ●

The Mobile Asphalt Unit working on the Snowy Mountains Highway (*State Highway No.* 4) *from a site beside Lake Eucumbene approximately* 16 *km east of Kiandra*



Wollongong

A Summary of Main Road Progress in the Area



THE WOLLONGONG AREA

Since the first settlers descended the escarpment of the Illawarra Range to the coastal plain where Wollongong now stands, roadmakers have been faced with one challenge after another in the establishment of satisfactory road communications to, and through, the Illawarra Region.

Lying between the Pacific Ocean, with The Five Islands offshore, and the escarpment inland, Wollongong on its narrow coastal plain is at the heart of a botanically lush region with a generous coastal rainfall. The rapid and widespread development of the Illawarra region has been influenced by the wealth of coal beneath the earth and the vast industrial enterprises it has fostered. Primary industry, particularly dairying, is also economically important.

The existence of coal deposits in the Illawarra region was known from 1797 when three shipwrecked sailors walked along the coast. Their report of a coal seam was confirmed soon after by George Bass. In pre-World War II years, although industrialised, the Wollongong-Port Kembla area remained very much the sleepy country town, where cattle could be seen grazing almost in the shadows of the furnaces. Coastal steamers and the railway (opened in 1888) transported most goods to and from the area as road communications were designed for light vehicles and heavy transports were few in number.

EARLY ROADS

During the early years of settlement, the only overland route into Illawarra lay along Dr Charles Throsby's track, made in 1815, when he drove cattle down the mountain from Appin to Bulli. The mountain descent was not suitable for carts, being steep and rough. From the foot of the escarpment the road went east to the beach, followed the shoreline to the harbour at Wollongong where tracks led off to the west and south.

In 1821, a settler named Cornelius O'Brien discovered a track south east from Appin to behind Mt Keira, the top of Mt Nebo and down to Figtree. Landholders in the district subscribed to bring the route into a passable condition and it subsequently became known as O'Brien's Subscription Road. Another mountain descent (discovered by Captain Westmacott in 1836 and known for many years as Westmacott's Pass) eventually evolved into the present day Bulli Pass. Convict labour was used to build part of this road in 1844.

A familiar landmark to Wollongong motorists is the massive fig tree growing beside American Creek. It was already an imposing landmark over one hundred years ago when this drawing was published in the "Illustrated Sydney News", dated 16th October, 1867. The photograph shows how closely today's Princes Highway follows the route of the old road at this location

Around this period tracks to Bong Bong and south to Shoalhaven were formed and Mr Surveyor Darke constructed a new route from Sydney, crossing Georges River instead of proceeding inland (see "Historical Notes on Georges River and Its Road Crossings" in December, 1973, issue of "Main Roads").

Many new settlers arrived in the Illawarra region during the 1840's, when transport still principally relied on the sea. Most settlers were occupied with agriculture but the potential for industrial development was foreshadowed by the completion of the first harbour improvements in 1844 even though by the 1850's the dairynig industry was still predominant. The first efforts to improve and maintain roads through Wollongong area involved settlers in voluntary contributions but these efforts were not successful. Under the Municipalities Act of 1858, Wollongong became the first Municipality proclaimed in the region and amongst the immediate works authorized was the metalling of Crown Street, Wollongong, at a cost of £1,370. The Central Illawarra Area, south of Wollongong became a Municipality soon after and revenue from rates and government grants was spent on bridges over Mullet Creek and at Figtree, opened in August, 1861. When the North Illawarra area became a municipality in 1868, a toll bar was erected at the northern boundary and was an unpopular feature of travel there until 1880. These three municipalities, with Bulli Shire, amalgamated in 1947 to become the City of Greater Wollongong.

From the mid-19th century wheeled vehicles became more numerous on the roads and gradual improvements occurred on routes in the Illawarra district. The principal street of Wollongong, Crown Street, which was to cause many traffic problems for roads planners in later years, was a busy thoroughfare even in the 1870's. The "Illustrated Sydney News" of 2nd August, 1873, contained an engraving reproduced in this article, with the following comments:

