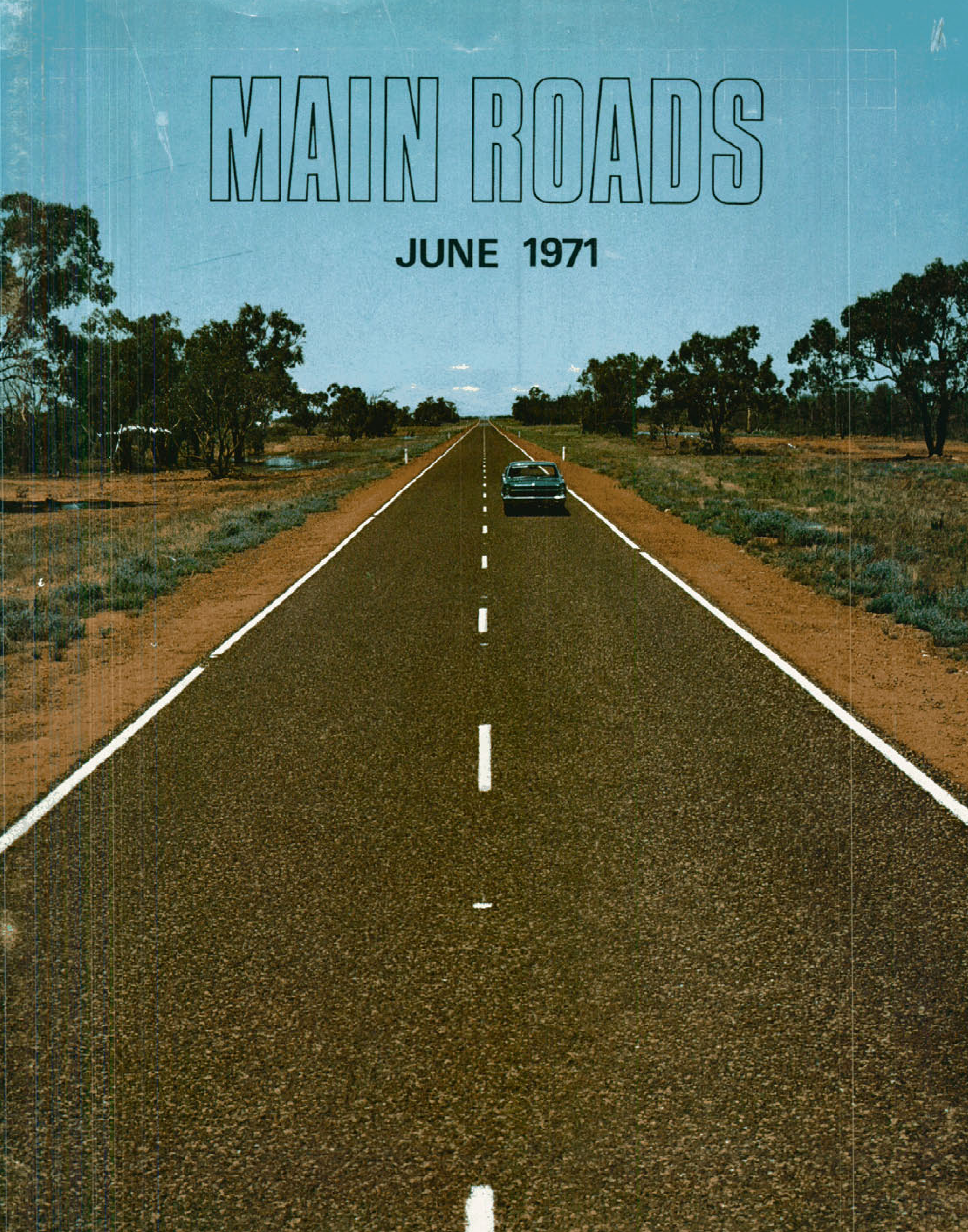
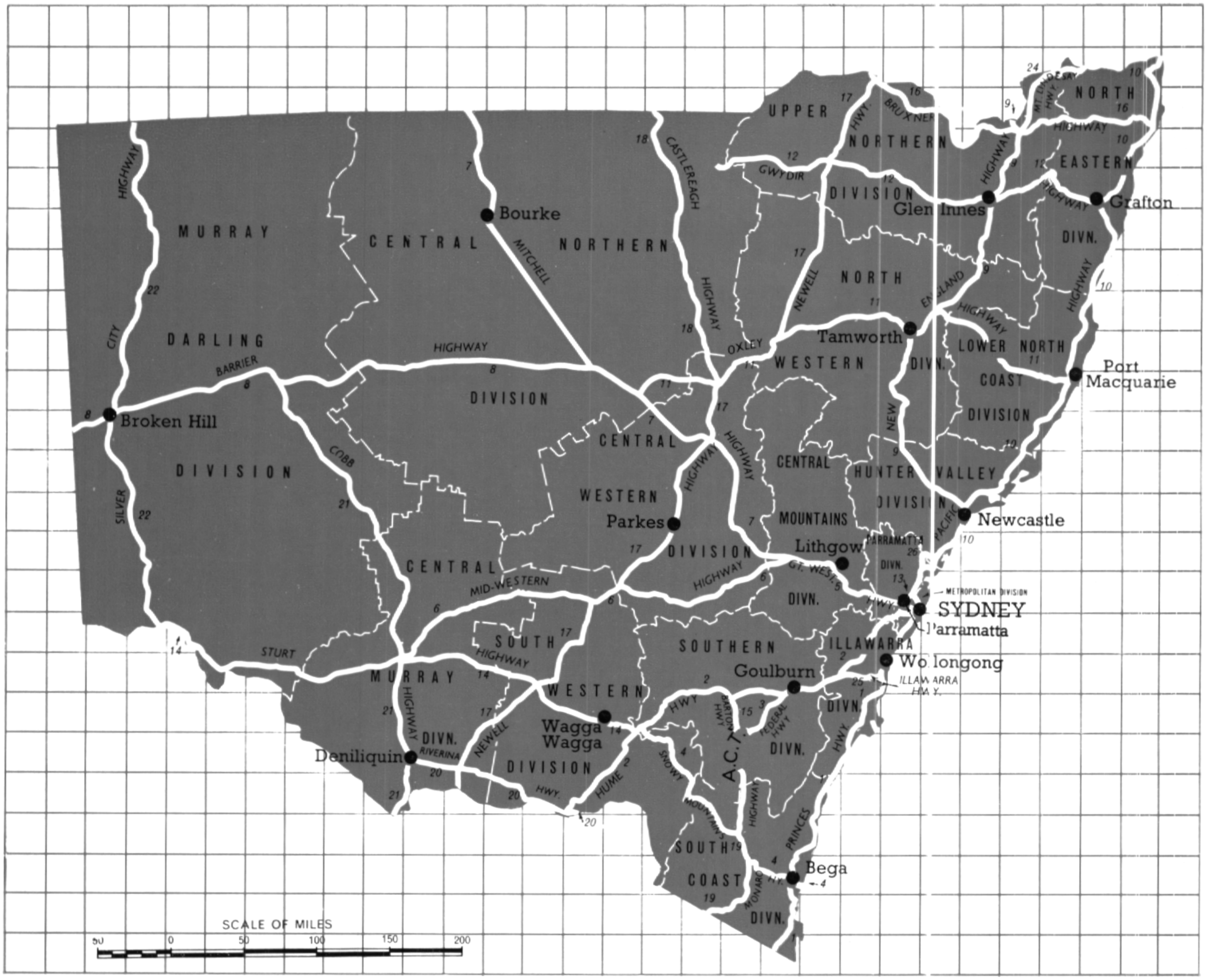
MAIN ROADS

JUNE 1971





HIGHWAY SYSTEM OF NEW SOUTH WALES

Mileage of Main, Tourist and Developmental Roads, as at 30th June, 1970

Expressways	26
State Highways	6.539
Trunk Roads	4,245
Ordinary Main Roads	11,572
Secondary Roads (County of Cumberland only)	176
Tourist Roads	219
Developmental Roads	2,741
	25,518
Unclassified roads, in western part of State, coming within the provisions of the Main Roads Act	1.572
TOTAL	27,090

Area of New South Wales—309,433 square miles

Length of public roads within New South Wales—129,745 miles

Population of New South Wales at 30th June. 1970—4,566,900 (estimated)

Number of vehicles registered in New South Wales at 30th June, 1970—1,974,345

STATE HIGHWAYS

DIVISIONAL BOUNDARIES

DIVISIONAL OFFICES

MAIN ROADS

JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

JUNE, 1971

VOLUME 36 NUMBER 4

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Back Cover: *Oxley Highway Highlights.*
Top left: *Typical reconstructed section of Highway, approximately* 10 *miles east of Walcha.*
Top right: *Stone cairn at Walcha commemorating Oxley's exploration.*
Middle left: *The beautiful Hastings River Valley.*
Centre: *Ferns beside the Highway as it climbs the Great Dividing Range.*
Right: *Spectacular Apsley Falls,* 12 *miles east of Walcha.*
Bottom left: *New bridge over King Creek, just east of Wauchope.*

CONSPICUOUS CONTRASTS

Travelling through New South Wales one can see many contrasts—from banana plantations near Coffs Harbour to snow-gums near Kiandra and, as the centre pages of this issue show, from the towering buildings which make the skyline of Sydney so spectacular to the flat, rugged conditions of immense regions in the outback.

Such vivid variations of views are being matched by similarly striking contrasts between what were previously adequate road conditions and what are now being provided by the Department. Contrasts in both *time* and *space* are apparent

☐ between the 1896 and 1971 versions of the bridge over Black Bob's Creek, on the Hume Highway (page 107),

☐ between the steam-driven Stockton vehicular ferries, of 1920's vintage, and the massive new bridge from Kooragang Island (page 111), which will soon replace them, and

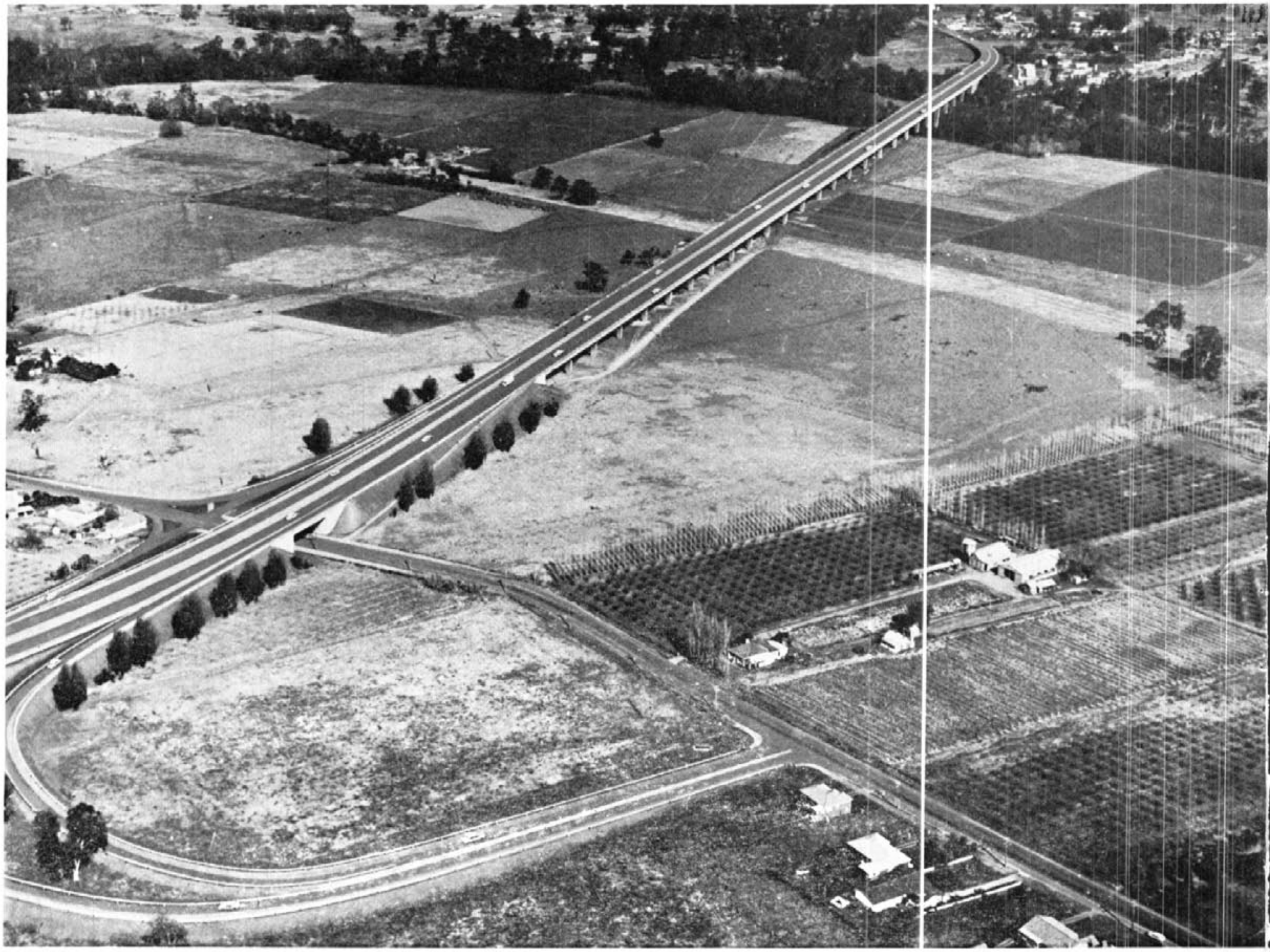
☐ between old and new sections of the scenic Oxley Highway (page 114).

On 8th October, 1818, explorer John Oxley, approaching Port Macquarie, was stopped by a large stream of fresh water. He noted: "At this place we were obliged to construct a bridge, which we did by two o'clock, sufficiently large and strong to take over the laden horses". Bridge building has seldom been *that* easy again, not even for David Lennox (page 109). There is a lot more to it now, as the article on the design of the new Nepean River bridge at Camden shows. The new bridge will be a flood-free 3,380 feet long structure compared with the low-level 390 feet long bridge it will replace. That's a much longer leap!—and with the adjoining highway deviation and link to the South Western Expressway, it will be an impressive and important improvement.

So, from the point of view of both scenic diversity and recent road and bridge development, motorists can regard New South Wales as a state with many pleasant contrasts.

DESIGN OF NEW BRIDGE OVER NEPEAN RIVER AT CAMDEN

Artist's impression of new bridge



The Department proposes to construct a five-mile long deviation of the Hume Highway which will allow through traffic to by-pass the towns of Narellan and Camden, 38 miles southwest of Sydney. This deviation will require a new crossing of the Nepean River at Camden upstream of the present highway bridge which is frequently submerged by flood waters.

Extensive investigations were carried out by the Department to determine the most suitable location for the new bridge. Particular attention was given to such requirements as:

- the need for the shortest crossing of the flood plain of the river,
- the provision of good road alignment,
- the reduction to a minimum of interference with built-up areas, and
- integration with planned future development at Camden.

The new road will leave the existing route of the Hume Highway approximately 3·4 miles northeast of Narellan and will rejoin it near Dobroyd Avenue, South Camden. The bridge will cross the river and flood plain approximately one mile upstream of the existing low level timber bridge. The new route will be completely above flood level. The Narellan-Camden deviation will also be linked with the 9·75 mile section of the South Western Expressway now under construction between Cross Roads (near Liverpool) and Maryfields (near Campbelltown) by the provision of a dual carriageway road from Campbelltown to Narellan.

The length of the new bridge will be 3,380 feet and when it is completed it will be the second longest road bridge in New South Wales. The bridge carriageway will be 30 feet wide and will provide two traffic lanes of sufficient width to minimize traffic disruption in the case of vehicle breakdowns. There will be one footway, 5 feet wide, on the downstream side of the bridge. Provision has been made for duplicating this structure when future traffic volumes so require.

Construction of the foundation piles for the bridge has been carried out by the Department's own Benoto Drilling Organization at a cost of approximately $300,000. On 9th February, 1971, a contract was let for the construction of the remainder of the substructure and the superstructure by John Holland (Constructions) Pty Limited at a cost of $2,270,682.

SITE CONDITIONS

The size and nature of the catchment precluded the usual waterway and high flood level calculations for this bridge site. Consequently an extensive investigation of the past flood history of the river was undertaken. The Bureau of Meteorology carried out a study which established that the probable "once in a hundred years" flood level at the proposed bridge site is R.L. 237.5. Their investigation confirmed the February, 1873 flood as being the maximum recorded, with a flood level at the site of R.L. 239.7.

A design flood level of R.L. 240 has been adopted, together with a minimum clearance of the superstructure above flood of 3 feet, to allow for the free passage of debris. However, the grading of the road needs to fit in with a grade separation at Macarthur Road near the eastern end of the bridge and the junction with the existing Highway at South Camden. For this reason the bridge will be on an under-vertical curve. The deck level at the middle of the bridge will be approximately 10 feet below that at the abutments.

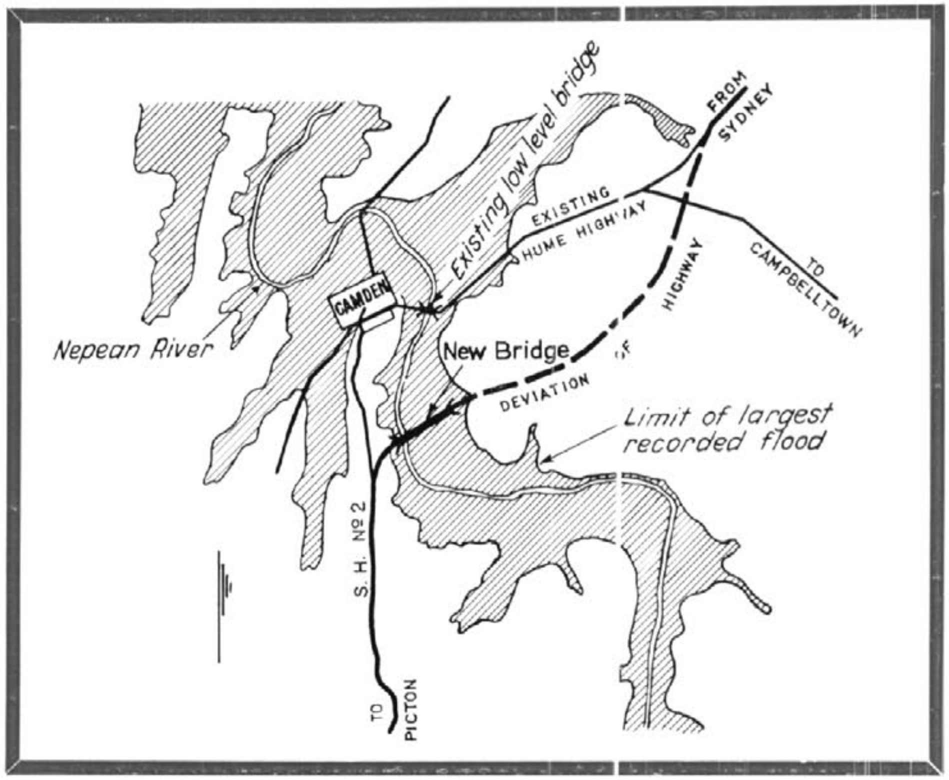
Observations during past floods indicate that fairly high stream velocities occur over the eastern side of the flood plain. A long embankment on the flood plain, which would alter the pattern of flow and possibly increase the extent of local flooding, has therefore been avoided. The abutments are located so that the maximum depth of water at the abutments for the design flood is approximately 11 feet.

The new bridge will extend across almost the full width of the flood plain and will thus cause very little restriction to the passage of floodwater. For this reason the bridge will not cause any appreciable raising of the flood levels upstream.

At the proposed bridge site the normal flow of the river is constricted to a channel 100 feet wide, on the western side of the flood plain. On the eastern side there is a distinct flood channel known as the "Ox Bow" but, as the bottom of this channel is 25 feet above normal water level, it does not carry any water during minor flooding.