"Our engraving on page twenty-one gives a very faithful representation of the

OLD WAYS ...
Left: Engraving from "Illustrated Sydney News" 2nd August, 1873 (discussed in text), of Crown Street, Wollongong. Centre: There were no traffic problems on this section of the road leading out of Wollongong to Dapto late last century. Bottom: Bulli Pass on Princes Highway in 1930

principal street of Wollongong, the flourishing seaport town of the coal and dairying district of Illawarra. Crown Street is of considerable length, and runs from St Francis Xaviers, near the sea beach (the end from which our sketch is taken) to the intersection of the Fairy Meadow Road, and the turn off to the Fig Tree. It boasts of numerous substantial *buildings* of a commercial, public, and private character, which would grace the metropolis itself. The tower and spire seen in the right hand distance are those belonging to the Scots' Church, a brick and stuccoed building of fair dimensions. The gable of the Wesleyan Church is also seen standing back from the right. The Queen's Hotel, a spacious block of building, is in this street, though not shown, being to the rear of point of drawing. The Commercial Branch Bank is situated to the left. The requirements of the coal trade are supplied by tramways which do not approach this street, but on steamer days, the traffic of carts to and from the wharf, conveying pigs, poultry, calves, and butter, to the boat, and returning to the various farms with goods from Sydney, or town purchased, is something surprising."

Motorized vehicles leading to the increased mobility of the population made it imperative by 1925, when the Main Roads Board was formed, to improve the condition of all main roads, particularly the route between Sydney and Wollongong. Even before the Main Roads Board assumed full control of the road, reconstruction between Sydney and Wollongong was in hand. In the Illawarra region the Councils of Bulli, North Illawarra, Wollongong, and Central Illawarra had commenced work on improving the surface condition, alignment and grades on roads in these areas and by 1929, most of this work had been satisfactorily completed.

ILLAWARRA DEVELOPS

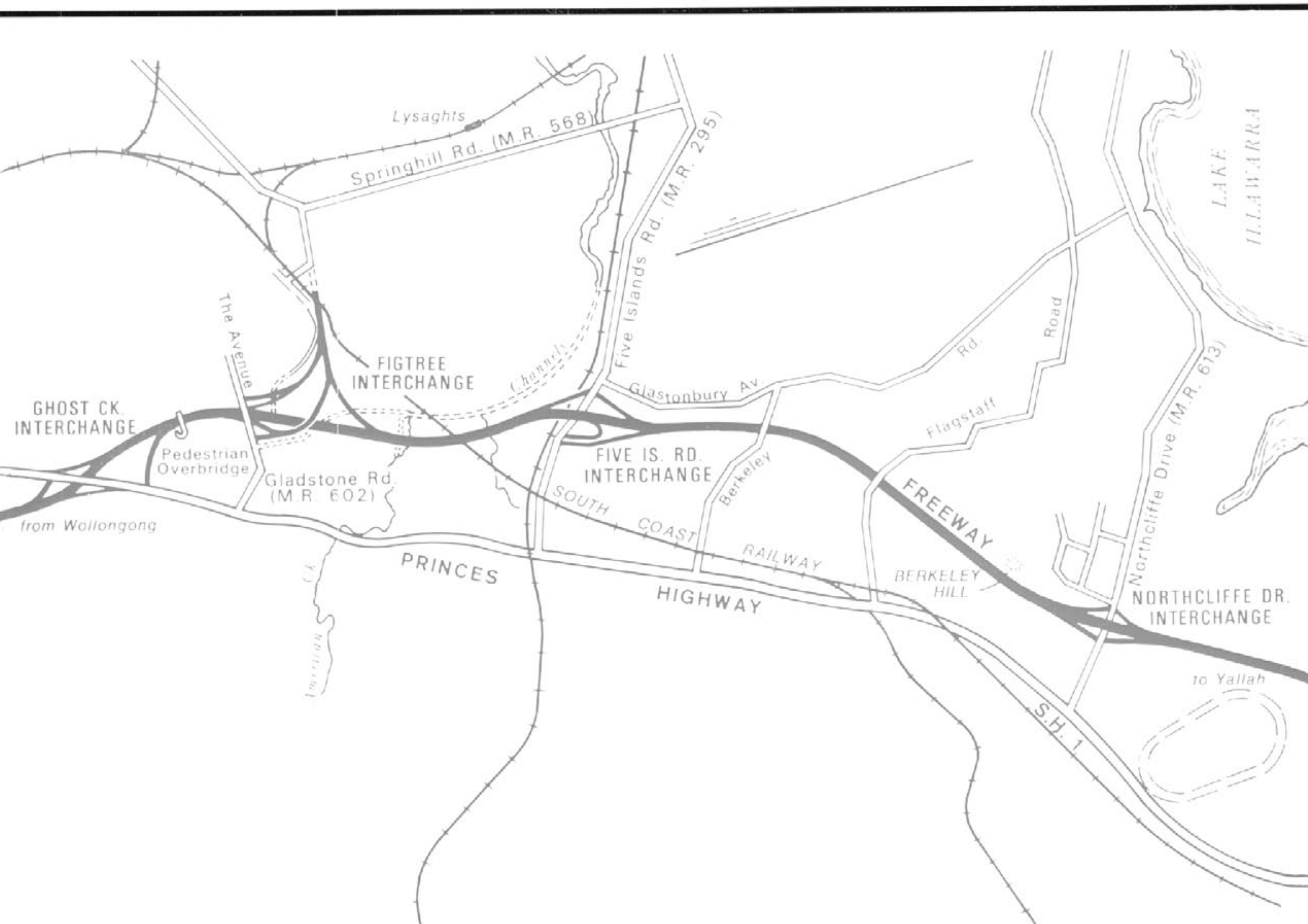
Prior to World War II, the industrial potential of the Wollongong-Port Kembla area had still to be fully realized, although the Hoskinses had transferred their Lithgow operation to Port Kembla in 1928 and built the then largest blast furnace in Australia in that year.