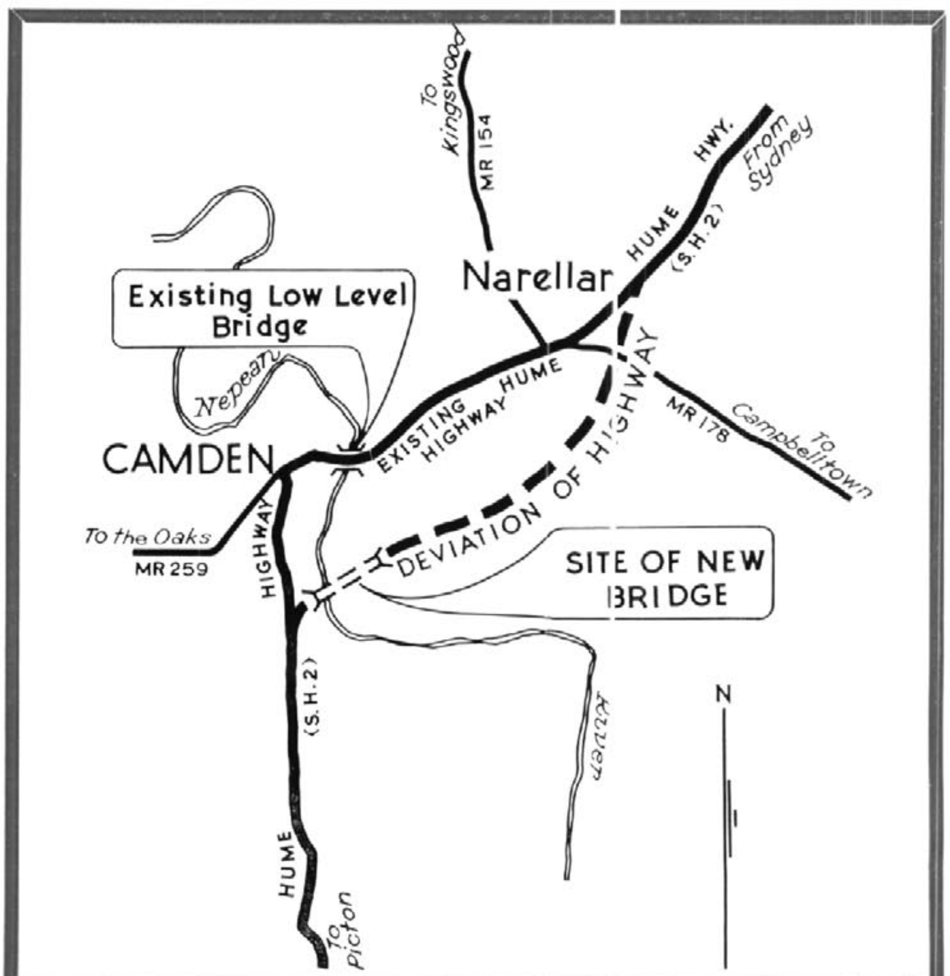
Normal river flow in the main channel is at 20° skew to the line of the bridge. For minor flooding the two high river piers will be subject to water flow at this 20° skew. At about half full flood, flow will occur through the Ox Bow channel, also at a 20° skew. However, there is no pier in this channel.

At full flood, flow will sweep mainly along the eastern bank, and the angle of skew will be reduced to 5°. As the effect



Map showing flood limits of Nepean River near Camden

Locality sketch



of the high floods is more significant, the piers will be placed square to the line of the bridge.

Preliminary foundation investigations at the bridge site were carried out in 1964, when eighteen test holes were bored to a depth of 50 feet below natural surface on the centreline at intervals of approximately 200 feet. These bores indicated the presence of relatively soft sedimentary strata with hard shale being encountered in the three holes nearest to the abutment on the western side of the river.

To establish the profile of the hard shale stratum, nine additional and deeper holes were bored on the centreline between the eastern bank of the river and the eastern abutment. The bores indicated the presence of hard metamorphosed shale at an average depth of 65 feet below natural surface over the whole length of the proposed bridge, although near the western abutment it rises to within 30 feet of the surface. Unconfined compression tests on six rock cores of 2-inch diameter gave high compressive strength from 7,000 to 14,000 pounds per square inch. The soil overlaying the rock has extremely variable characteristics and ranges from soft clays to coarse sands.

DESIGN OF BRIDGE

The bridge will be a composite concrete and steel box girder structure, 3,380 feet long and will have 26 spans each 130 feet long.

Superstructure

The superstructure will be divided into five continuous lengths, of 520, 780, 780, 780 and 520 feet respectively with expansion gaps at Piers 4, 10, 16 and 22. The expansion joints in the deck will take the form of steel finger plates designed for maximum movements of plus or minus 4 inches.

The two 520 feet long end sections will be anchored at the abutments to resist longitudinal forces. The three 780 feet long sections will be fixed at mid-length by anchor piers. All other piers will have rocker bearings at top and bottom to allow for longitudinal superstructure movements.

The superstructure will consist of two continuous steel plate box girders acting compositely with a reinforced concrete deck. Each box girder will be 9 feet wide at the top and the two girders will be spaced at 18 feet centre to centre. The overall depth of the girder and deck will be 64 inches, the minimum concrete deck thickness being 6½ inches. The deck cantilevers will extend from the box girders by 3 feet 5 inches on the upstream side and 8 feet 3 inches on the downstream side. This assymmetry is caused by the footway on the downstream side. The cantilever distances have been chosen so as to produce equal maximum positive and negative transverse moments in the slab.

There are no stiffeners on the webs of the box girders and internal diaphragms are provided at the piers only. The external faces of the box girders will therefore present a smooth unbroken line. The flat surfaces of the box girders will facilitate the painting of the bridge. A longitudinal stiffener is required on the bottom flange in the negative moment region where the bottom flange is in compression. This stiffener, in the form of a small rolled taper flange beam welded to the bottom flange, has been extended through the full length of the bridge in order to provide a rail on which a maintenance trolley can run inside the box girders.

A "California-type" undercut kerb and dwarf concrete parapet wall, surmounted by a twin tubular rail crash barrier, will be provided on either side of the carriageway. A single line of steel grill handrailing will be provided on the outside of the footway.

A 2-inch thick asphaltic concrete wearing surface 27 feet wide, with a 3 percent crossfall from the carriageway centreline, will be provided to give a smooth running surface. The asphaltic concrete will be flanked on either side by 1 foot 6 inch wide concrete gutter strips.

Piers

A simple two-column frame will be used for the piers, with tapered pier columns of rectangular section. Such a pier will give less resistance to skew flow than a wall pier and will be quite adequate for the passage of debris.

At the anchor piers (piers 7, 13 and 19), the pier columns will be framed into a wide "table-top" headstock just below ground surface and founded on four cast-in-place piles per pier. At the other piers, the columns will be free to rotate in the longitudinal direction of the bridge at both the top and bottom and thus will provide vertical and transverse support only. These piers will be supported on a tie beam just below ground surface and founded on two cast-in-place piles per pier.

Generally the piers will vary in height from 21 to 32 feet above the ground. To allow maximum re-use of formwork, all but six piers will have the same shape at the top and the same taper.

Abutments

The two abutments will be approximately 30 feet high to road level. Each abutment will impart longitudinal stability to portion of the superstructure by providing an anchor against longitudinal forces on the four spans at each end of the bridge.

The abutments are some distance from the main channel and will only be affected by major floods of relatively short duration and at infrequent intervals. Closed abutments are therefore unnecessary and the more economical open "spill-through" type has been chosen instead.

On minor bridges, the "spill-through" abutment usually takes the form of a normal shape pier frame buried in the approach embankment. For this bridge, in order to provide the necessary stability, the "open buttress" type has been used. In this form of abutment the columns are replaced by triangular shaped buttress walls supported on pile-cap beams. The walls themselves support the abutment head-stock carrying the superstructure bearings.

The sloping surface of the road embankment in front of the abutment will be faced with precast concrete slabs to prevent scour and erosion, particularly under the bridge where grass will not normally grow.

Foundation Piles

The cast-in-place concrete piles have been constructed using the Department's "Benoto E.D.F. 55" pile drilling machine. This machine forces a steel drilling tube into the ground with a semi-rotary action and simultaneously excavates the material inside the tube by a hammer-grab. (For details of this machine see the article in the June, 1963 issue of "Main Roads" Vol. 28 No. 4, pp. 122–125.)

The piles extend through overlying sands and clays and are founded in hard metamorphosed shale. The depths of the piles vary from 30 feet to 90 feet below the ground. It was originally intended that the piles be left uncased except in the upper 20–30 feet of their length but, due to difficulties with water-charged sand experienced during construction, a full length corrugated light gauge steel casing was provided.

A steel reinforcing cage of eighteen 1⅛-inch diameter deformed bars welded to a 29-inch diameter helix of ½-inch hard-drawn wire is provided in the upper section of the piles. The amount of reinforcement is reduced in the middle section and the lower section is not reinforced. The piles are 33 inches in diameter.

Bearings

Bearings will be provided at the tops of all piers, two sets of bearings being required on the piers at the superstructure expansion joints. Two bearings will be provided under each box girder, each being located near a web of the box. The maximum load on each bearing will be 140 tons.

The superstructure will be fixed to the abutments and anchor piers by means of special cast-iron rocker bearings. At all other piers laminated elastomeric pads will be used. These pads consist of a rectangular block of either natural or artificial rubber, reinforced with a number of thin steel plates.

At each of the four expansion joints, one end of the superstructure will be supported on elastomeric pad bearings. Longitudinal movements will be allowed by supporting the adjacent end of the superstructure on elastomeric bearings also incorporating a polished stainless steel surface sliding on a sheet of P.T.F.E. (Polytetrafluoroethylene).

Rotational movements at the bases of the pier columns will be allowed by means of "rubber pot" type bearings. These bearings have a pad of rubber confined under pressure inside a steel pot and permit small rotations under very high loads.

Materials

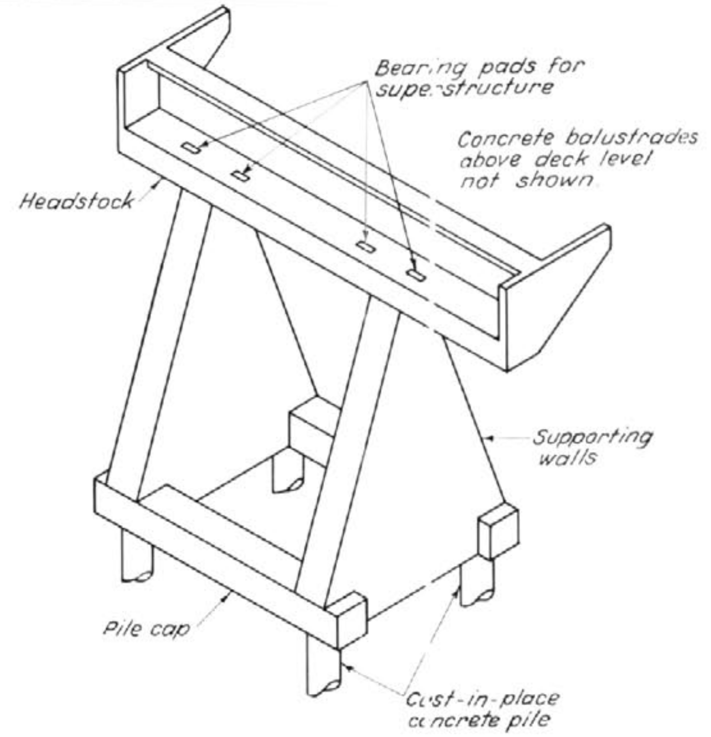
The design provides for the use of Class 4K concrete (4,000 lb/sq. in. at 28 days) for the deck, piers and piles. The use of the higher strength concrete in the deck will not materially affect the cost but will provide better flexural rigidity in the composite section.

Structural grade steel to A.S.A. 149 and notch ductile steel to A.S.A. 135 will be used for the box girders. Consideration was given to the use of weldable structural steel plate of higher yield stress to A.S.A. 151, but there was no advantage in further reducing the plate thickness.

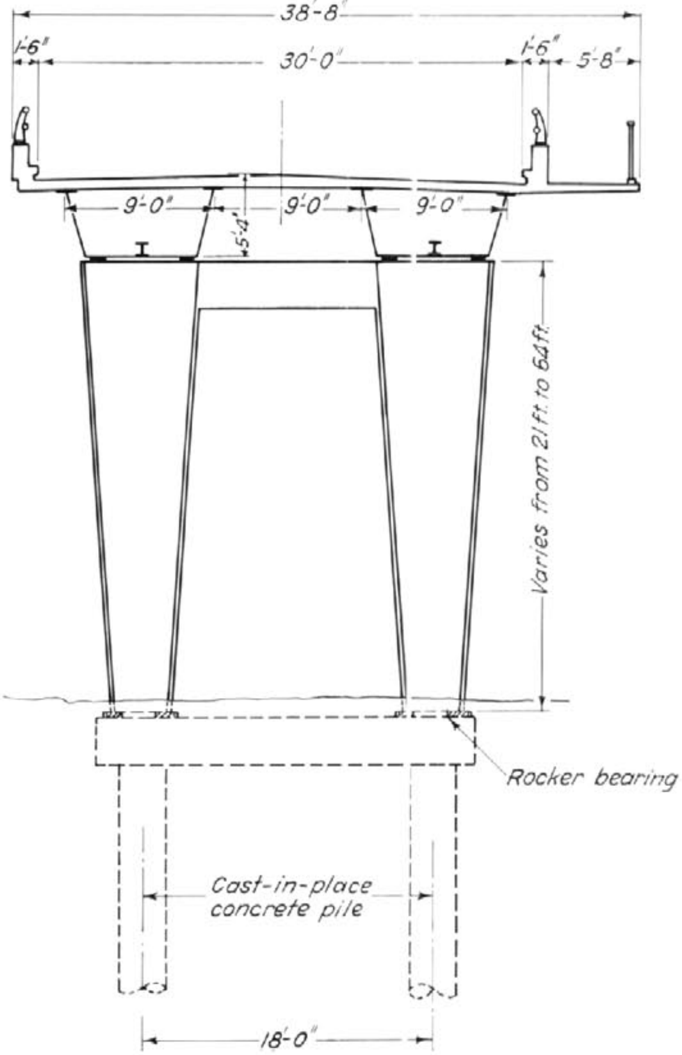
The approximate quantities of materials which will be used in the bridge are:

- Steel box girders — 2,040 tons
- Concrete Class 4K in piers and abutments — 1,800 cubic yards
- Concrete Class 4K in superstructure — 3,650 cubic yards
- Reinforcing steel in piers and abutments — 130 tons
- Reinforcing steel in deck — 540 tons

General outline of abutment



Typical cross-section of new bridge



Prestressing of Superstructure

Each of the five continuous sections of steel box girder will be erected initially with its ends supported on the end piers or abutments and with the remainder raised up on temporary supports above the intermediate piers. After the concrete deck is poured and cured, the superstructure will be lowered down onto the permanent bearings on the intermediate piers. The maximum lowering will be 58½ inches for the six-span continuous lengths and 26½ inches for the four-span continuous lengths.

This prestressing technique has been incorporated in the design for the following reasons.

- Major variations in the thickness of steel plate in the box girders have been avoided because of the redistribution of bending moments which will arise in the composite steel and concrete box sections.
- An initial compression will be produced in the concrete deck slab to counteract the effects of shrinkage and of tensile stresses over the piers.

The method has been successfully used for continuous steel box girder bridges in Europe, and variations have also been used in Japan in recent years.

Fabrication and Erection of Box Girders

The girders will be fabricated in 60 feet and 70 feet lengths generally, weighing 13 tons and 16 tons respectively.

The fabrication of the box girders will be relatively simple as the majority of welding consists of longitudinal butt welds between the webs and flanges. The only shop welds transverse to the axis of the girder occur at the diaphragms at each pier. Consequently, the bulk of the shop welding will be eminently suitable for automatic or semi-automatic processes.

The main longitudinal welds between the webs and the flanges will be full penetration butt welds, instead of the more commonly used fillet welds. Butt welds will be better able to withstand the transverse loading on the box girders and can be checked by non-destructive testing methods. With normal production line techniques for the 114 segments of box girder, the edge preparation can be done at the same time as the stripping of the plate to width. It is also envisaged that all longitudinal welding will be done in the optimum position by the use of suitable manipulators.

The erection of the girders will prove simple, with the girders being lifted by mobile crane directly from the road transport vehicles onto the piers and temporary intermediate supports.

The shop frabricated lengths of girder will be field-welded together to form continuous lengths of 520 feet (4 spans) and 780 feet (6 spans). The welded joints are near the points of contraflexure of the spans.

The Department's practice for steel bridge construction has been to use shop-welded fabrication with field-riveted and, later, field-bolted connections. The prime reason for this was the lack of skilled operators who could handle the out-of-position welds under field conditions, and the need for rigorous supervision of the welding.

However, there are now considerable numbers of welding operators in Australia who have had experience with similar types of field welding which involve out-of-position (vertical, overhead, etc.) manual welding, the techniques of which have been developed to a large degree in relation to the welding of steel pipe lines.

A portable cover will be required during field-welding of the box sections to shield the welds from the effects of wind or rain. With two joints per span a single cover could be used 50 times and its cost would be of little significance.

The field butt welds will be tested using radiographic and/or ultrasonic methods, as for shop welds.

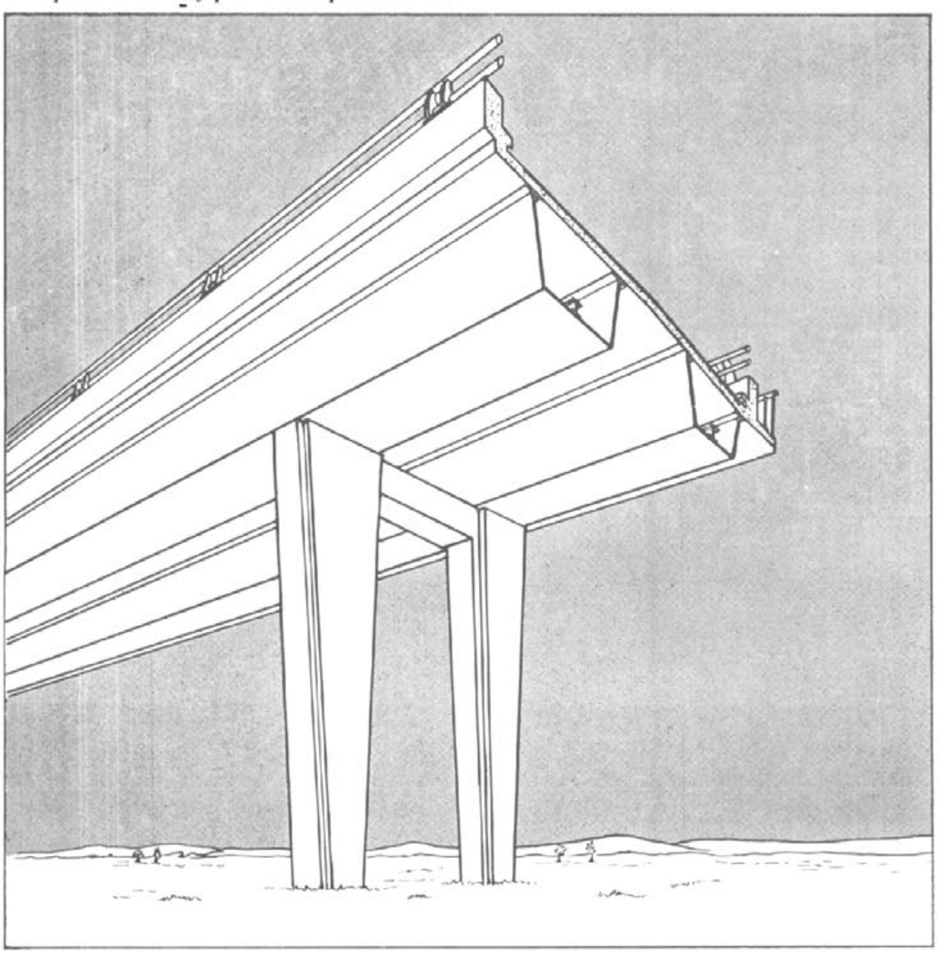
Protective Treatment of Steelwork

All metal surfaces will be abrasive blast cleaned and coated with either a zinc silicate or an organic zinc-rich primer for the basic protective treatment. The internal surfaces of the box girders will receive no further treatment. The final coat for the exterior surfaces will be of a vinyl or chlorinated rubber type paint and might be of a colour other than the usual grey.

*

This article has been adapted from a paper presented to the Civil Engineering Branch, Sydney Division, of the Institution of Engineers, Australia, on 28th April, 1970 by Mr A. R. Smith, B.E., M.I.E. Aust., and Mr R. J. L. Wedgwood, B.E., M.Eng.Sc., M.I.E. Aust. of the Department's Bridge Design Section.

Perspective view of pier and superstructure



NEW BRIDGE OVER LOWER WARRELL CREEK NEAR MACKSVILLE

On 21st May, 1971, the Minister for Highways, the Hon. P. H. Morton, M.L.A., officially opened a new bridge over Lower Warrell Creek on a deviation of the Pacific Highway 2·2 miles south of Macksville.

The new prestressed concrete bridge has six spans, with a total length of 752 feet. The two end spans are 106 feet long and the intermediate spans are 135 feet. The carriageway width is 28 feet and provides two traffic lanes. A footway, six feet wide, has been incorporated on the western side of the bridge.

The bridge was designed by the Department and was built by Central Constructions Pty Ltd. The bridge is located about half a mile downstream from the previous bridge and, as well as the Creek, it spans Scott's Head Road on the southern side. It has a maximum clearance of 13 feet above the highest recorded flood level. The approaches are also flood free and involve a two-mile deviation which eliminates the easily flooded section of the Highway across Hunt's Flat.

The approaches were constructed by the Department's own forces and include two concrete box culverts and 223,000 cubic yards of earthworks. The deviation has a 24 feet-wide bituminous sealed pavement on a 44 feet-wide formation.

DESIGN FEATURES OF THE NEW BRIDGE

The bridge is founded on composite steel and concrete piles 18 to 37 feet long, with 17 inch x 17 inch heads, and lengths of H rolled steel section, selected to allow easier penetration of underlying gravels. The deepest pile is 61 feet. The superstructure consists of twin post-tensioned concrete boxes, continuous for the full length of the bridge. The superstructure is the same as that of the bridge being constructed over the South Arm of the Bellinger River at Urunga, the only difference being in the shape of the twin pier shafts and the type of piling.

The pile caps contained pre-cast concrete skirting units around the top of the pile so that the use of cofferdams was not necessary. The piles were designed to withstand a flow of 10 feet per second.

The design of the bridge gives a slim graceful appearance in silhouette and blends with the site, which has pleasantly wooded slopes on the northern side, pastoral flats to the south, and clusters of waterlilies in the stream itself.

In selecting the site, consideration had to be given to flood discharges and the necessity for a flood-free approach alignment. The immediate approaches are straight and square on to Lower Warrell Creek.

The final cost of the bridge will be approximately $653,000, while an additional $585,000 has been spent on the approaches and deviation. The total cost of the work, which is being met by the Department, will therefore be in the vicinity of $1,238,000.

The new bridge and deviation forms another link in the improvement of the Pacific Highway, one of the State's major traffic arteries. It also marks the completion of the first stage of a deviation of the Pacific Highway which will eliminate the low-level railway underpass near the village of Warrell Creek.

PREVIOUS BRIDGE AND FERRY CROSSING

The new bridge replaced an old narrow timber bridge on poor alignment. Prior to the opening of this bridge in 1908, Lower Warrell Creek was crossed, about 50 yards downstream, by a small "rope-pulled" punt. This punt was in operation prior to 1896, when it carried two horses and sulkies and was apparently run by an Irishman named John Fowler.

Research indicates that the old bridge was built by Mr Wally Boulton from Gumma for Bellingen Shire Council, which controlled this area at that time. The Macleay Chronicle of 4th July, 1907 recorded that "Mr W. Boulton has the contracts to build a wharf and bridge at Warrell Creek."

On 2nd July, 1908, the Macleay Chronicle noted that "The opening of the new bridge at Warrell Creek is to be celebrated with a day's sports on Monday, 6th July, 1908. Mr G. S. Briner, Member for Raleigh says that 6th July has been proclaimed a public holiday in the licensing district of Nambucca in connection with the opening."

Although a bridge over Upper Warrell Creek was apparently also opened to traffic in 1908, the reminiscenses of the local residents suggest that the above-mentioned newspaper article referred to the bridge over Lower Warrell Creek.

According to some residents, a local aboriginal named Putt "jumped the gun" at the opening ceremony and was the first to cross the bridge—by foot. It is also said that the road was built by Mr John Hunt.

BRIEF HISTORY OF THE AREA

The Nambucca River was probably first discovered in November, 1818 by a party in search of the vessel "William Caesar", which had been seized by convicts in Sydney in July, 1817. In December 1820, explorer-surveyor John Oxley examined the entrance to the river, while in 1838, a Lieutenant Henderson visited the district and later referred to the "Nam Bucca" as an unexplored river, running parallel to and north of the Macleay.

Nambucca is an aboriginal word meaning "crooked river" or "crooked water".

By 1842 cedargetters had begun to work in the area and on 21st October, 1870, the site of the village of Nambucca was proclaimed in the *Government Gazette*. After the passing of the Land Act of 1861, settlers began to take up areas along the Nambucca River, although there had been some large pastoral stations before this.

Macksville was originally known as Central Nambucca and the name was officially changed to Macksville on 1st December, 1889. It was named after Mr Angus McKay and Mr Hugh McNally, early pioneers who made a joint subdivision of their two adjoining farms.

Warrell Creek was also known as "Gurravembi Creek". "Warrell" may have originated from an aboriginal word "Warral" meaning "a bee", "honey" or "honeysuckle".

The first meeting of Nambucca Shire Council was held at Bowraville on 20th December, 1915. Prior to this time the area had been under the control of the Bellingen Shire Council.

EARLY COMMUNICATIONS

As communications by road were rough, slow and often dangerous, early settlers used river and sea routes as their main means of communication.

During 1898, the arrivals and departures of vessels at Nambucca Heads totalled 277, and involved an aggregate of 13,513 tons of shipping. Exports were sawn hardwood, girders, spokes, shingles, cedar, maize, pigs, eggs and poultry. Trade by sea from Nambucca was good, in spite of the handicap of a bad sand bar.

About the turn of the century, the droghers, which normally carried logs, pigs, produce, etc., along the rivers, were now and then cleaned up, festooned with flags and put into use to carry local residents to the Warrell Creek Crossing for picnics or to attend sports which were periodically held on the flats nearby.

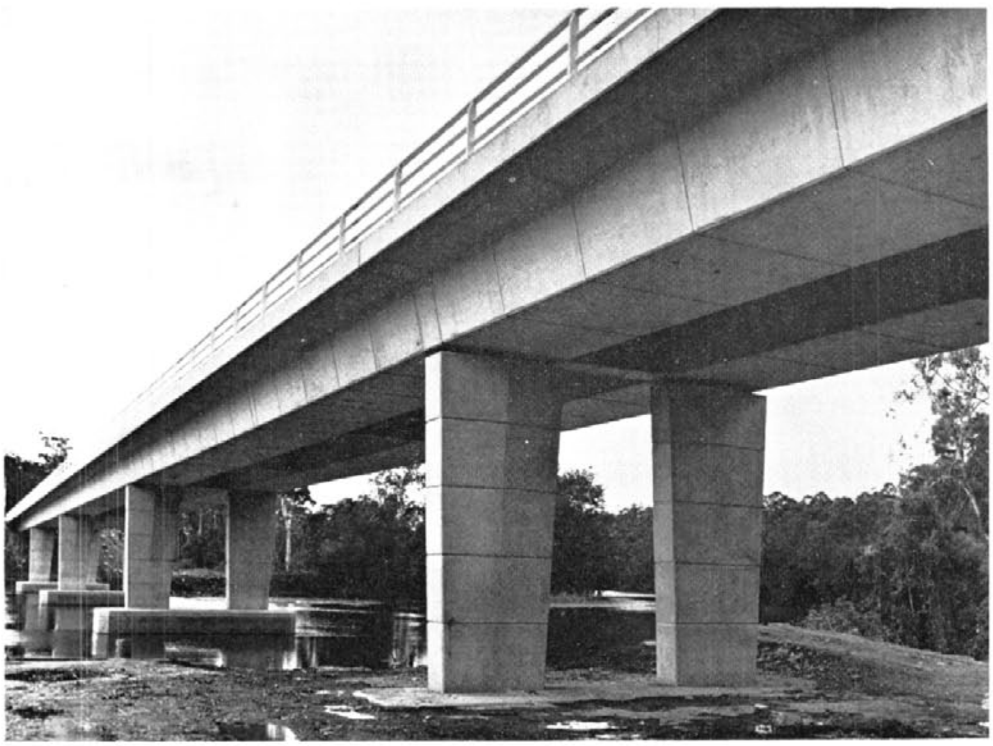
Road communication to the north began as far back as 1840 with the road between Raymond Terrace and the Australian Agricultural Company's centres at Booral, Stroud and Gloucester. By 1857 the road extended north to Port Macquarie and Kempsey, inland to Armidale and then northeasterly to Grafton. A route closer to the coast through Bowraville and Coffs Harbour was open in 1895 and this road was altered to pass through Macksville by 1909.

The railway line was opened to Macksville in 1919 and provided a popular and fast link with city markets. After the arrival of the railway, tomatoes increased in importance as a crop, and the first bananas sent from the Nambucca district to Sydney were forwarded in 1926. Timber, dairying and bananas now form the bulk of industries in the area, while peas, beans, cucumbers and other vegetables are also marketed.

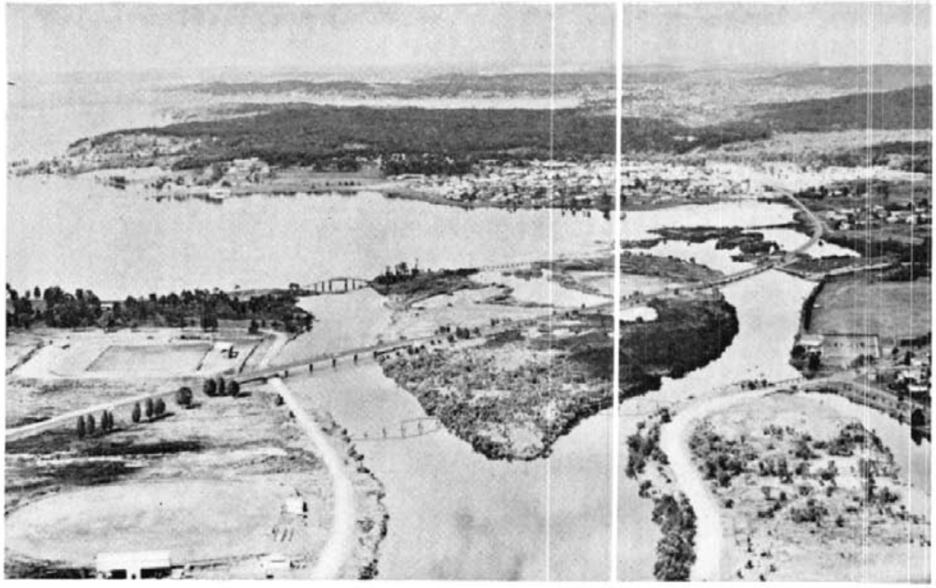
* * * * *

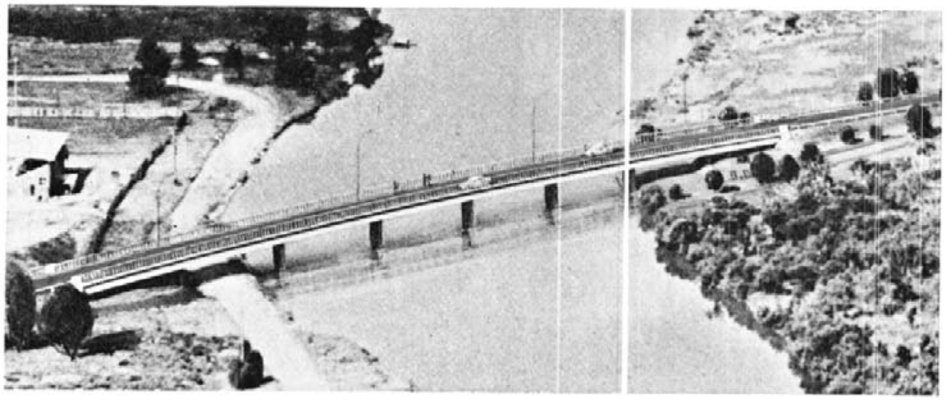
The spectacular postwar and recent increases in the use of the motor vehicle as an everyday means of transport can be seen in traffic counts taken on the Pacific Highway near Scott's Head Road. The Annual Average Daily Traffic (A.A.D.T.) Volume for 1970 was 3,240 vehicles compared with an estimated 90 to 100 vehicles per day, thirty years ago. During 1969-70, traffic volumes at this site rose by 11 per cent.

These figures vividly illustrate the need for good roads and bridges in our increasingly mobile society.



PROPOSED NEW BRIDGES OVER COCKLE CREEK NEAR BOOLAROO





Details were given in the March, 1971 issue of "Main Roads" (Volume 36, No. 3, Page 73) of two new bridges; one to be built over the North Arm of Cockle Creek and the other over the South Arm, near Boolaroo at the northwestern corner of Lake Macquarie.

The contract for the construction of these two bridges was awarded in April, 1971 to Central Constructions Pty Ltd. The tendered amount was $692,511 and completion of the work is scheduled for September, 1972.

The artist's impression above right shows the bridges as they will appear when completed. The view is looking south along the associated one-mile deviation of Main Road No. 217. The lower illustration provides a closer view of one of the bridges which will be identical 8-span, 576-feet-long prestressed concrete structures.

PROPOSED NEW BRIDGE OVER MACLEAY RIVER AT SMITHTOWN

Tenders, closing on 13th July, 1971, have been invited for the construction of a new bridge over the Macleay River between Smithtown and Gladstone, approximately ten miles north of Kempsey.

The new bridge will eliminate yet another vehicular ferry service from the State's Main Roads System.

Linking the townships of Smithtown and Gladstone, the ten-span bridge will be 1,125 feet in length and carry two lanes of traffic. The width between kerbs will be 28 feet and there will be one footway, 7 feet 6 inches wide, on the upstream side.

Allowance will be made for river traffic by the provision, in accordance with Maritime Services Board regulations, of a clearance of 30 feet above the mean water level. In addition the bridge can be modified to include a lift span if this should become necessary.

The bridge was designed for the Department by Sir Alexander Gibb and Partners, Australia, consulting engineers. The approaches will be constructed by Macleay Shire Council.

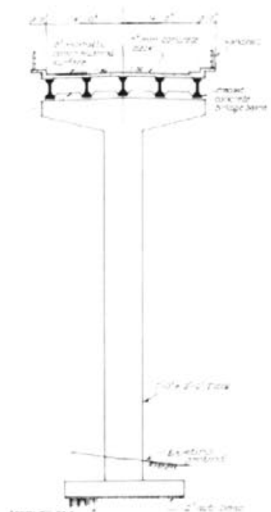
Travellers to the popular tourist resort of South West Rocks will derive considerable benefit from the new bridge because of its location on the road (Main Road No. 556) which runs from the Pacific Highway at Sevenoaks to the Kempsey-South West Rocks Road (Main Road No. 198) at Gladstone.

NEW BRIDGE OVER BLACK BOB'S CREEK

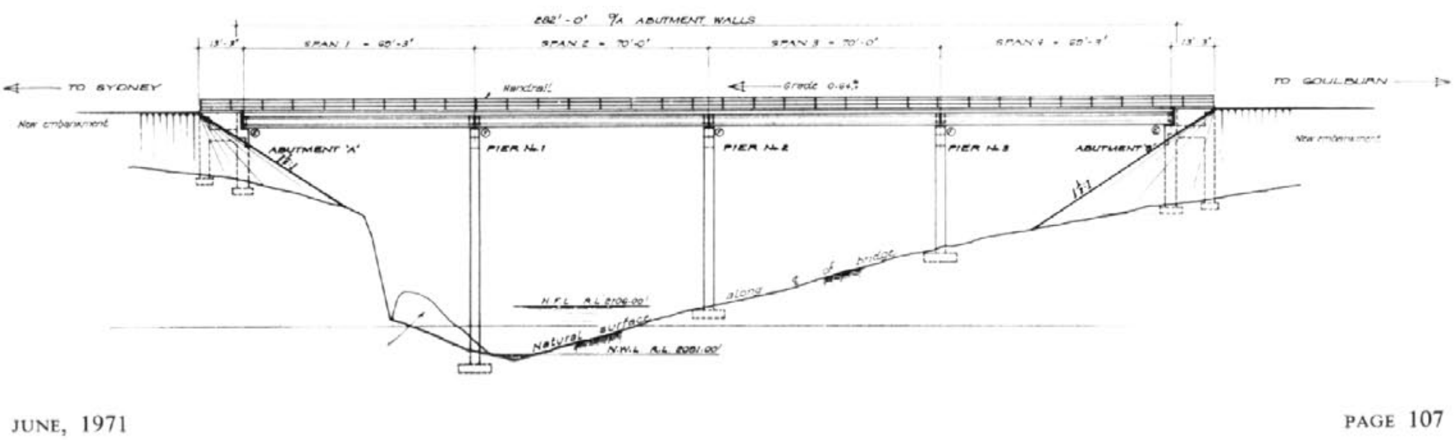
Historic crossing on Hume Highway near Berrima

On 5th April, 1971, a new bridge over Black Bob's Creek was opened to traffic. This bridge is approximately 7½ miles south of Berrima on a one-mile deviation of the Hume Highway.

Cross section at pier



Elevation looking upstream



The new prestressed and reinforced concrete bridge consists of four spans with an overall length of 282 feet and a width between kerbs of 28 feet.

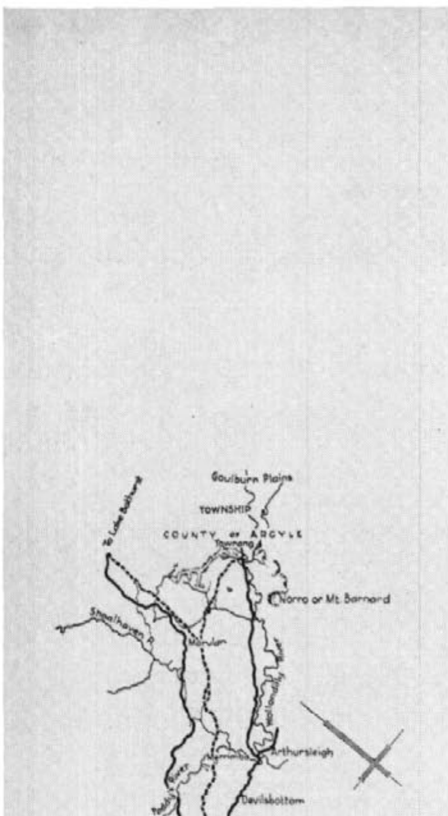
High single column piers, between steep embankments, give an attractive appearance to the bridge which is gracefully blended with the environment. The piers are approximately 70 feet high and extend 7 feet below creek level where they are founded on rock.

Consulting engineers Macdonald, Wagner and Priddle designed the bridge in co-operation with Freeman, Fox and Partners. It was built under contract by Peter Verheul Pty Limited and the cost of the bridge and approaches was approximately $160,000.

The deviation, which is on an improved alignment, was constructed by the Department's own organization at a cost of approximately $200,000.

The new bridge, together with the realigned section of Highway, will greatly improve the flow of traffic in the area.

A roadside rest area has been established, between the new and old routes of the Highway, at full cost to the Department and was opened at the same time as the bridge.



Roads from Bargo to Goulburn, 1830, *showing Mitchell's proposed line.*

Earlier Bridges

The new bridge replaced a stone arch bridge on poor alignment and is the third to be built over Black Bob's Creek at the site; the previous structures being located approximately 200 yards downstream. The stream itself was previously known as Crawford's or Narrawar Creek.

In 1828 the first township of Goulburn Plains was laid out by the Surveyor-General, Major Thomas Mitchell and, as a consequence, he was faced with the location of a new road link to Sydney. Subsequently Mitchell surveyed a trial line in 1829 and submitted a report on 26th March, 1830. At that date there were two roads to Goulburn Plains bifurcating at Black Bob's Creek; these were the old Lake Bathurst Road and Riley's Road, which roughly followed the route of the Wollondilly River. Mitchell's exhaustive report described the ideal location as almost a straight line between Bowler's Bridge (which was later replaced by Lansdowne Bridge) and Goulburn, avoiding both the Razorback and Mittagong Ranges. "It remains to be seen what deviation is necessary from this straight line for the sake of a level road", Mitchell noted. (*See map at left.*)

The new line passed through Bowral to Berrima where Mitchell reported there were two natural piers of rock upon which a small but permanent bridge could be built. The line then went southwards along almost flat country to Black Bob's Creek, where there was a slight detour to the east in order to avoid a deep gully which Mitchell recommended should be bridged. The old track to Goulburn was intersected almost immediately after crossing Black Bob's Creek and the new line reached Paddy's River at Murimba.

In a later report, entitled "Progress in Public Works and Roads in New South Wales to 1855", Mitchell wrote . . . "The line continues southward along a country nearly quite flat, passing near Harry Marr's Station, and it reaches the Narrawar or Black Bob's Creek at 4 miles from the Midway.

A slight detour to the left is made on approaching this rivulet in order to head the tremendous rocky gully which it sinks into immediately below.

At a mile from the crossing place, where I would also recommend a small stone bridge to be erected, the road lies between two hills of trap or whinstone, so that the materials are at hand and of the best quality for making roads."

Approval was given in 1832 to the construction of the road on the new line surveyed by Mitchell in 1830. In the course of an address to the Legislative Assembly in 1833, the Governor stated the road might be opened in six months. However, it was not completed until some years later. Ironed gangs were stationed at intervals to perform the work of construction. Gangs were based in stockades on the Razorback Range, at Myrtle Creek, and at Gibraltar as well as in huts at Berrima, Black Bob's Creek, Wingello, Marulan and Towrang.

There are no definite records as to the order in which the roadworks were carried out, but there are records of the bridges built by David Lennox in conjunction with the road construction.