During the war years heavy industry expanded rapidly. Great new industrial plants were constructed and the steelworks at Port Kembla soon became the largest in Australia.

As population grew, the city centre at Wollongong developed and residential areas boomed. Wollongong was proclaimed a city in 1942 and the intense industrial development continued into the post-war years. New housing estates were built—largely to the south and west of Wollongong and into the foothills of the coastal range.

This expansion had been foreshadowed in the mid 1930's and it became apparent that Prince's Highway passing through Wollongong would be inadequate for future traffic needs.

During World War II, the Department, for strategic reasons, provided an



alternative descent from the tableland by means of a new road connecting the top of Bulli Pass with North Wollongong via Mount Ousley and in addition connected this new road to the existing main road system at Wilton.

THE DEPARTMENT'S PLANNING

By 1959 it was evident that a new road to by-pass the central business district of Wollongong was warranted. In planning the road system for Wollongong the Department recognized the need to cater for these classes of traffic:

Commuter Traffic—with the local vehicle-owner population which had increased with the intense industrialisation of the region and which now clogged the existing network of roads during peak periods coinciding with the changes of shift in heavy industry.

Industrial Traffic—another product of industrial growth, made even heavier since the demise of the coastal steamer trade.

Through Traffic—which used the Prince's Highway as a major interstate route and as access to the growing resort areas and towns of the south coast.

Plans were made for the construction of a north-south arterial road through the Illawarra region, which would include a bypass of Wollongong's central business district.

WOLLONGONG BY-PASS

Construction of the by-pass commenced in 1959. Two lanes were in service by July, 1963, giving needed traffic relief for a distance of 3·4 km between North Wollongong and West Wollongong near Mt Keira Road. The final plan included four carriageways with restricted access and a Link Road 1·6 km long, connecting the by-pass to Mount Ousley Road. Overpass bridges were provided at important council roads (Gipps Road and Reserve Street) and at Mt Keira Road.

This Link Road was completed and opened to traffic in March, 1964, with a channelised intersection constructed at its junction with the by-pass. All other crossings at grade were eliminated in September, 1968, by the opening of the Porter Street Bridge over the by-pass and the Porter Street Extension Bridge over the Link Road serving both Northfields Avenue and Murphys Avenue.

SOUTHERN FREEWAY

By the early 1960's, population expansion and the consequent growth of vehicle numbers had resulted in further considerable increases in traffic volumes on roads in the Illawarra region. More intensive land development and growth of tourist activities southerly from Kiama added to the need for an improved road system. The Department decided to extend the Southern Freeway leading from

NEW WAYS . . .
Top: Porter Street (Extension) Bridge over the Mt Ousley Link Road, with the bypass of Wollongong Central Business District running along the top left hand corner to connect with the Link Road. Above centre: The most recently completed length of Southern Freeway near Wollongong is this section between Five Islands Road, Unanderra, and Northcliffe Drive, Kembla Grange. Right: Ghosts Creek interchange where Princes Highway passes over the Southern Freeway

Sydney to Wollongong as far as Kiama and incorporate the north-south Arterial Road in the planning.

GHOSTS CREEK TO GLADSTONE AVENUE, FIG TREE

This section was the next to be put into service—in December, 1967. It included a grade separated interchange with the Prince's Highway at Ghosts Creek, West Wollongong, where a new prestressed concrete 2/41·2 m span bridge carried the highway over the route of the Southern Freeway. Four carriageways were provided together with breakdown lanes, and adequate space was left in the median to allow for two future additional lanes.

To provide pedestrian access from the east to the Fig Tree Shopping Mall a prestressed concrete pedestrian overbridge was constructed at Byarong Avenue.