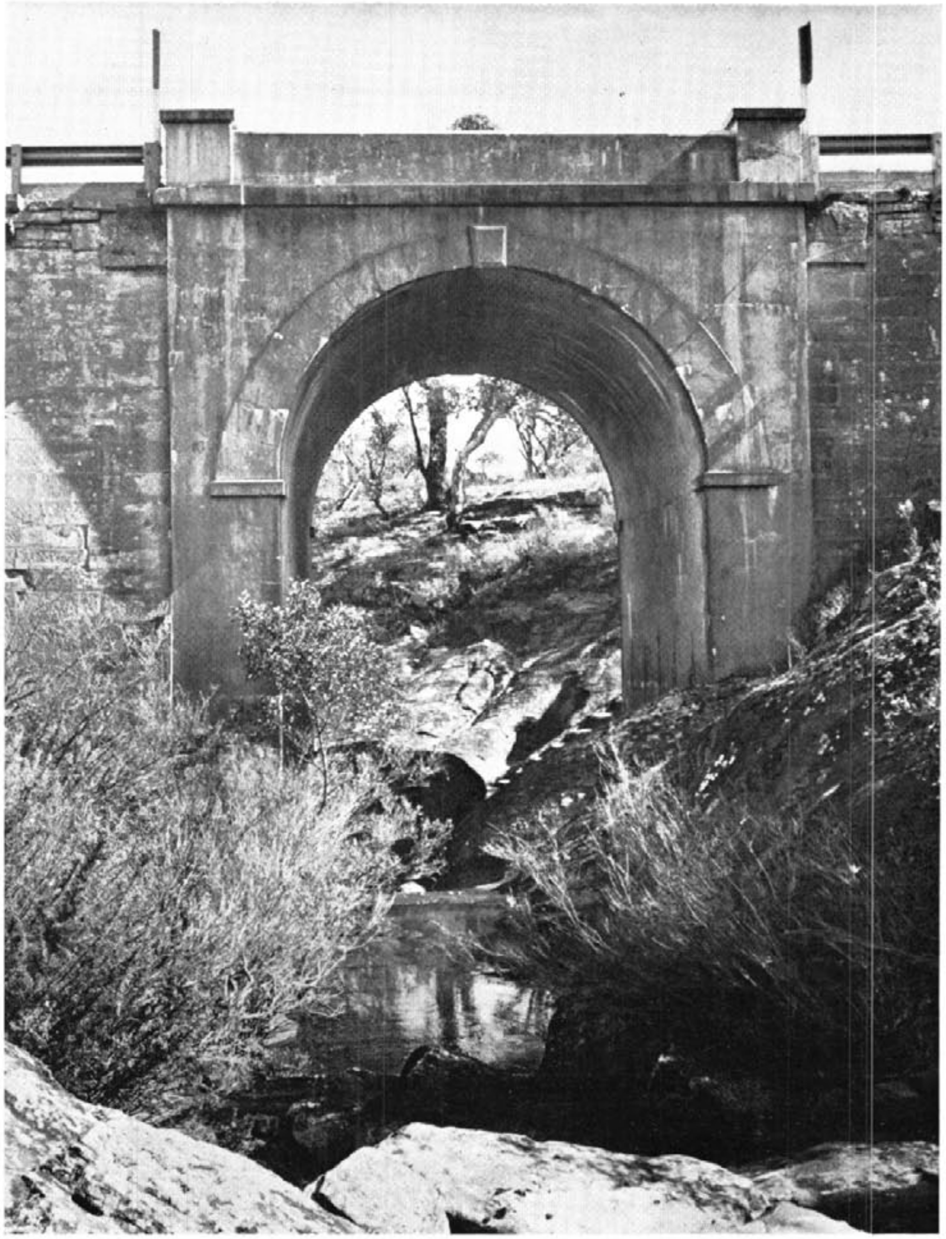
On 30th May, 1833, Lennox, writing from the "Grey Hound Inn", near Liverpool, where he was supervising the construction of Lansdowne Bridge, refers to his instructions for a stone bridge over the Wingecarribee River at Berrima, and shortly afterwards reports that, on inspection, he finds the site an excellent one, with abundance of building stone on the spot. For this work he proposed a replica on a reduced scale of the bridge he was building over Prospect Creek, with an arch span of 50 feet, and width of 27 feet, including parapets, and this proposal was duly approved. In his report he mentions two smaller bridges with stone piers to be built on the Southern Road, referring evidently to those subsequently erected over the Midway Rivulet and Black Bob's Creek. (Incidently, the name Midway was probably given on account of the situation of the stream midway between the Wingecarribee River and Black Bob's Creek. It has now become known as Medway.)

In January, 1834, Lennox again visited Berrima, and laid out the sites of the three bridges in the locality, reporting preliminary operations well in hand, and asking permission to build Berrima Bridge first.

The wooden bridge at Midway Rivulet was supported by three masonry piers 20 feet apart and was completed by January, 1835. Berrima Bridge was completed in June, 1836. Both of these bridges were destroyed by floodwaters in 1860.

At Black Bob's Creek, Lennox is said to have originally proposed a stone arch similar to that at Berrima and to take the same centering. The following extract from Mitchell's report on the Southern Road dated 19th January, 1835, gives an idea of the character of the bridge as actually erected:

> "The bridge at Black Bob's Creek will be a still more striking specimen than that of Midway of the improving character of these constructions, and the advantage of having a practical man like Lennox to superintend the work. The pier and wing walls on the right bank are in course of construction with blocks of excellent stone, well set, and each pier will rest on a solid mass of rock—across these the bridge will be constructed of strong beams, supported by braces resting in a projecting course."



Old bridge over Black Bob's Creek, built by the Department of Public Works in 1896

The design was apparently similar to that of a number of bridges constructed by Lennox on the Gloucester-Berkeley Canal in England and was suitable primarily for a location free from flood waters, where the diagonal braces would not collect floating debris.

Work seems to have proceeded slowly owing to the absence of skilled labour and possibly because of the absence of Lennox himself, who had his headquarters near his major work, Lansdowne Bridge. It was not until 3rd August, 1835, that the last pier was almost completed, and the work likely to be finished in three or four months. However, though the bridge was passable for traffic in April, 1836, the hand railings were incomplete. As late as 1st November, 1836, Mitchell, returning from one of his expeditions, noted in his journal—"On Crawford's Creek I found a bridge of stone buttresses had been nearly completed."

In 1896 the Lennox structure was superseded by a single-span stone arch 30 feet long and 29 feet wide, which was erected by the Department of Public Works and has now been replaced by the present modern concrete bridge.

References included an article entitled "David Lennox, the Bridge Builder, and his Work" by Henry Selkirk, published in the Journal of the Royal Australian Historical Society, Volume VI, Part V, 1920 ●

NEW MAPS OF SYDNEY & SUBURBS AND SYDNEY & SURROUNDING DISTRICTS

The Department has just published a revised edition of the maps of "Sydney and Suburbs" and "Sydney and Surrounding Districts". These maps are printed back-to-back on a sheet 27⅞ in. by 39⅜ in. and are folded to the more convenient size, 7 in. by 9⅞ in.

As well as showing the routes of proposed expressways and those sections already constructed or under construction, both maps show, by distinctive colours, the different classifications of roads in the Main Roads System. These colours are: Expressways—green, State Highways—blue, Trunk Roads—brown, Main Roads—red, Secondary Roads—yellow, and Tourist Roads—orange. For the benefit of both Council and Departmental officers who may regularly use the maps for reference purposes and for the information of other authorities and interested persons, the classified numbers of State Highways, Trunk Roads, Main Roads, etc., are shown on the maps adjacent to the appropriate roads.

The "Sydney and Suburbs" map extends from Broken Bay in the north to Port Hacking in the south and to Blacktown and Liverpool in the west. The map of "Sydney and Surrounding Districts" covers the area bounded by Gosford in the north, Kiama in the south, and Mt Victoria and Moss Vale in the west. The scale of the former map is one mile to the inch and that of the latter is 2·6 miles to the inch.

Limited numbers of each map are also available, printed one side only and supplied flat. These are suitable for mounting on board or on linen and for installing on rollers in wall-mounted map units. These unfolded maps are also being overprinted to show the Department's divisional boundaries.

Copies of these maps, as well as another new map showing Roadside Rest Areas on Main Roads in New South Wales, are available free of charge from the Public Relations Section, Head Office or from any of the Department's Divisional Offices ●

NEW SCALE MODELS OF EXPRESSWAYS

Late in March, 1971, Departmental officers put the finishing touches to the largest scale model yet prepared by the Department to illustrate future road proposals.

The model shows the expressway system in Sydney's surrounding districts, extending from Avalon in the north, to Helensburgh in the south and to Blaxland in the west. It is roughly square in shape, each side being approximately 15 feet long. Constructed of layers of cork with a plaster-of-paris overlay, the model is appropriately contoured using a horizontal scale of 1,320 feet = 1 inch (i.e., 1 mile = 4 inches) and a vertical scale of 400 feet = 1 inch. The surface is made up of approximately 260 aerial photographs, glued onto the contoured base to give authentic and detailed information on the area covered by the model.

All State Highways and Main Roads are shown as coloured lines on the mosaic, while the majority of suburbs and townships are labelled for quick orientation. The routes of all expressways, radiating from Sydney, are shown in green, with interchanges high lighted as green "diamonds" and the model gives viewers an idea of the extent of the Department's expressway proposals.

The model was first displayed at the Department's exhibit at Sydney's Royal Easter Show during April, 1971, and drew large crowds interested either in seeing the general scope of the overall expressway scheme or in studying some particular section.

Designed and constructed within the Department, the model has been made in sixteen sections so that separate segments on different expressways can be exhibited individually if required. It is proposed that the model will be usually on display in the area adjacent to the Public Relations Section, 3rd Floor, Head Office.

* * * * *

So that model-making assignments can be more effectively undertaken within the Department, a small subsection of three experienced model-makers was established during 1970 under the control of the Road Design Engineer.

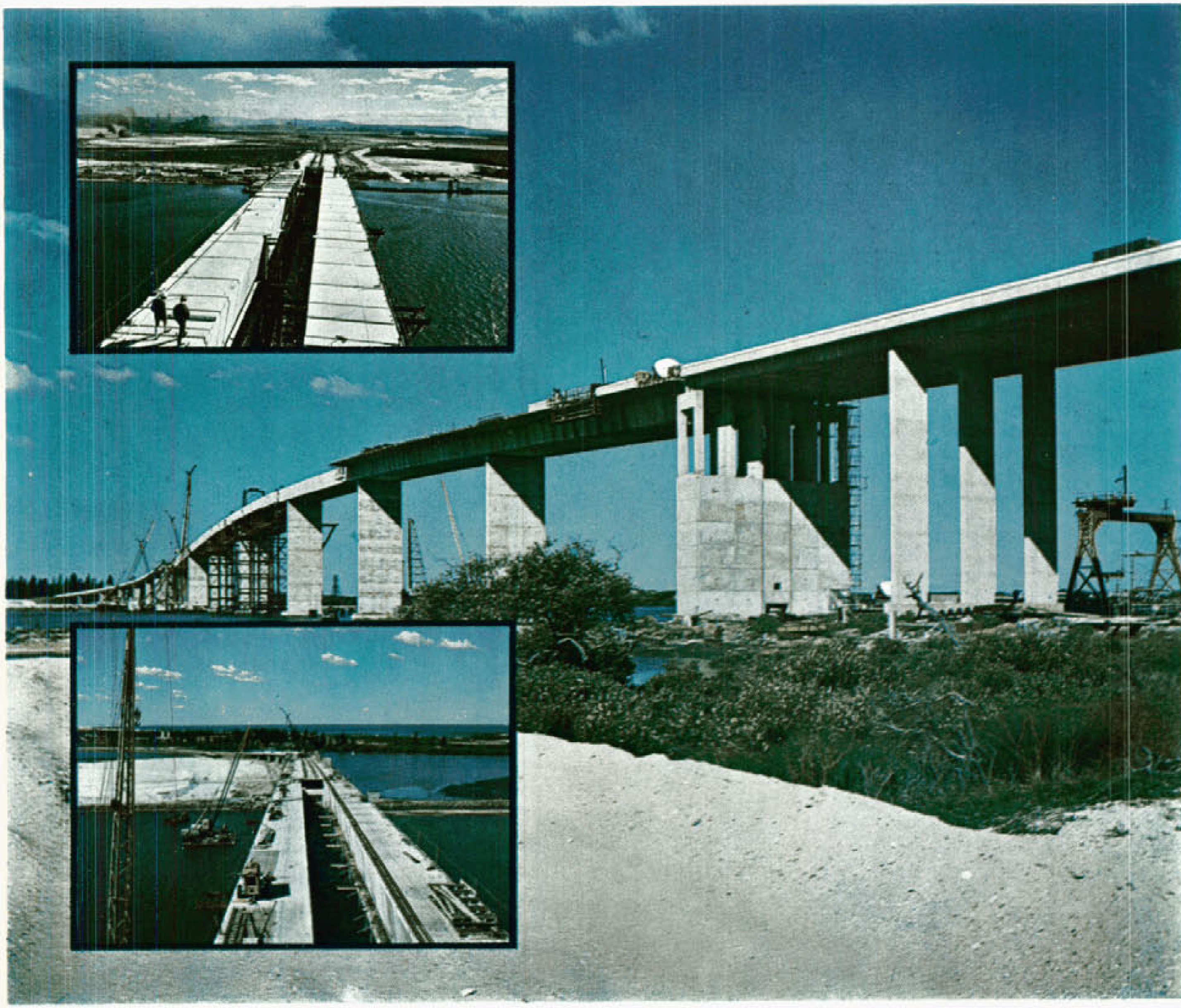
The Department's concern to adequately inform the public of its road and bridge proposals is reflected in these model-making activities. Many of the Department's construction projects are complex and scale model reproductions aid both technical and aesthetic appreciation of the proposals. These models graphically illustrate the Department's proposals to councils, other authorities and the general public and play an important role in their acceptance.

Recently, the Department's model-makers prepared a model to show in detail the section of the South Western Expressway which is now under construction between Cross Roads, near Liverpool and Maryfields, near Campbelltown. Arrangements are being made for this model, which shows interchanges and the overbridges where the Expressway crosses local roads, to be loaned to the State Planning Authority for display at their office in the Civic Centre at Campbelltown. In this way, local residents will be given the opportunity to see where this section of the Expressway is being located and what it will look like when completed. ●

HIGH AND WIDE OVER THE HUNTER

The huge proportions of the new bridge over the North Arm of the Hunter River, north of Newcastle, are now becoming apparent. The bridge will be 100 feet high at the centre and almost two-thirds of a mile "wide".

The insets below show views along the deck, looking west towards Kooragang Island (top) and east towards Stockton Peninsular (bottom). Two 2-lane carriageways, 26 feet wide, will be provided on the deck with a central footway between them.



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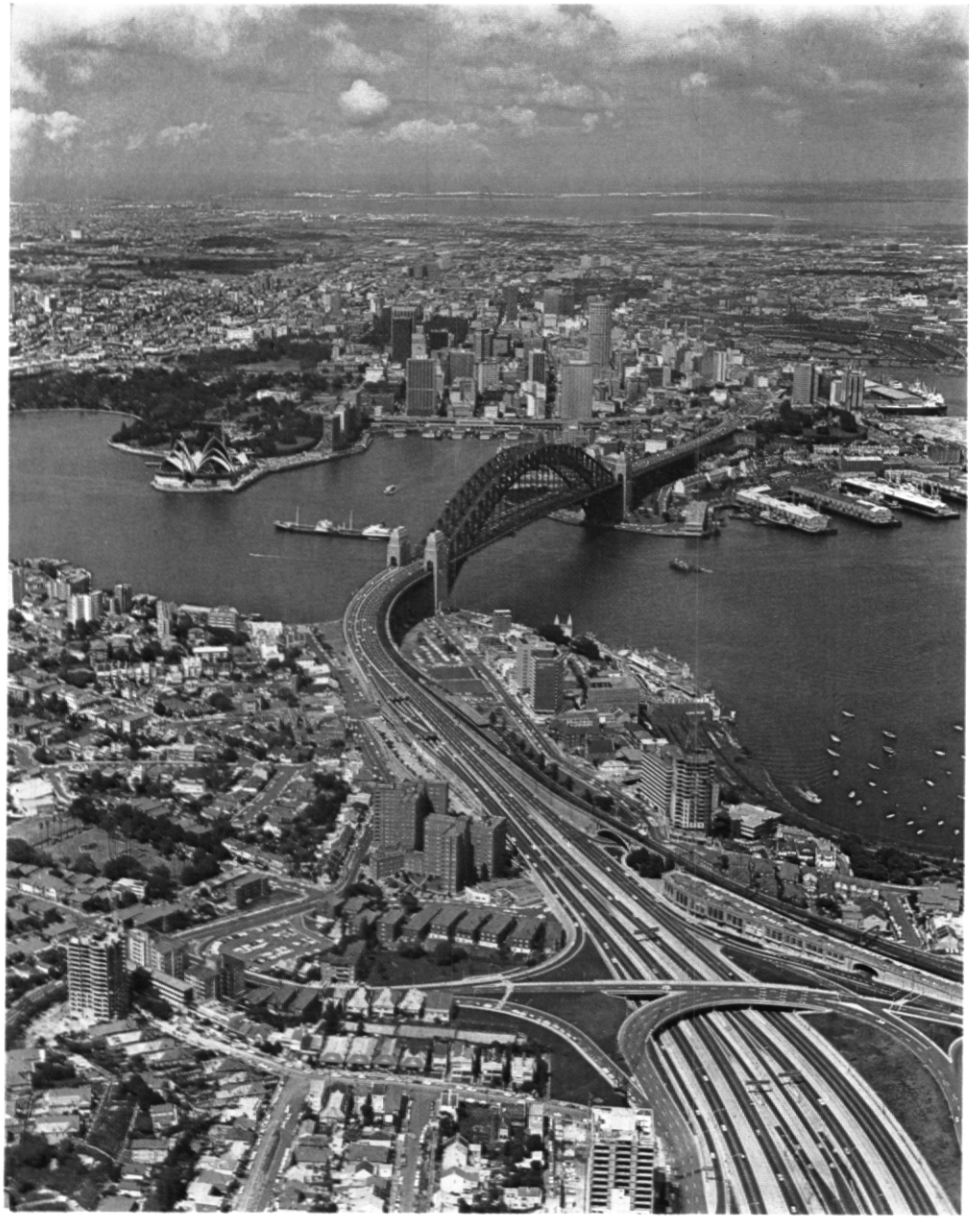
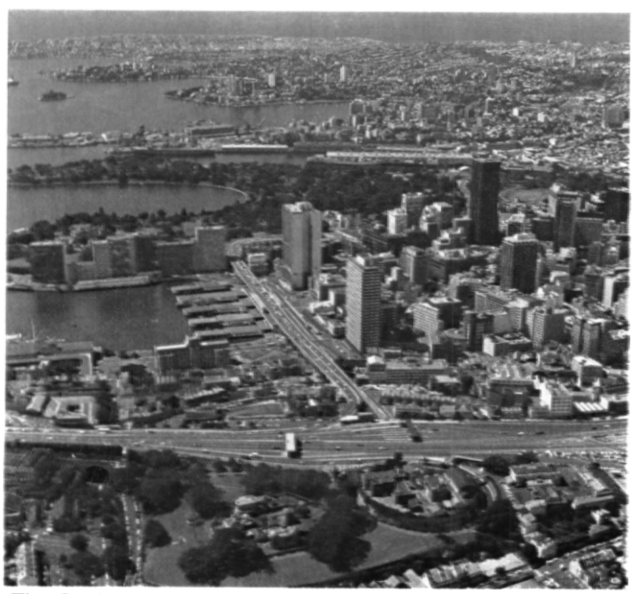


Δ *The Warringah Expressway — now as much part of the scene as Sydney Harbour Bridge and the Opera House.*

The vast state, throughout which the Department's activities are undertaken, has a varied landscape which reflects not only geographical contrasts but also the different social patterns of population density.

Nowhere are these differences more startling that between the crowded vitality of bustling urban Sydney and the solitude of stretches of near-empty country surrounding Wilcannia and Broken Hill. However dissimilar the scenery, the hot dusty work on the Barrier Highway, where the Department's "Rosehill Red" construction equipment blends with the red soil, is no less important than the building of multi-lane expressways close to the cool blue waters of Sydney Harbour.

The Department serves both the man in the country and the man in the city, amid their contrasting surroundings, and seeks to satisfy their mutual need for good roads.



The Cahill Expressway skirting Circular Quay — with the southern toll plaza of the Bridge in the foreground.

View showing the first section of the Western Distributor under construction.

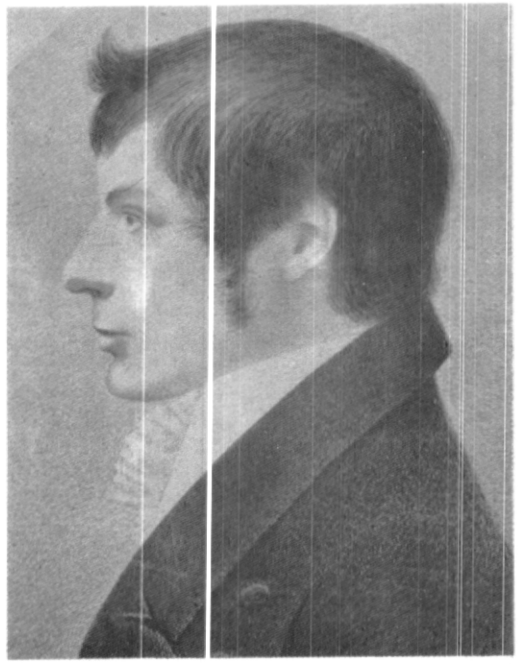
OUNTRY
RASTS

Δ *Reconstruction of the Barrier Highway through "McCullochs Range", east of Wilcannia.*

Δ *The Barrier Highway, 25 miles west of Broken Hill.*

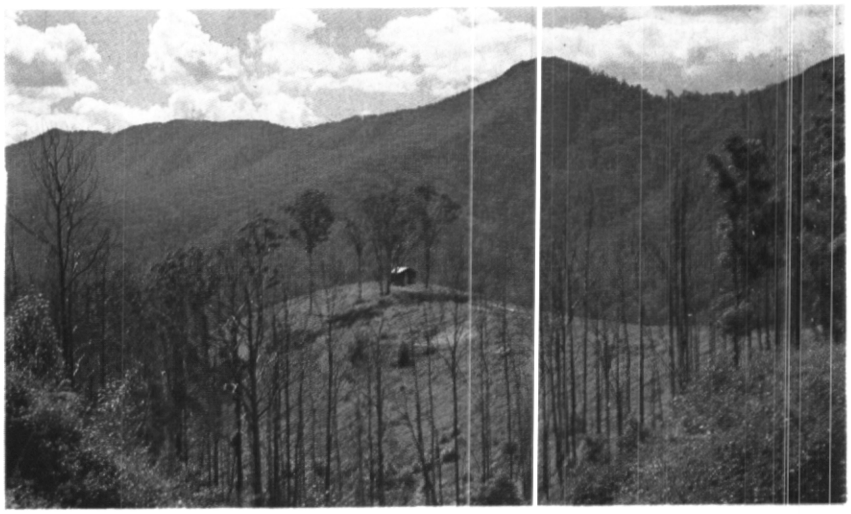
View showing where the Western Distributor will be extended along Darling Harbour.

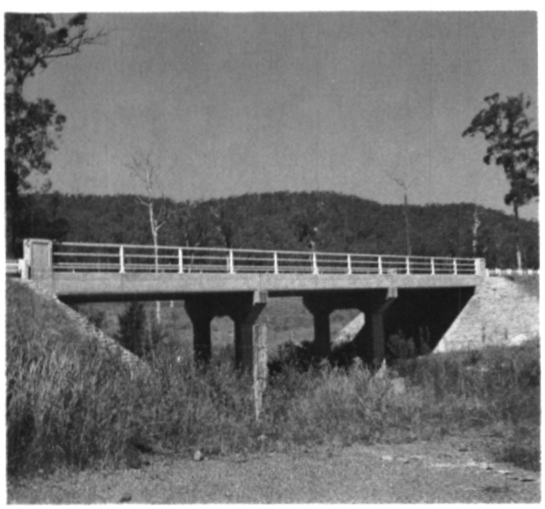
The Barrier Highway, 70 miles east of Wilcannia.

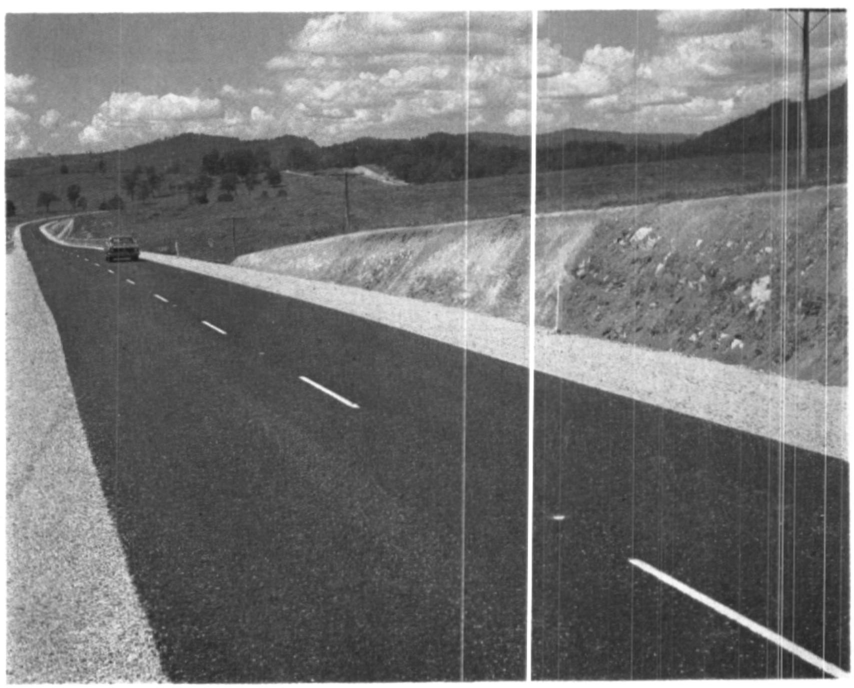


OXLEY HIGHWAY

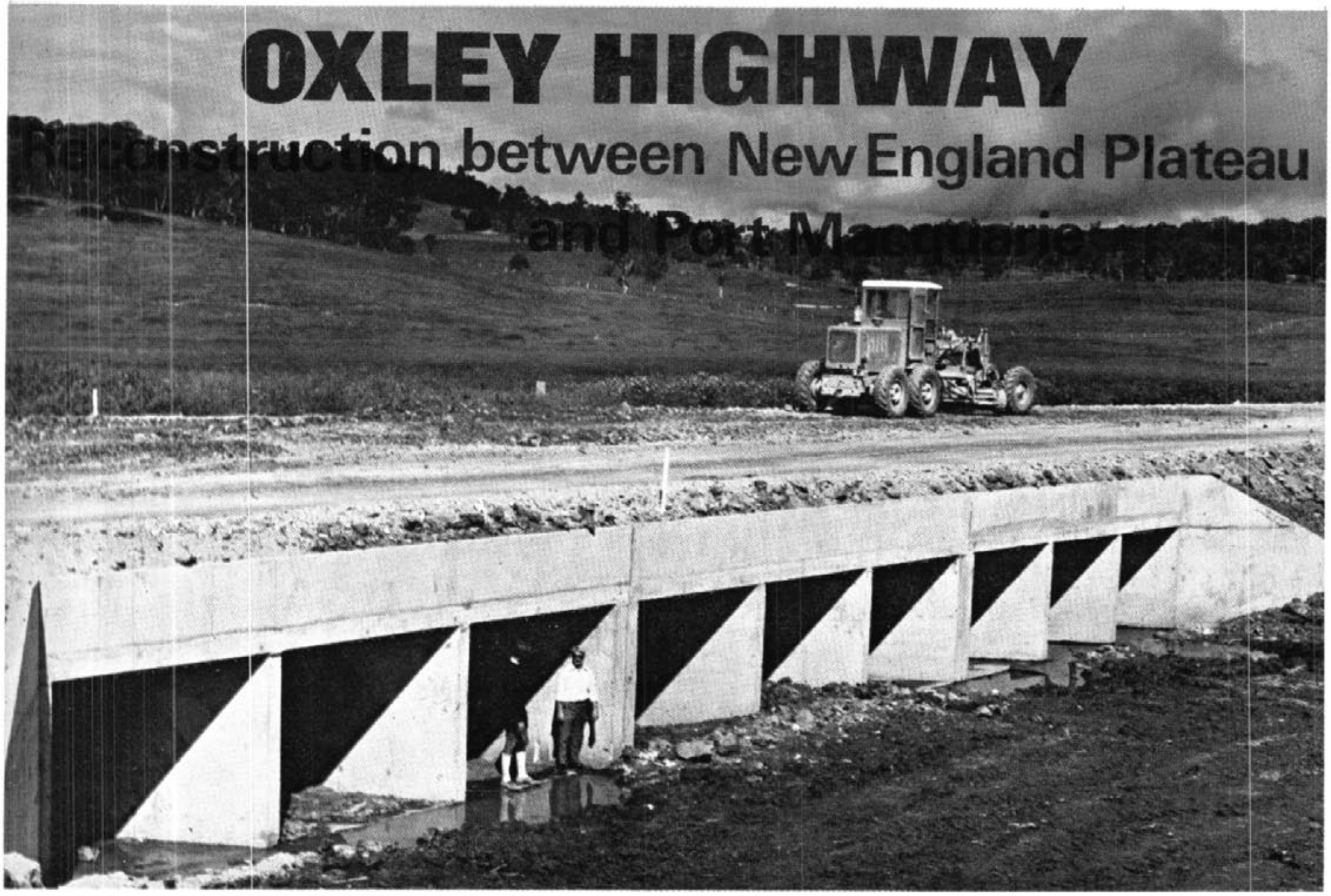
Top right:	*The man behind the name – John Oxley (1783–1828) naval officer, surveyor and explorer. – Reproduced by courtesy of Mitchell Library, Sydney.*
Top left:	*Reconstructed section east of Walcha.*
Centre right:	*Scene from Highway near Mt Seaview.*
Bottom right:	*Recently sealed section between Ellenborough and Yarras.*
Bottom left:	*Bridge over Gannon's Creek, between Wauchope and Ellenborough.*







OXLEY HIGHWAY
Reconstruction between New England Plateau and Port Macquarie



A nine-cell reinforced concrete box culvert at Tiara Creek, 19 miles east of Walcha

OXLEY'S JOURNEY AND EARLY ROAD DEVELOPMENTS

The present route of the Oxley Highway generally follows the route taken by John Oxley in 1818, when as Surveyor-General of New South Wales he was commissioned by Governor Macquarie to "prosecute the discoveries made to the westward of the Blue Mountains by George William Evans, Deputy Surveyor of Lands".

Oxley was accompanied by Evans, ex-surgeon John Harris, botanist Charles Fraser and twelve men. Setting out from Bathurst to discover an inland sea, the party was held up by the Macquarie Marshes and turned eastward. Oxley crossed the Moonbi Ranges north-east of Tamworth and followed the Great Dividing Range to the Apsley River where he camped on a grassy flat on which the town of Walcha was surveyed in 1852. Continuing eastward, he first saw the Pacific Ocean from a mountain which he appropriately named "Sea View" Oxley descended to the Hastings River valley and reached the coast at Port Macquarie, which he named. Of his descent from Mt Seaview he wrote "How the horses descended I scarcely know; and a bare recollection of the imminent dangers which they escaped makes me tremble."

As the Hunter River Valley was settled, and settlers extended the limit of occupation further north, the New England district received attention from squatters from 1832. The settlers in Port Macquarie, realizing the value of diverting the New England trade to their port began to interest themselves in the establishment of a good road between Port Macquarie and the interior.

In 1838 an announcement appeared in the Sydney press that a movement was being made at Port Macquarie to have a road to New England constructed, and a bullock track was developed over a period of years, largely by convict labour.

The earliest road was extremely steep and was used by bullock teams hauling the wool clips from the Inverell, Armidale and Walcha districts to Port Macquarie. The time of the journey varied greatly with the weather, the quickest journey recorded, from Tiara to Port Macquarie and return, a distance of about 200 miles, being twenty-two days and the slowest from Waterloo to Port Macquarie and return, about 220 miles, taking six months and five days.

Oxley's track continued to be a major outlet for the New England area until the Great Northern railway line was completed to Tamworth in 1878 and to Uralla in 1882. The road then ceased to be a significant through route, although the easterly portion continued to serve the Hastings Valley as a local road to Port Macquarie and the western portion carried traffic from sheep runs to the railway. The central section between Yarras and Yarrowitch was not maintained and became impassable in time. It continued to be neglected until the arrival of the motor vehicle and its development during the 1920's into a major means of transport.

Additional information on Oxley's journey and the early history of the route are given in the article "The Story of the Oxley Highway", published in the March, 1953 issue of "Main Roads" (Vol. XVIII, No. 3, pages 66–75).

PREVIOUS RECONSTRUCTION

In July, 1928, the Main Roads Board re-organized the State's Main Roads System into State Highways, Trunk Roads and Ordinary Main Roads. In this classification, Oxley's road was selected as a link in the State Highway System. As State Highway No. 11, it now commences at Port Macquarie and connects the main coastal and tablelands highways (the Pacific and New England Highways). Continuing westward and southward of Tamworth, it traverses the western slopes and plains to join the Mitchell Highway at Nevertire.

The initial reconstruction of the Oxley Highway was commenced in 1928 and was completed in 1935. The work comprised the construction of a new mountain road forty miles long between Yarras and Yarrowitch and the reconstruction of other sections between Port Macquarie and Yarras and between Yarrowitch and Bendemeer.

A detailed account of this work is given in an article entitled "The Reopening of the Oxley Highway from the New England Plateau to Port Macquarie" which appeared in the August, 1933 issue of "Main Roads" (Vol. IV, No. 12, pages 170–183). A supplementary article entitled "Locating the Tobin's Creek Deviation" was published in the May, 1934 issue (Vol. V, No. 3, pages 62–64). The Department has also in its 16 mm film library a black and white, silent film which was produced in 1930 by the Main Roads Board and shows the construction of the 21 mile-long Tobin's Creek Deviation, between Yarrowitch and Yarras.

The more heavily used lengths were sealed with tar or bitumen but the pavement was generally left unsealed. The standard of construction provided a two-lane road suitable for the traffic of that time.

From 1939 to 1953 the Department's resources were used firstly on defence work and secondly in reconstructing other roads which were judged to have a higher priority. Consequently, no major work was carried out on the Oxley Highway during this period.

Between 1953 and 1959, several lengths of pavement were strengthened by the addition of gravel along the existing alignment and then bitumen sealed so that, by 1959, a dust-free pavement extended from Port Macquarie to the junction with the Comboyne Road (Main Road No. 112) and from Bendemeer to Walcha.

PRESENT RECONSTRUCTION PROGRAMME

In 1963 a programme was initiated for the reconstruction of those sections of the Oxley Highway in the Shires of Hastings and Walcha which had not yet been sealed with bitumen. These sections had a length of 95·7 miles, 49·2 miles being within the Hastings Shire and 46·5 miles within the Walcha Shire. The work fell into three separate and distinct divisions as follows:

1. Along the Hastings River Valley from Main Road No. 112 (approximately 7 miles west of Wauchope) to Ralfe's Creek (approximately 2 miles west of Yarras).
2. Across the tablelands from near Mt Seaview to Walcha.
3. Climbing the escarpment of the Great Dividing Range from Ralfe's Creek to near Mt Seaview.

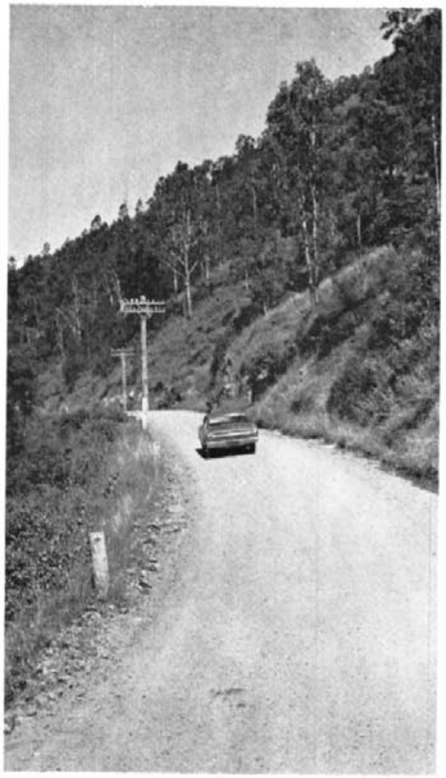
Along Section 3 the road rises 3,500 feet in 20 miles. The grade is relatively constant at 5 per cent and the alignment is winding with many small radius curves. The country is rough and mountainous and in view of the difficulties involved in improving the alignment, the existing line, which had been constructed between 1928 and 1935 was retained. The road has been improved by widening the formation, strengthening the pavement with gravel and flush sealing with bitumen. This work was commenced in 1963 and by 1968 the full length of 20 miles had been completed.

Reconstruction of Section 1, where the road follows the Hastings River Valley, was commenced in 1963 at the junction with Comboyne Road (Main Road No. 112) and has extended in a westerly direction from year to year until it has now reached Yarras.

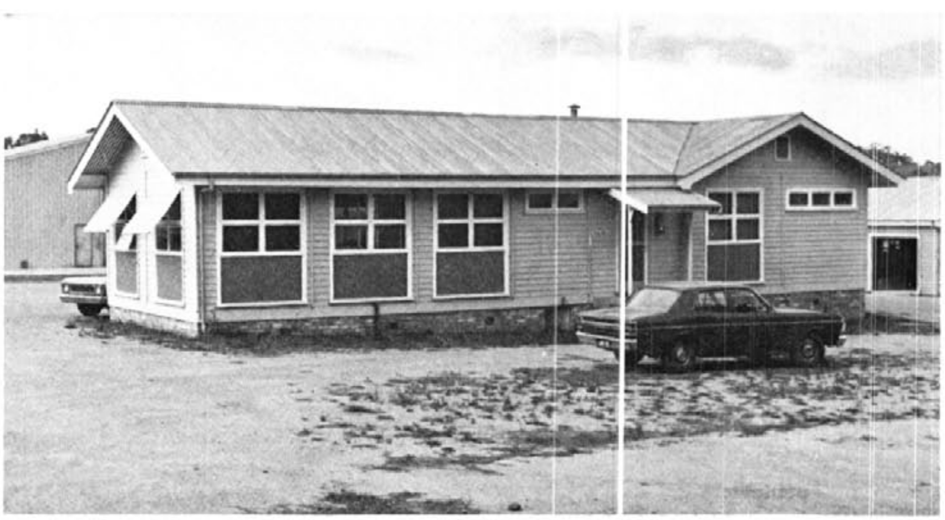
The Department commenced the reconstruction of Section 2 east of Walcha in 1966, and, in a similar manner to the work on Section 1, the bitumen-sealed pavement has been extended each year in an easterly direction to the vicinity of Tia River, 20 miles east of Walcha.

* *See map on page* 119.

Section of highway near Yarras, prior to reconstruction



Department's Works Office at Walcha



STANDARD OF DESIGN

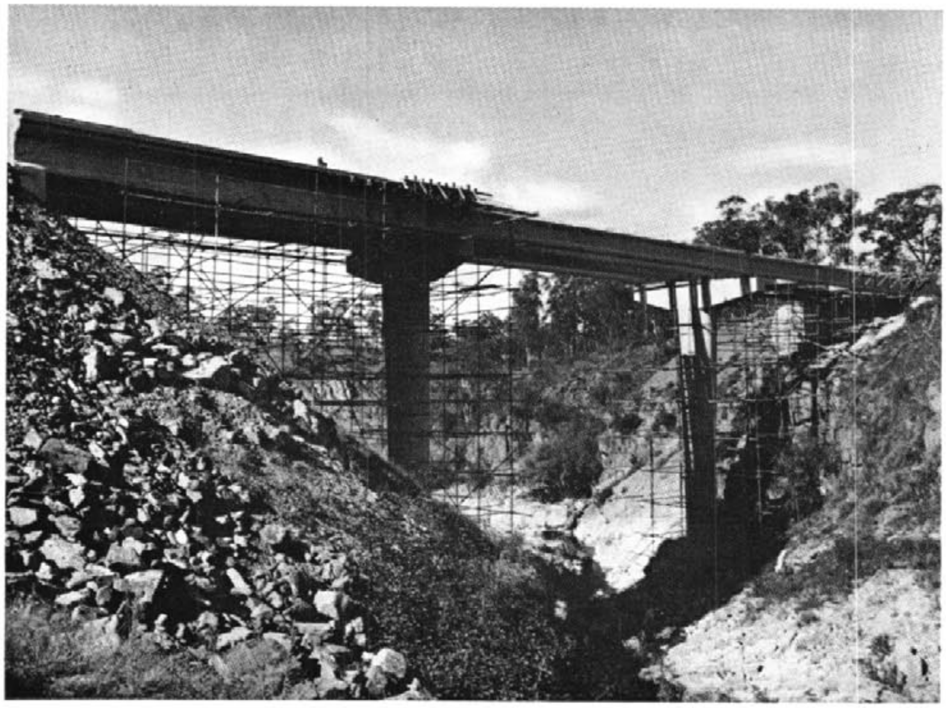
The standard of design adopted in the work carried out between 1928 and 1935 has become generally unsuitable for present day motor vehicles. Consequently with the exception of the section from Ralfe's Creek to near Mt Seaview, where, as mentioned above, the existing alignment has been retained, the new road has been designed to a higher speed standard. Generally, a 60 mph design standard has been adopted with short transitional sections of 50 mph and 40 mph standard on the approaches to the mountain section. A sealed pavement width of 22 feet on a 34 feet wide formation has been provided, again with the exception of the mountain section on which the pavement width is 20 feet.