GLADSTONE AVENUE TO FIVE ISLANDS ROAD

Work commenced on this 2 km section of Freeway in the financial year ended 30th June, 1966. The route of the Freeway crosses a floodplain and the terrain presents many natural construction difficulties. The floodplain, dissected by two large streams, is already occupied by the Main South Coast Railway, a private railway line, a main sewer carrier and three high voltage feeder lines. Diversion of one creek (Byarong Creek) into the other (American Creek) is necessary and in all the plan calls for a total of 20 bridges (including six overbridges) and culverts of bridge size. Complex alterations to other public utilities are also necessary.

The overpass structures at Gladstone Avenue are designed to provide a grade separated interchange with Main Road No. 602 and to give direct access between the residential area of Mt St Thomas and the shopping centre at Fig Tree.

Designs of the overbridge structures at Fig Tree Interchange were undertaken by consultants and Wollongong City Council is designing an overbridge to carry a deviation of Gladstone Avenue (Main Road No. 602) over the Main South Coast Railway Line. All other structures were designed within the Department and with the exception of a large reinforced concrete box culvert which will carry Gladstone Avenue (Main Road No. 602) over Byarong Creek all structures are being constructed by contract.

At the interchange with Five Islands Road (Main Road No. 295) at Unanderra twin bridges have been constructed to carry the Freeway over the relocated main road and three additional bridges have been constructed nearby to carry the freeway over a relocated private double track railway to the steelworks and a reservation for future road access.

This section of freeway is expected to open late in 1974.

FIVE ISLANDS ROAD TO NORTHCLIFFE DRIVE, BERKELEY

The route of this section of freeway lies through open country cutting two roads, Berkeley Road and Flagstaff Road and bridges overpassing the freeway have been constructed at these points.

Near the interchange with Northcliffe Drive (Main Road No. 613) the route passes through a 27 m deep cutting in Berkeley Hill where practically all the excavation required drilling and blasting. Extreme caution was exercised here because the main 330 kV electricity power line to Port Kembla passes above the southern end of the cutting and more than 100 houses are located close by the cutting. The explosive used was an ANFO mixture with gelignite primers fired by detonating fuse. The edges of the cutting were defined by presplit blasts and excavation commenced at the northern end of the cutting. Blasting was controlled by measuring the particle velocity of ground vibrations using a Mark L. 10 geophone to record vibrations on the three principal planes. The vibrations were magnified and recorded on a Tektronik recording oscilloscope to which was attached a polaroid camera to make a permanent record of the traces of the vibrations. Charges were calculated to keep within the limits set by the Australian Standards Association of Australia.

This section, 3·1 km long, was completed and opened to traffic in December, 1973 and has relieved the traffic situation on the Prince's Highway where it passes through Unanderra.

WOLLONGONG NORTHERN SUBURBS DISTRIBUTOR

From Thirroul at the foot of Bulli Pass, the Prince's Highway follows a route along the coastal plain to North Wollongong. It has been evident for years that the highway would not always meet the demands of traffic generated in this area. It was also evident that widening the highway through the suburbs to the north of Wollongong would not provide an answer to the situation.

The Wollongong Northern Suburbs Distributor (see map) has been planned as a direct link between Thirroul and the Southern Freeway at Gwynneville. It generally parallels the highway along the route of the previously planned North South Arterial Road and will have a total length of 11 km. Access to the Distributor will be restricted to entrance and exit ramps located at intervals of approximately 2·5 km and minor streets and roads will be terminated adjacent to the Distributor.

For construction purposes the Distributor has been divided into the following sections:

Section 1: Prince's Highway at Fairy Meadow to Towradgi Road at Towradgi.

Section 2: Towradgi Road at Towradgi to Rothery Street at Bellambi.

Section 3: Rothery Street at Bellambi to Gray Street at Woonona.

Section 4: Gray Street at Woonona to Prince's Highway at Bulli.

Section 5: Prince's Highway at Bulli to Prince's Highway at Thirroul.

Section 6: Prince's Highway at Thirroul to Lawrence Hargrave Drive at Thirroul.

Each successive stage of the Distributor will be opened to traffic as it is completed and it will be progressively extended from Gwynneville northerly towards Thirroul.

A CHALLENGE CHANGES

In 1822 Alan Cunningham on his tour of New South Wales remarked of the South Coast: "a cart road will consequently never be practicable here: nearly all the produce, therefore, must necessarily be transmitted to Sydney hereafter, as now, by sea".