ORGANIZATION AND EQUIPMENT

When reconstruction of Section 1 along the Hastings River Valley was commenced in 1963 the work was supervised from the existing Works Office at Port Macquarie. Section 3, up the escarpment, which was started shortly afterwards, was also constructed by the Port Macquarie organization. In 1966 another Works Office was established at Walcha to undertake the construction of Section 2 through the tablelands east of Walcha.

Up to 1966, work on these sections of the Highway was divided between the Department's Lower Northern (now the Hunter Valley) Division at Newcastle, which included the Hastings Shire, and the North Western Division at Tamworth, which included the Walcha Shire. On 27th June, 1966, a Divisional Office was established at Port Macquarie as the administrative headquarters of the new Lower North Coast Division. Since then the work on these sections of the Highway has been supervised by the Divisional Engineer at Port Macquarie. The late Mr H. J. Vant was the Divisional Engineer from 28th June, 1966, until his death on 19th September, 1968, and Mr T. P. Desmarchelier has held the office since 6th November, 1968.

The construction organizations based at Walcha and Port Macquarie each has an average of forty men employed on this work and is equipped with basic Departmental plant such as medium tractors, graders, rollers and compressors. These plant items are supplemented as required by hired plant, such as self-propelled scrapers, heavy tractor-dozers and other heavy duty or specialized equipment. Similarly haulage is carried out, as required, by hired contract lorries.



Construction of bridge over Stony Creek, 15 miles east of Walcha

PROGRESS OF WORK

Work has been in progress continuously since 1963, and the length of unsealed pavement between Wauchope and Walcha has been reduced from 95·7 miles to 37·1 miles; 4·6 miles being in the Hastings Shire and 32·5 miles being in the Walcha Shire. An average annual length of 7·33 miles of completed road has been achieved.

Construction is currently in progress on a further length of 7·6 miles.

STRUCTURES

The bridges and larger culverts along the old road are mainly timber with narrow decks and are unsuitable for incorporation in the new route. Two steel truss bridges over Deep Creek and Ralfe's Creek (which flow into the Hastings River) have been retained but all other bridges have been or will be replaced.

The following bridges and bridge-size box culverts have been completed to date:

Between Port Macquarie and Yarras

- *King Creek*—2 miles east of Wauchope. A six-span concrete bridge, 237 feet long, was completed in 1970 to replace a narrow concrete bridge on inferior alignment.
- *Gannon's Creek*—21·2 miles west of Port Macquarie. A four-span steel and concrete bridge, 180 feet long, was completed in 1965.
- *Hyndmans Creek*—22·1 miles west of Port Macquarie. A three-span steel and concrete bridge, 180 feet long, was completed in 1966.
- *Moripo Creek*—24·6 miles west of Port Macquarie. A three-span concrete bridge, 106 feet long, was completed in 1967.
- *Rushers Creek*—38·0 miles west of Port Macquarie. A three-span concrete bridge, 80 feet long, was completed in 1965.
- *Yarras Creek*—44·5 miles west of Port Macquarie. A three-cell 11 feet x 11 feet concrete box culvert was completed in 1970.

Between Walcha and Yarras

- *Mainey's Creek*—5·7 miles east of Walcha. A three-span bridge, 182 feet long, was completed in 1969.
- *Blackfellows Gully*—7·3 miles east of Walcha. A six-cell 10 feet x 7 feet concrete box culvert was completed in 1968.
- *Reedy Creek*—9·9 miles east of Walcha. A two-span bridge, 50 feet long, was completed in 1963.
- *Stony Creek*—15·2 miles east of Walcha. A three-span bridge, 190 feet long, has just been completed.
- *Tiara Creek*—19·0 miles east of Walcha. A nine-cell 9 feet x 7 feet concrete box culvert has just been completed.

In addition, six other bridge-size box culverts over 20 feet long have been constructed.

EARTHWORKS

Heavy earthworks have been necessary to achieve the required grading. The deepest cut is 43 feet and the highest fill is 45 feet. The total quantity of earthworks completed since 1963 is as follows:

Wauchope to Yarras	1,190,000 cubic yards
Walcha to Yarrowitch	860,000 cubic yards
Total	2,050,000 cubic yards

The average quantity of earthworks is 34,300 cubic yards per mile.

The major proportion of earthworks has been rippable and has been loosened by heavy tractors with rear-mounted rippers, then hauled by self-propelled scrapers which have been push-loaded by tractors.

The remainder of the earthworks (i.e., 307,500 cubic yards or about 15 per cent of the total quantity) has been drilled with track-mounted drills and loosened with explosives, mainly Ammonium Nitrate-Fuel Oil and AN60 gelignite.

The type of rock varied with the location. Conglomerates and serpentine were encountered west of Wauchope, while slate was found east of Walcha.

PAVEMENT MATERIALS

Over the full length which has been reconstructed to date, good quality base-course material has been located in the rock cuttings as construction has proceeded. Conglomerate gravel has been used as a surface course west of Wauchope, while granite gravels have been used east of Walcha.

TESTING OF MATERIALS

Testing of materials and field tests of completed work are carried out regularly by the staff from the testing laboratory at Port Macquarie.

The height of fill ranges up to 45 feet and to ensure that proper compaction has been achieved, in order to reduce future settlement, density-in-situ tests are carried out as a matter of routine.

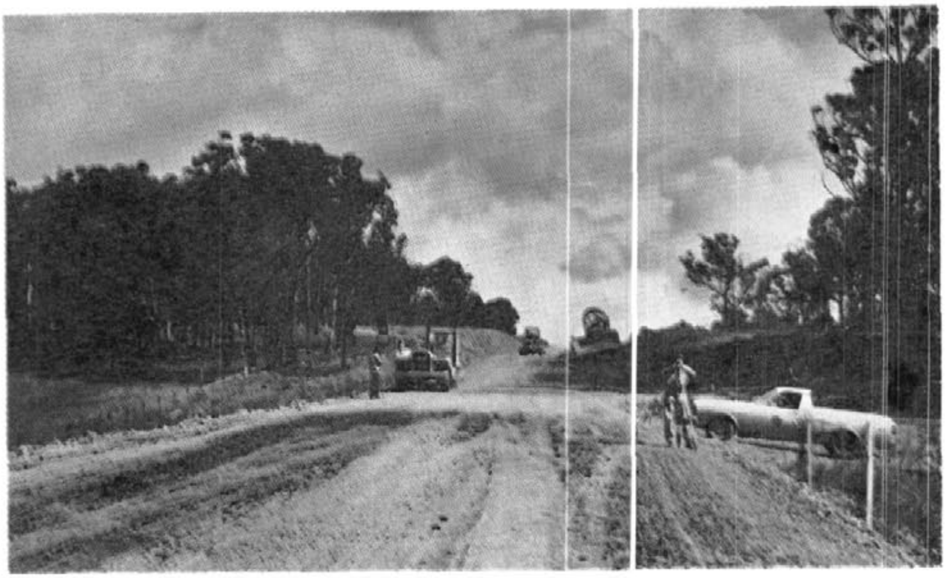
Samples of all pavement materials, both base-course and surface-course, are taken from the deposits and from the finished pavement. These are then tested to ensure compliance with the Department's specifications.

EXPENDITURE

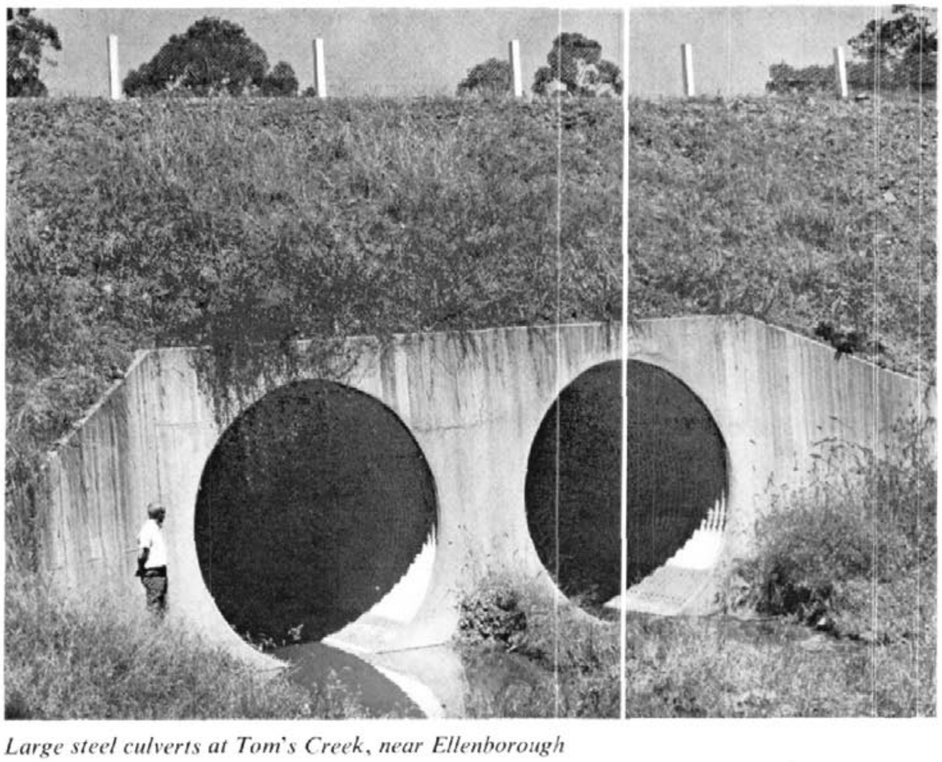
Since the commencement of the current reconstruction programme, expenditure has amounted to $7,441,036. Details of annual expenditures are given below, and include expenditure on both roadworks and bridgeworks:

	$
1962–63	84,081
1963–64	171,366
1964–65	406,132
1965–66	604,458
1966–67	855,835
1967–68	940,665
1968–69	1,240,064
1969–70	1,608,435
1970–71 (estimated) ..	1,530,000
Total	$7,441,036

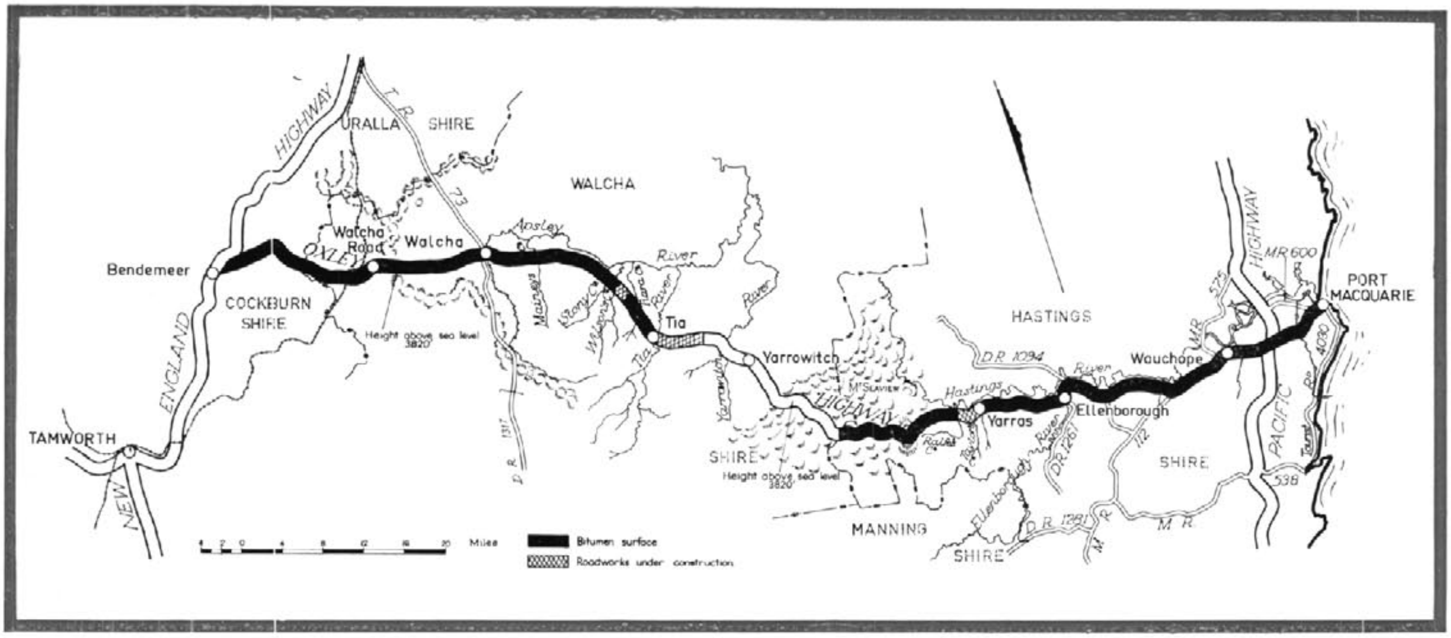
Good progress has been made in this important project, and it is expected that reconstruction will continue to advance at the present rate until there is a modern all-weather bitumen surfaced road between Wauchope and Walcha. When reconstruction is completed, this section of the Oxley Highway will become a valuable asset to a large area of the State by providing another major sealed link between the western slopes and plains, and the coastal districts. It will not only contribute to the easier and faster movement of goods but will also open up a particularly interesting and scenic route for the increasing tourist traffic.



Earthworks on deviation near Tia



Large steel culverts at Tom's Creek, near Ellenborough



OXLEY HIGHWAY—Notes for tourists

On page 114 and the back cover of this issue are shown some of the attractive and colourful scenes to be seen from along the Oxley Highway between Walcha and Port Macquarie. The following article gives details and *background* notes of these and other sights which motorists might be interested to stop and view when they next visit the New England-Port Macquarie area.

● WALCHA

In the township of Walcha, there is a stone cairn with the following inscription.

"John Oxley
Surveyor General
on his journey of
exploration to the coast
camped approximately
1 mile S.E. of here
8th September, 1818.
Walcha Historical Society".

This cairn was built by the Walcha Apex Club and unveiled by the Federal Member for New England, Hon. Ian Sinclair in April, 1964. In his journal Oxley recorded on September 8th: "we proceeded . . . through the finest open country, or rather park, imaginable. We halted in a fine and spacious valley . . . watered by a fine brock" (the Apsley River).

Walcha's first settler, H. C. Semphill, arrived in 1832, from Belltrees, in the Hunter River District. The track over the Moonbi Ranges had been pioneered the year before by E. C. Cory of the Paterson River, but it was Semphill who occupied the valley described in Oxley's journal, and made his headquarters near the site of the explorer's old camp, naming his squattage Walcha (Wolka). Walcha is of aboriginal origin and means "Sun".

In 1844 Semphill's Walcha run was bought at auction by D. W. Jamieson and J. McKenzie, and Jamieson resided there for the remainder of his life. Jamieson could justly be called the "founder" of Walcha township for it was he who, during the early years of his occupancy, caused to be erected the various "industrial" structures (flourmill, store, smithy, etc.) which, in the 1850's, formed the nucleus of the village. Walcha was gazetted a town in 1852 and proclaimed a municipality in 1889.

The Walcha district is one of the most elevated sheep- and cattle-producing areas in Australia (3,500 feet to 4,500 feet above sea level) and holds particular interest to graziers and agriculturists because it was here on 1st February, 1950, that *aerial agriculture* in Australia was first introduced. A successful spread of superphosphate was dropped from a Tiger Moth aeroplane piloted by the late Captain B. McKenzie. The drop was made over the property "Mirani" for the late Mr A. S. Nivison, and initiated a technique which has proved to be invaluable in the development of the pastoral industry in Australia. The Tiger Moth, VH-PCB, was donated later to Walcha Historical Society by Aerial Agriculture Pty Limited, and is now housed in a hanger at the Society's Pioneer Cottage and Museum at Walcha.

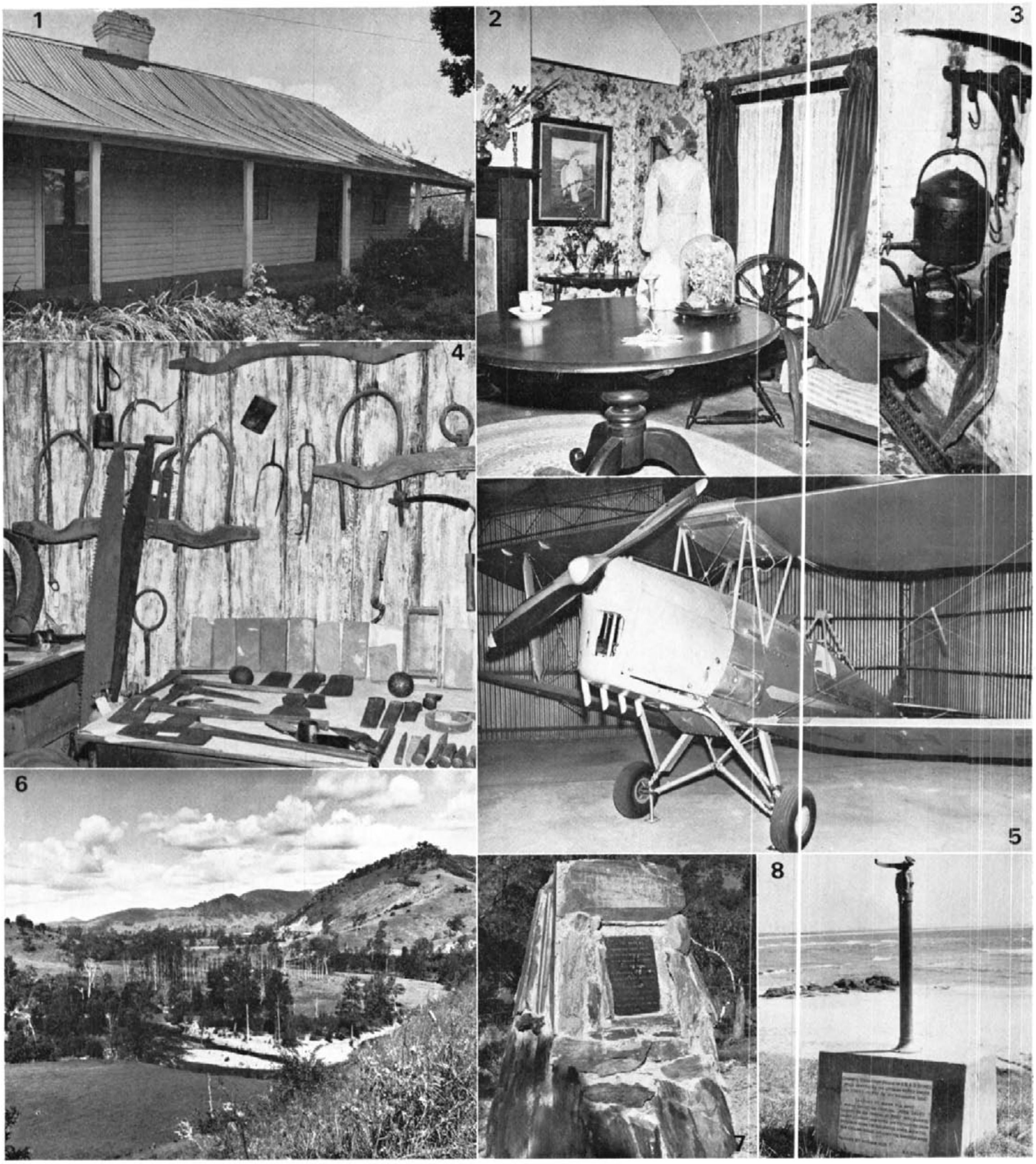
The Pioneer Cottage, which is about 100 years old, has been reconstructed and furnished in the style of a typical pioneer's home of the last century. A shed at the rear of the cottage houses old agricultural machinery and implements, while in the garden section an old stringybark tree has been erected to show the carvings made on it by the aborigines of this area. The cottage is open for inspection between 11 a.m. and 4 p.m. on weekdays, on payment of an entrance fee.

● APSLEY FALLS

Twelve miles east of Walcha, on the north side of the Highway, are the Apsley Falls. The first fall is 375 feet and the second, which is about ½ mile further on, drops 640 feet. Although Oxley was hampered by the district's precipitous gorges, he was enthusiastic about the many magnificient falls in the area. However, differences between his journal and chart make their identification confusing. Never the less, it seems that his entry for 15th September, 1818 applies to the Apsley Falls. It "so far surpassed anything which we had previously conceived even to be possible, that we were lost in astonishment . . ." The falls and river "were respectively named Bathurst and Apsley, in honour of the Noble Secretary of State for the colonies".

In 1961, the Lions Club of Walcha erected a stone cairn near the Falls with a plaque commemorating Oxley's discovery. A steel stairway (replacing wooden steps built in 1902) and a look-out were also constructed to enable visitors to view the Falls in safety. The adjacent area has been named the John Oxley Park and provided with picnic amenities.