Surveyor-General Mitchell however was not quite so pessimistic when attempting to set priorities for the construction of great roads in the 1830's. Mitchell wrote "that the Cliffs which enclose the district on the land side, especially towards the Sydney extremity are such as to render the formation of a road a work of great difficulty and expense".

The cliffs, the difficulty and the expense still exist but the challenge of the construction of a road link from Sydney into and through the Illawarra region has been overcome by thoughtful planning and the application of engineering expertise.

The next challenge to be overcome is the completion of the Freeway link between Sydney, the Capital City of New South Wales and Wollongong, the centre of an already vast and still expanding industrial complex.

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 March, 1974.

Road No.	Work or Service	Name of Successful Tenderer	Amount
			$
Warringah Freeway	Municipality of North Sydney. Excavation of West Street cut.	Ford Excavations Pty Ltd	159,350.00
State Highway No. 9	New England Highway. Shire of Tenterfield. Construction of a Armco multiplate arch over the main northern railway line, 15·3 km north of Tenterfield.	M. and E. Firth Civil Constructions (Tamworth) Pty Ltd.	98,950.00
State Highway No. 10	Pacific Highway. Shire of Hastings. Construction of a 3-span prestressed reinforced concrete bridge 32 m long over Cooperabung Creek, 5·6 km north of Telegraph Point.	Pearson Bridge Pty Ltd	61,350.00
State Highway No. 12	Gwydir Highway. Shire of Boomi. Construction of a 3-span prestressed and reinforced concrete plank bridge 32 m long over Black Gully, 98·8 km west of Moree.	M. and E. Firth Civil Constructions (Tamworth) Pty Ltd.	59,667.00
Trunk Road No. 63	Shire of Ashford. Construction of a 4-span prestressed and reinforced concrete bridge 42·7 m long over Ottley's Creek, 52·5 km north of Warialda.	L. G. Rixon	68,310.00
Trunk Road No. 78	Shire of Lockhart. Construction of a 5-span prestressed and reinforced concrete bridge 53·4 m long over Yerong Creek, 46·7 km south of Wagga Wagga.	Siebels Concrete Constructions Pty Ltd.	81,712.00
Main Road No. 286	Shire of Snowy River. Load, haul and tip approximately 6 100 m^3 of pavement material between Betts Creek and Charlotte Pass.	K. Brown	22,400.00
Main Road No. 574	City of Parramatta. Construction of a single span prestressed concrete portal frame bridge 36·3 m long to carry Kissing Point Road over Rydalmere Avenue.	E. M. Moore Pty Ltd	218,110.00

TENDERS ACCEPTED BY COUNCILS

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

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
				$
Bibbenluke	S.H. 19	Monaro Highway. Reconstruction to subgrade level between 17 and 21 km south of Bombala.	V. Heffernan Pty Ltd	82,473.05
Coffs Harbour	M.R. 151	Construction of a 3-cell, 3·7 m x 3·7 m reinforced concrete box culvert over Star Creek, 67·6 km south of Grafton.	M. O. & P. J. Kautto	34,994.24
Lockhart	T.R. 59 and M.R. 370.	Bitumen resealing at various locations	Emoleum (Aust.) Ltd	23,350.55
Murrurundi	D.W. 3213	Construction of a 5-span prestressed and reinforced concrete bridge 53 m long over Phillips Creek and approaches, 41·7 km west of Willow Tree.	R. Bruno and M. Eampese	54,587.00
Scone	D.R. 1243	Construction of a 2·6 km section of the Sargeant's Gap road.	Continential Construction Pty Ltd.	79,701.38
Tamarang	T.R. 72	Construction of a single span prestressed concrete and steel bridge 16·8 m long, over the northern railway line at Braefield including approaches.	Emoh Ruo Court Pty Ltd	133,140.20
Tumbarumba	M.R. 281	Construction of a 4-span prestressed and reinforced concrete bridge 43 m long over the Murray River Flood Channel, 2·4 km south of Welaregang.	Siebels Concrete Constructions Pty Ltd.	81,168.50
Wollondilly	M.R. 177	Construction of earthworks, drainage and bitumen surfacing of eastern approach to King's Falls Bridge over the Georges River, east of Appin.	Eastick Constructions Pty Ltd.	186,577.66

Working With Asphalt

(Left): Broken asphalt is loaded into trucks for removal.

(Below): A special ripping boot breaks up the asphalt surface.

(Above): Making a straight cut off at the end of a length.

(Left): Dozer pushes up broken asphalt ready for loading.

... and moving around

The Mobile Asphalt Unit at a location beside Lake Eucumbene where it is producing asphalt for the Snowy Mountains Highway (S.H.4)