1, 2, 3—Pioneer Cottage and Museum at Walcha showing sitting room and kitchen. 4, 5—Pit saws, shingling axes, yokes from bullock drays and convict-made bricks are on display, as well as the first aeroplane used in Australia for the aerial distribution of superphosphate. 6—View from Highway as it descends into Hastings Valley. 7—Oxley memorial at Apsley Falls. The plaque, erected by public-spirited people, has been disfigured by those less concerned and shows the scars of irresponsible shooting. 8—Memorial at Town Beach, Port Macquarie



● TIA FALLS

Approximately 10 miles further east and about $3\frac{1}{2}$ miles north of the Highway (and rather difficult to locate) are the Tia Falls on the Tia River, which Oxley appears to have named Croker's River on 16th September, 1818.

● YARROWITCH

About 1836, John and Francis Allman (sons of Captain Francis Allman, first commandant of the Port Macquarie penal settlement, 1821–1824) became the first settlers in this district.

There is still an area of Yarrowitch, known as Public House Flat, where a small inn, erected by Major Archibald Clunes Innes, once stood. It is reputed to have been used at night to lock up the convicts working in chain gangs on the road.

● YARRAS

Major Innes, who had previously been Commandant at Port Macquarie in 1826–27, returned to the area in 1830. He soon acquired extensive properties and stock, including an inn and stock station at "The Yarrows", now Yarras. He was apparently instrumental in having convict labour used to build the old Wool Road (now the Oxley Highway) between Port Macquarie and properties on the New England tableland.

Early in 1842, the first bales of wool were shipped to Sydney from Port Macquarie after a "short" 10 day journey in drays from Innes' station at Yarras—a saving of nearly 3 weeks compared with the usual dray journey to Maitland.

● HASTINGS VALLEY TO WAUCHOPE

East of Yarrowitch the highway descends the Great Dividing Range, passing near Mt Seaview to the north. This is probably the most beautiful section of the Highway as it drops through fern-studded rain forests into the lovely Hastings Valley. It then follows the Hastings River to Yarras, Ellenborough, Wauchope and Port Macquarie.

Oxley was again responsible for the naming of the main geographical points of interest. In his journal he noted that on 23rd September, 1818, he and Evans climbed a tall peak and "on gaining the summit . . . we beheld Old Ocean at our feet: it inspired us with new life: every difficulty vanished and in imagination we were already at home . . The mountain from whence we first saw the ocean was named Sea view Mount". On 26th September, the Hastings River was named "in honour of the Governor General of India" and on 29th September, they reached "a fine stream from southward . . . We crossed and named it Ellenborough River, in honour of the Chief Justice of England." On October 4th, Oxley came upon another stream which was named King's River (now King Creek) "after my friend, who is now surveying the coast of this continent". This was Phillip Parker King, 1794–1856, (eldest son of the third governor of New South Wales) who carried out exploratory coastal surveys and became the first Australian to attain the rank of admiral in the Royal Navy.

● WAUCHOPE

This name and its association with the present town is linked with the family history of Captain Robert Wauch, 1786–1866, who, on retiring from the army in England, brought his family to New South Wales in 1836. He purchased over 4,000 acres of land near King Creek and called his property "Wauchope". This had been the family name prior to a legal battle over estates which his father lost and subsequently, in bitterness, deleted the letters "ope" from his own name. When opening a post office in the vicinity in 1881, postal authorities officially adopted the name of the property.

● PORT MACQUARIE

On 8th October, Oxley and his party reached the mouth of the Hastings River ". . . after twelve weeks travelling over a country exceeding 350 miles, in a direct line from the Macquarie River . . . We pitched our tent upon a beautiful point of land . . . commanding a fine view of the interior of the port and surrounding country." On 11th, Oxley noted: "I named this inlet, Port Macquarie, in honour of His Excellency the Governor, the original promoter of these expeditions".

Port Macquarie has many interesting historical sites, including one with which we can appropriately conclude this article on the Oxley Highway. On a rise looking out to Town Beach is a memorial which commemorates an unusual combination of events. The plaque reads "Compass stand from bridge of H.M.A.S. Sydney which destroyed the German raider Emden at Cocos Island on 9th November, 1914. Erected to mark the spot where Surveyor-General John Oxley camped on his arrival at Port Macquarie on 8th October, 1818, after his expedition from Bathurst, down the Macquarie River, over the New England Range, and down the Hastings River. Unveiled 8th October, 1929. A. C. Elliot—Mayor" ●

UNUSUAL BRIDGE

There are so few suspension bridges still remaining in New South Wales that it is probably well worth a short "side-trip" to see one.

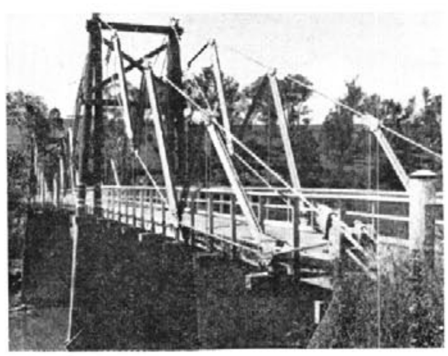
A short distance along Developmental Road No. 1094, which joins the Oxley Highway (from the north side) just east of Ellenborough, is a 369 feet-long suspension bridge spanning the Hastings River at Kindee Crossing.

The bridge is of the trussed cable type and has three spans of 88 feet, 220 feet and 88 feet respectively. The piers, abutments and deck are all of timber, the deck being supported throughout by hangers attached to the braced cables. The cables are plough steel wire ropes and are anchored to concrete blocks buried in the approach embankments.

The bridge was designed by the Department and steelwork was supplied by Messrs Morison and Bearby of Newcastle. Timber was supplied by Mr R. McMillan of Long Flat, via Wauchope. The contractor for the construction, Mr R. B. Haydon, was killed in an accident at the site in April, 1936 and the work was subsequently completed by the Department's own forces. The bridge was officially opened on 19th December, 1936 and the total cost, including approaches, was approximately \$10,000.

As the bridge was intended primarily to serve farms along Kindee Creek and as no through traffic was contemplated, a light single-lane structure was considered adequate.

For those seeking more technical information, full details of the design of this bridge were given by Messrs V. Karmalsky and A. T. Britton, of the Department's staff, in a paper presented to the Sydney Division of the Institution of Engineers, Australia, and published in Volume XVIII (December, 1937, pages 463–471) of the Institution's Transactions ●



CHANGES FOR "CROSS" TRAFFIC
Proposed new bridge at Kings Cross

A major step was taken to relieve traffic congestion at Kings Cross when tenders were invited during February, 1971 for the construction of the first structure in connection with the Department's Kings Cross road project. This structure will be a two-span 90 feet long, prestressed concrete bridge, which has been designed by the Department.

The whole project, which will be implemented in stages, will consist of a four-lane roadway for through traffic leaving William Street, near Dowling Street and joining Bayswater Road east of Nield Avenue. The Bayswater Road junction has been integrated with the layout of the Eastern Suburbs Railway in this area. The roadway will pass under Victoria Street and emerge approximately 800 feet to the east under the new bridge.

The new bridge will form the eastern portal of the tunnel and will have four traffic lanes and two footways. Together with a new road at Craigend Place, it will provide a direct access from Craigend and Surrey Streets to Bayswater Road and Kellett Avenue.

Preliminary works, including the southerly extension of Kellet Avenue from Bayswater Road to Kings Cross Road, were commenced by the Department at the end of 1970. While the bridge is being built a temporary road will be provided to carry traffic around the construction site.

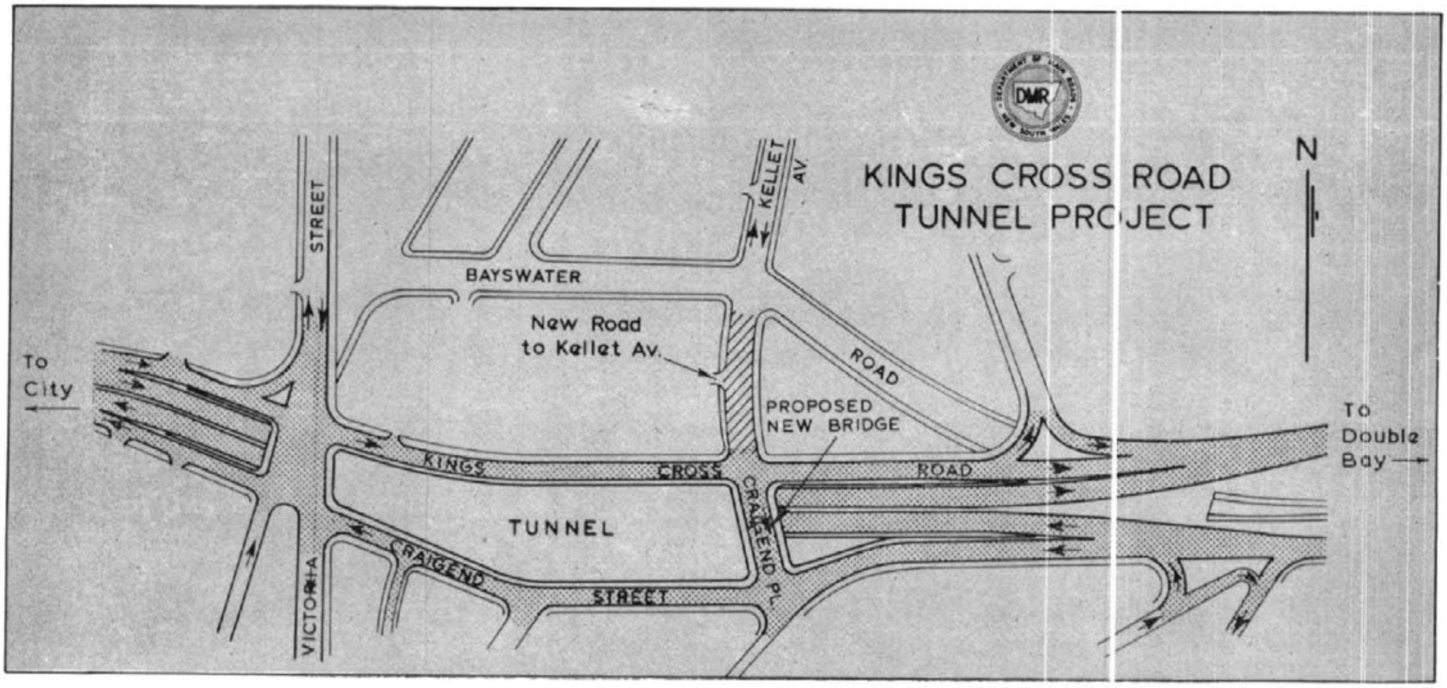
The calling of tenders for this bridge is the culmination of nearly two years of negotiations with property owners in the area. Ninety percent of acquisitions of properties required for the project have been completed and over half of the properties have been demolished.

The Department's Kings Cross road project will change the traffic pattern in and around Kings Cross by providing high standard road facilities for through traffic and considerably improved conditions for local traffic.

*

A short, illustrated article and an editorial on this project appeared in "Main Roads"—March, 1969, Vol. 34, No. 3, pages 73–75.

Artist's impressions and a "photo-mosaic" model of the project are on display in the Model Room at the Department's Head Office (Third Floor) ●



$5 MILLION EXTENSION FROM SOUTHERN CROSS DRIVE

During January, 1971, plans were announced for a $5 million extension from Southern Cross Drive at Wentworth Avenue, Botany to General Holmes Drive, Mascot.

Southern Cross Drive was completed and opened to traffic on 13th October, 1969 and, in conjunction with the widening of South Dowling Street as far as Flinders Street, Darlinghurst, it has provided an excellent traffic route along the eastern side of Sydney, leading towards the Sydney (Kingsford Smith) Airport.

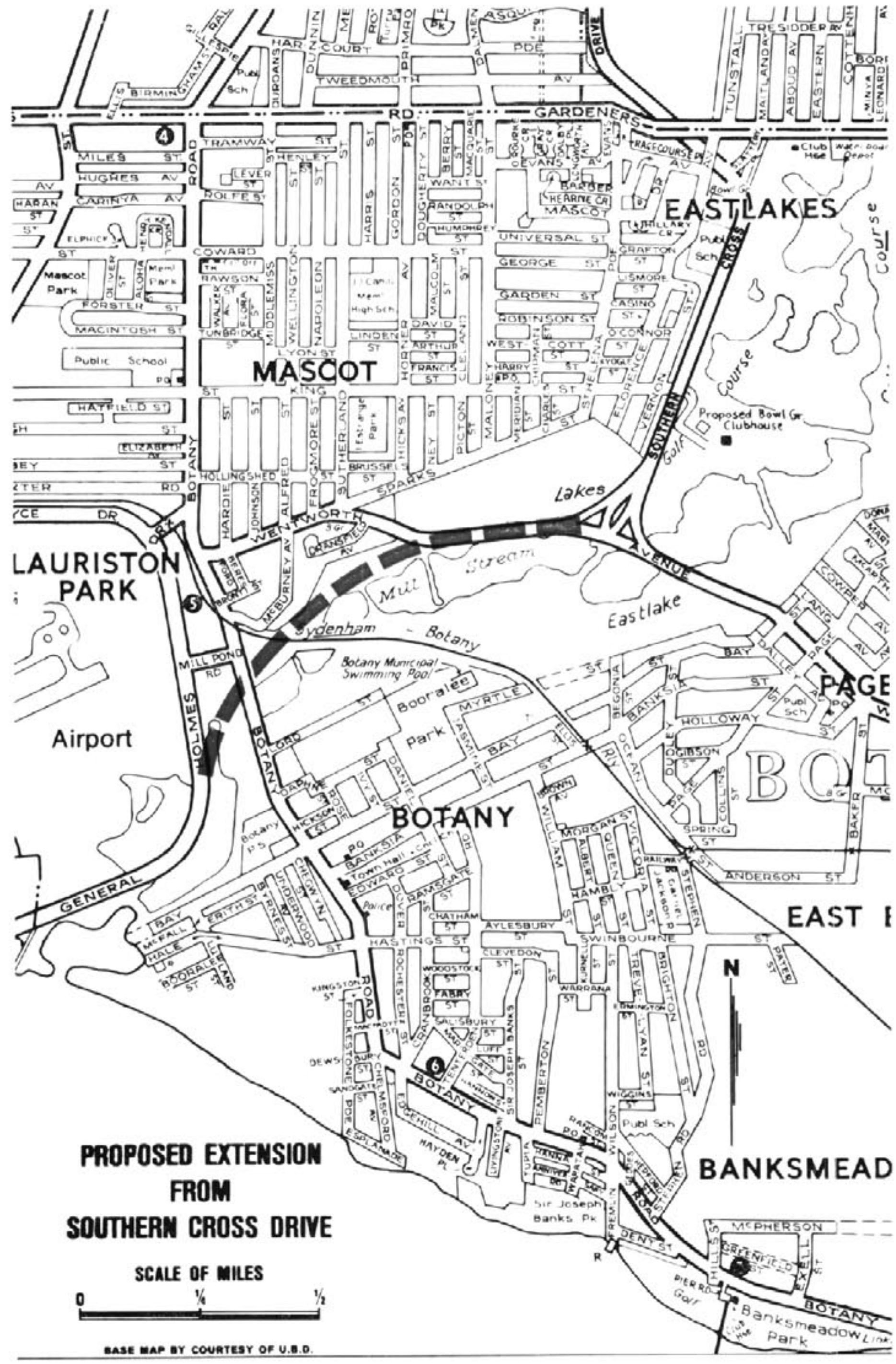
The work now proposed by the Department provides for an extension of the new road from Wentworth Avenue to the southeastern corner of the airport. It will involve crossings of the railway line and Botany Road. The Department plans to construct bridges at these crossings as well as interchanges at the junctions with General Holmes Drive and Wentworth Avenue.

The Department is proceeding with the design for this extension with a view to commencing as soon as practicable. Construction of the work will be complicated because of the influence of the adjacent airport and its requirements for aviation, and because of the low lying area which has to be traversed.

The Department will co-ordinate its design and construction activities with the relevant authorities and it is expected that structural work for the bridges will commence in 1972.

Completion of the work will assist travellers on General Holmes Drive by alleviating traffic congestion which occurs at the northern end of General Holmes Drive during peak traffic periods. It will also facilitate the movement of traffic to the South Coast pending the construction of the Southern Expressway which is planned as the ultimate route between Sydney and Wollongong.

Articles on Southern Cross Drive have appeared in "Main Roads" issues June, 1969, December, 1969, and September, 1970.



PROPOSED EXTENSION FROM SOUTHERN CROSS DRIVE

STABILIZATION OF CRUSHED SLAG WITH IRON OXIDE
for top course pavement construction

This article describes the investigation of the stabilization of crushed blast-furnace slag with an iron oxide dust, both materials being by-products of steel works. Following this investigation stabilized crushed slag was successfully utilized for top course pavement construction and this resulted in worthwhile savings to the Department in connection with road works carried out in and around Wollongong.

Slag is a by-product resulting from the refining of metals from their respective ores. In iron and steel works, a blast-furnace is used to convert iron ore into pig-iron which, in turn, may be refined in an open-hearth furnace for the production of steel.

Blast-furnace slag is formed by the combination of gangue minerals in the iron ore (silica, alumina, etc.) with the limestone or dolomite flux in the furnace so that the impurities in the ore may be conveniently separated and discharged in a liquid state. The molten slag, after being discharged from the furnace, is allowed to cool and solidify before it is crushed and screened to produce a range of particle sizes ready to be used in concrete or road-making materials.

In the Wollongong area of New South Wales, a large quantity of blast-furnace slag is produced annually from the steel works at Port Kembla. For a number of years, the Department used uncrushed pit run slag as fill material, as well as for sub-base course (not top course) construction in road works. Top course is defined as the layer of pavement, usually six to eight inches thick, over which a wearing surface, such as bituminous seal or a thin layer of bituminous concrete, is applied. Crushed blast-furnace slag aggregate has also been successfully applied by the Department in the production of bituminous concrete from its hot mix plant at Bellambi. However, owing to the acute deficiency in the short term cohesive property of the fine fractions of crushed slag, the material had not been used as top course crushed rock pavement material prior to 1967. Instead, an artificial mixture, comprised of equal parts of $\frac{3}{4}$-inch crushed slag aggregate and crushed basalt fines ($\frac{3}{16}$-inch) had been used for top course pavement construction. Table I shows the test results of a typical mixture when tested in accordance with the Department's specifications for crushed rock top course material. The results of a graded crushed slag are also included for comparison.

The crushed basalt fines required for the production of the above slag-basalt mixture were obtained from a quarry located approximately 15 miles from the steel works. Because of production and haulage costs, the resultant mixture was relatively expensive. A laboratory investigation was initiated in 1967 with a view to improve the cohesive property of the crushed slag fines so that a top course material, composed mainly of crushed blast-furnace slag, could be obtained as an alternative to the slag-basalt mixture. Such a material, if successfully produced, was likely to be more economical than the slag-basalt mixture.

At the beginning of the investigation, a superfine flyash obtained from a thermal power station located at Tallawarra, approximately 10 miles from the steel works, was applied to stabilize the crushed slag. A satisfactory top course material was obtained by adding approximately 4 per cent (by weight) of flyash to a graded $\frac{3}{4}$-inch crushed slag. Subsequently, the iron oxide dust, as collected from the electrostatic precipitators inserted in the stacks of open-hearth furnaces of the steel works, was tried to replace the flyash which had to be imported to the steel works, as did the basalt fines.

In the open-hearth furnace, hot oxygen gas is introduced and blown over molten pig-iron so that the level of carbon content may be reduced for the production of steel. The hot oxygen, in oxidizing the carbon of the pig-iron, reacts also with the molten iron to form a very fine iron oxide dust which is collected by the electrostatic precipitators. Collected together with the iron oxide dust, there is also a small portion (8 to 10 per cent) of zinc oxide dust which is formed by the oxidation of zinc coatings on some of the scrap iron used in conjunction with pig-iron for the production of steel.

LABORATORY EXPERIMENTS

Properties of Crushed Slag Before Stabilization

In order to derive a satisfactory top course material, it is desirable to obtain a crushed slag having particle size distribution nearest to the maximum density grading, by combining various fractions obtained from the slag crusher. The optimum mixture was found by combining equal parts (by weight) of $\frac{3}{4}$-inch crusher run material with the minus $\frac{3}{16}$-inch slag fines. When the combined material was tested in accordance with the Department's specifications, the results showed deficiencies in the minus 200 B.S. sieve fraction as well as in the less than 0·0135 mm fraction. (See results in Table I.) In addition, the material exhibited very little, if any, cohesive property. It was found during the preparation of 3-inch cube specimens for the "Maximum Dry Compressive Test" that the specimens could not be formed after compaction at optimum moisture content. However, when this material was subjected to a C.B.R. test after four days of soaking, a C.B.R. value of 40 per cent was obtained (average of two samples).

Characteristics of Iron Oxide Dust

As mentioned previously, the iron oxide dust collected from open-hearth furnaces is a very fine material. Its particle size distribution is shown in Table II. Being essentially oxide of iron, it has a deep red colour and a specific gravity of 4·9. When the material is subjected to plasticity tests, it shows a plasticity index of 11. From an inspection of its grading and cohesive property, it can be seen that this material is ideally suitable for stabilizing the crushed slag.

TABLE II
PARTICLE SIZE DISTRIBUTION
OF IRON OXIDE DUST

B.S. Sieve or diameter	Percentage passing or less
100 B.S. Sieve	100
200 B.S. Sieve	98
300 B.S. Sieve	96
0·026 mm dia.	92
0·019 mm dia.	90
0·013 mm dia.	89
0·009 mm dia.	87

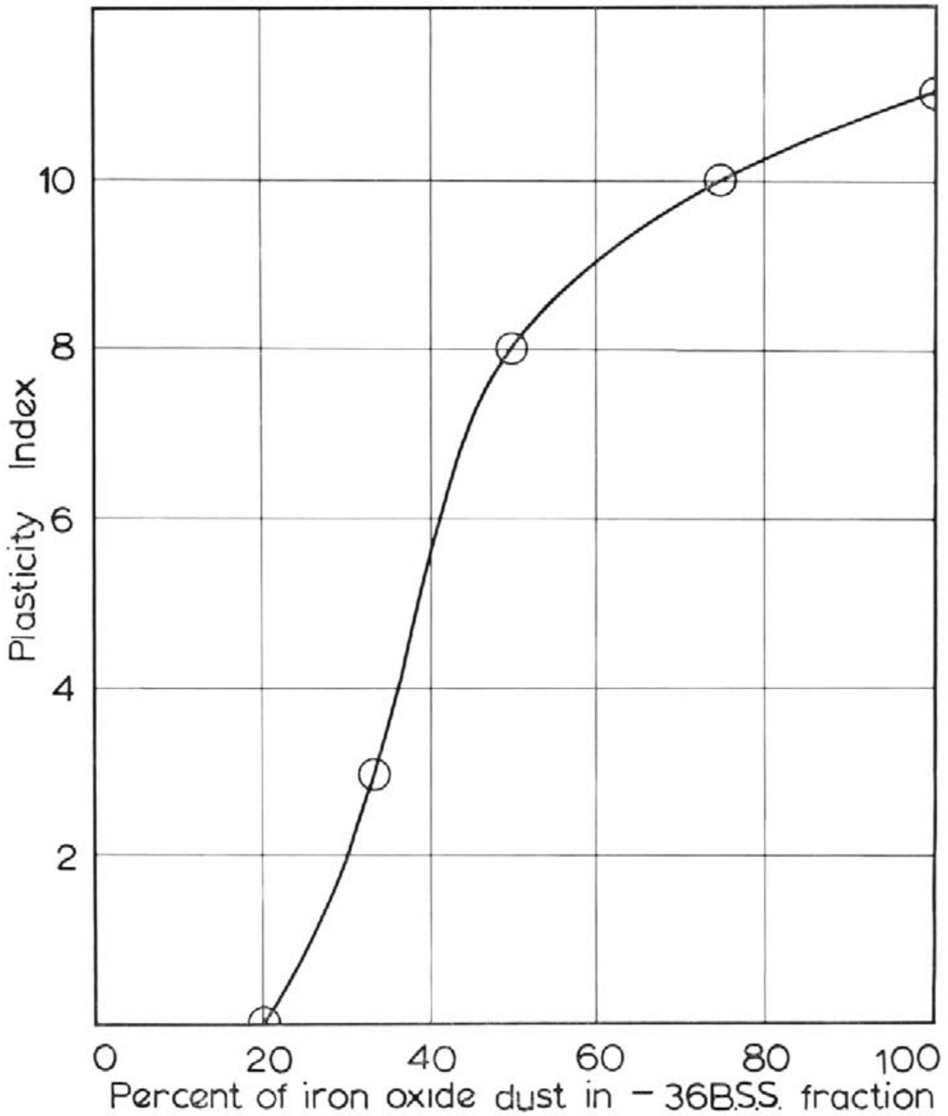
Experimental Stabilization of Crushed Slag

From the particle size distribution of the ¾-inch graded crushed slag (Table I) and iron oxide dust (Table II), the proportions of these two materials required to produce a suitable grading may easily be calculated (i.e., taking the limits of the specification as the constraint). A suitable combination was found to be that of 100 parts of crushed slag and 5 parts of iron oxide dust by weight. Accordingly, an artificial mixture was prepared in the laboratory and the resultant material was tested in accordance with the Department's specifications. In addition, C.B.R. tests were carried out for the mixture after 4 days of soaking. The results are shown in Table III.

The test results of the stabilized crushed slag have shown that, besides satisfying the specification in every respect, the material has a higher "maximum dry compressive strength" and also higher C.B.R. value than those of the slag-basalt mixture. Although the iron oxide dust has a plasticity index of 11, the resultant mixture with crushed slag exhibits no plasticity. This phenomenon may be explained by the "packing theory", which is that if the plastic fines (iron oxide dust) are acting as the filling material within the void spaces of the non-plastic particles (slag fines), then the resultant mixture is also non-plastic.

To confirm this theory, a simple experiment was designed to investigate the effect of increasing the proportions of iron oxide dust relative to the slag fines on the plasticity of the mixtures. Samples of minus 36 B.S. sieve fraction containing various percentages of iron oxide dust (0 to 100 per cent) were prepared and tested for plasticity. The results are presented in the adjacent graph. It can be seen from this graph that the slag fines can accommodate up to 20 per cent of the plastic iron oxide dust without being plastic. (N.B.—This percentage refers only to the minus 36 B.S. sieve fraction.)

Graph showing the effect of increasing proportions of iron oxide dust relative to slag fines on the plasticity of the mixtures.



Property	TABLE I Test Results of a Typical Slag-Basalt Mixture			TABLE III Test Results of Iron Oxide Stabilized Crushed Slag		
	Specification	Graded Slag	Slag-Basalt Mixture	Specification	Graded Slag (before stabilization)	Stabilized Slag
Coarse Fraction—						
Percentage passing 1-inch B.S. Sieve	100	100	100	100	100	100
Percentage passing ¾-inch B.S. Sieve	95–100	99	99	95–100	99	99
Percentage passing ½-inch B.S. Sieve	75–90	..	..	75–90	..	..
Percentage passing ¼-inch B.S. Sieve	55–75	..	..	55–75	..	..
Percentage passing No. 7 B.S. Sieve	35–55	50	38	35–55	50	52
Fine Fraction (for portion passing No. 7 B.S. Sieve.)—						
Percentage passing No. 36 B.S. Sieve	..	42	40	..	42	44
Percentage passing No. 200 B.S. Sieve	..	15	16	..	15	18
Percentage less than 0·0135 mm dia.	..	4	7	..	4	8
Ratios						
(A) Pass 36 B.S. Sieve	37–57	42	40	37–57	42	44
(B) Pass 200 B.S. Sieve / Pass 36 B.S. Sieve	37–57	36	40	37–57	36	41
(C) Less than 0·0135 mm / Pass 200 B.S. Sieve	37–57	27	44	37–57	27	44
Liquid Limit (if non-plastic)	20 max.	19	18	20 max.	19	16
Plastic Limit (if plastic)	20 max.	Non-plastic	Non-plastic	20 max.	Non-plastic	Non-plastic
Plasticity Index	6 max.	Nil	Nil	6 max.	Nil	Nil
Max. Dry Compressive Strength (lb/sq in)	At least 250	Nil	450	At least 250	Nil	590
C.B.R. (4 days soaking)	Not in specification	40%	130%	Not in specification	40%	160%

FIELD TRIALS

As the laboratory experimental results were encouraging, a field trial was arranged to examine the practicability of producing and applying the iron oxide stabilized slag to pavement construction. A trial batch of approximately 100 tons of the material was prepared. To achieve the mixing of iron oxide dust with ¾-inch graded crushed slag, a front-end loader was found to be quite efficient. The proportioning was carried out on a volumetric basis after the necessary conversion from weight to volume. It was observed during the mixing process that the red colour of the iron oxide could be conveniently used as the indicator to determine the degree of homogeneity achieved. Although the percentage of iron oxide required was small, because of its fine particle size distribution, the red colour eventually stained all the slag particles so that a well mixed material showed an evenly distributed red colour throughout a stockpile.

The mixture was laid as top course pavement material on a section of motorway near Wollongong. A 20-ton rubber-tyred roller was used to compact the material. After eight passes by the roller, the degree of compaction obtained could easily satisfy the requirement of one hundred per cent of the laboratory density. An inspection was carried out recently on this section of motorway and the pavement was found to be performing well to date.

One serious disadvantage of iron oxide stabilized crushed slag, discovered during subsequent full scale application, was that the red iron oxide dust tended to stain any concrete kerbs and gutters. In addition, if traffic was allowed to run over the material before it was sealed, the occasional occurrence of dust nuisance was encountered. It has since been found that effective compaction of iron oxide stabilized crushed slag requires that the surface be kept wet during rolling. This practice generally ensures that traffic does not use the new pavement before sealing, except in some restricted urban locations where the diversion of traffic may be, at times, extremely difficult.

Since the successful field trial of the stabilized crushed slag in 1967, a large quantity of the material, in excess of 100,000 tons, has been applied by the Department in the construction and reconstruction of pavements in Wollongong and nearby areas.

It was used during 1970 in the correction of a distorted sealed pavement on Mt. Ousley Road (Main Road No. 513), where correction depths exceeded 3 inches. The corrective layers of iron oxide stabilized crushed slag were applied direct to the old sound pavement and prepared in the usual way, before sealing and application of an asphaltic concrete surface. There was good adhesion to the old pavement and the material gave a satisfactory "feather edge". Although the grades on this road are in excess of 8% and traffic is in excess of 7,000 vehicles per day no failures have occurred during 18 months of service.

* * * * *

The initial economic advantage of this material is illustrated by the fact that it was used for reconstruction of major sections of the Hume Highway, despite haulage distances of up to 50 miles. However, as iron oxide stabilized crushed slag is now marketed commercially, the economic advantage has been reduced and, consequently, only limited quantities have been used in the Department's Illawarra Division since August, 1970.

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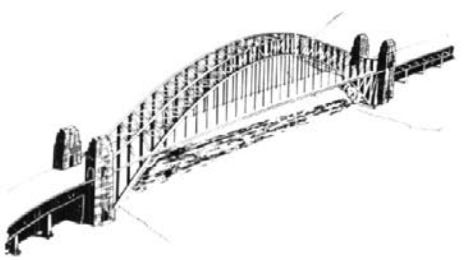
This article has been edited from a paper prepared by Mr K. Y. K. Fung, B.E., and presented to the Australian Road Research Board's Fifth Conference in August, 1970. The experimental work was carried out by the laboratory staff of the Department's Divisional Office at Wollongong, where Mr Fung was an engineering analyst, under the supervision of the Divisional Engineer, Mr G. A. Thompson ●

TENDERS ACCEPTED BY COUNCILS

The following tenders (in excess of $10,000) for road and bridge works were accepted by the respective Councils during the three months ended 31st March, 1971.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
				$
Berrigan	D.R. 1172	Construction of two composite steel and concrete bridges and approaches on Developmental Road No. 1172, 5·5 miles and 9·0 miles from Tocumwal.	Danckert Constructions Pty Ltd	37,784.40
Bibbenluke	S.H. 19	Reconstruction and bituminous surfacing of the intersection of State Highway No. 19 with Trunk Road No. 93 and Burrumbooka Road.	T. A. Deacon Pty Ltd	18,904.00
Boolooroo	S.H. 12 & M.R. 507	Flush reseal 12 feet wide between 12·2 miles and 17·6 miles on State Highway No. 12 east of Moree. Bituminous surfacing on Main Road No. 507 between 28·3 miles and 30·3 miles west of Goondiwindi.	Shorncliffe Pty Ltd	10,768.40
Carrathool	T.R. 80, M.R. 244, 387 & 501	Supply of ⅜-inch aggregate to various locations	Griffith Metal Sand and Gravel Pty Ltd	10,545.36
Carrathool	T.R. 80, M.R. 244, 387 & 501	Resealing of roads at various locations	Allen Bros (Asphalting Contractors) Pty Ltd	22,709.32
Culcairn	T.R. 125, M.R. 331 & 547	Resealing 0·6 miles west of Walbundrie. Reconsrtuction and bituminous sealing 10 miles 2,800 feet to 12 miles 2,400 feet west of Culcairn. Reconstruction and approaches to new Billabong Creek Bridge, 0 miles to 1·15 miles from Main Road No. 331.	Canberra Asphalters Pty Ltd	17,567.50
Hay	M.R. 514	Supply and delivery of 478 cubic yards of ½-inch aggregate to stockpile 32 miles west of Hay and 499 cubic yards of ½-inch aggregate to stockpile 35·5 miles west of Hay.	Lake Boga Quarries Pty Ltd	10,162.90
Lake Macquarie	M.R. 217	Haulage of up to 150,000 cubic yards of fill material for approaches to bridge over Cockle Creek at Teralba.	S. J. Bailey Pty Ltd	61,700.00
Leeton	T.R. 80	Reconstruction and bituminous surfacing 18 miles 2,200 feet to 20 miles 5,000 feet west of Leeton.	Emoleum (Aust.) Pty Ltd	12,513.70
Liverpool Plains	S.H. 11	Construction of a single cell 8 ft x 8 ft and a five cell 8 ft x 8 ft reinforced concrete box culvert at 5·5 miles and 4·9 miles west of Gunnedah.	Enpro Constructions Pty Ltd	22,026.00
Shellharbour	M.R. 522	Southern approach to Windang Bridge. Supply and delivery of up to 55,000 tons of fill material.	South Coast Equipment Pty Ltd	25,530.00
Warringah	M.R. 530	Construction of a three-span reinforced and prestressed concrete bridge 105 feet long over Harbord Lagoon at Curl Curl.	Moy Bros Pty Ltd	65,980.10
Weddin	M.R. 237	Construction of a 4-cell 10 ft x 10 ft and a 4-cell 10 ft x 8 ft reinforced concrete box culvert at Warraderry Creek 8 miles from Grenfell.	W. A. Winnett and Sons	26,080.00



INSTALLATION OF TELEVISION ON SYDNEY HARBOUR BRIDGE

A closed circuit television system has been installed on Sydney Harbour Bridge to test its effectiveness in traffic surveillance and control.

The use of television for traffic surveillance and control on Sydney Harbour Bridge has been actively investigated by the Department for some time. The need for more modern methods of detecting breakdowns and then providing assistance to clear the obstruction, as well as for controlling traffic, has been brought about due to the increasing growth of traffic volumes on the Bridge.

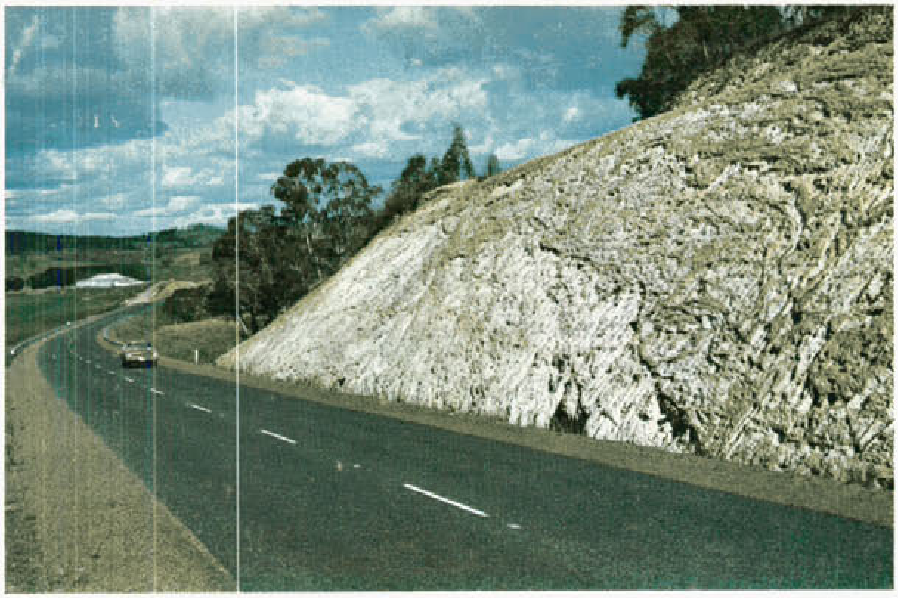
During April, 1971, arrangements were made with Philips Industries Ltd for the installation of a single television camera and receiver to be tested under traffic conditions.

At this stage the duration of the testing period has not been determined but, if as expected, the trial proves successful, further television equipment will be installed to provide complete coverage. Preliminary investigations indicate that six television cameras will be sufficient to cover the entire bridge and its approaches including the southern end of the Warringah Expressway and the Cahill Expressway as far as Macquarie Street.

TENDERS ACCEPTED BY THE DEPARTMENT OF MAIN ROADS

The following tenders (in excess of $10,000) for road and bridge works were accepted by the Department during the three months ended 31st March, 1971.

Road No.	Work or Service	Name of Successful Tenderer	Amount
			$
Sydney-Newcastle Expressway (X3)	Shires of Hornsby and Gosford. Construction of an 11-span steel and concrete bridge 2,016 feet long, excluding piles and pile caps, over the Hawkesbury River.	The Hornibrook Group (Southern Division).	2,966,848.00
Southern Expressway (X6)	City of Wollongong. Construction of a 2-span prestressed concrete overbridge 206 feet long over the Expressway at Cawley Road.	Ermani Constructions Pty Ltd	64,151.80
State Highway No. 1	Princes Highway. Shire of Mumbulla. Bridge over Dry River at Quaama. Supply and delivery of 15 x 70 feet long precast post-tensioned concrete girders.	Peter Verheul Pty Ltd	24,057.00
State Highway No. 2	Hume Highway. Municipality of Camden. Construction of a 26-span steel and concrete bridge 3,380 feet long over the Nepean River at Camden.	John Holland (Constructions) Pty Ltd.	2,270,682.00
State Highway No. 8	Barrier Highway. Shire of Central Darling. Construction of a prestressed concrete box culvert 47·3 miles east of Wilcannia.	Monier Pipe Co.	14,533.76
State Highway No. 8	Barrier Highway. Shire of Central Darling. Construction of a prestressed concrete box culvert 34 miles east of Wilcannia.	Dyson Holland Pty Ltd	19,904.00
State Highway No. 8	Barrier Highway. Shire of Central Darling. Construction of three sub-artesian bores adjacent to State Highway No. 8 between 40 miles and 44 miles east of Wilcannia.	W. A. Juett	10,328.00
State Highway No. 8	Barrier Highway. Shire of Central Darling. Supply of ¼-inch aggregate to various locations.		
State Highway No. 14	Sturt Highway. Shire of Balranald. Supply of ¼-inch aggregate to various locations.	A. G. Leech Pty Ltd	11,783.25
State Highway No. 22	Silver City Highway. Shire of Wentworth. Supply of ¼-inch aggregate to various locations.		
State Highway No. 8	Barrier Highway. Shire of Central Darling. Supply of ¼-inch aggregate to various locations.		
State Highway No. 14	Sturt Highway. Shire of Balranald. Supply of ¼-inch aggregate to various locations.	Cobar Aggregate and Sand Supply	39,661.20
State Highway No. 22	Silver City Highway. Shire of Wentworth. Supply of ¼-inch aggregate to various locations.		
State Highway No. 9	New England Highway. City of Newcastle. Supply and delivery of up to 1,300 tons of ¾-inch gauge asphaltic concrete to Beresfield Deviation.	Boral Road Services Pty Ltd	14,690.00
State Highway No. 9	New England Highway. City of Maitland. Supply and delivery of up to 2,850 tons of ¾-inch gauge asphaltic concrete to west of Maitland.	Boral Road Services Pty Ltd	33,744.00
State Highway No. 9	New England Highway. City of Maitland. Haulage of up to 26,000 tons of slag products from B.H.P. to State Highway No. 9 at Maitland for road construction works between Long Bridge and Tally Ho Park.	Brambles Industrial Services	38,740.00
State Highway No. 14	Sturt Highway. Shire of Balranald. Construction of a 7-span composite steel and reinforced concrete bridge 470 feet long over the Murrumbidgee River at Balranald.	McMillan Constructions Pty Ltd	376,740.40
State Highway No. 16	Bruxner Highway. Shire of Ashford. Construction of a 8-cell 15 ft x 15 ft reinforced concrete box culvert over Big Oaky Creek 9·5 miles east of Bonshaw.	N. Del Gatto	46,065.60
State Highway No. 21	Cobb Highway. Shire of Hay. Construction of a 6-span composite steel and reinforced concrete bridge 638 feet long over the Murrumbidgee River at Hay.	Central Constructions Pty Ltd	699,880.00
Main Road No. 108	City of Newcastle. Supply and delivery of up to 23,000 tons of ¾-inch gauge asphaltic concrete to western approaches of bridge over North Arm of Hunter River.	Boral Road Services Pty Ltd	25,277.00
Main Road No. 108	City of Newcastle. Haulage of up to 26,000 tons of slag products from B.H.P. to western approaches of bridge over North Arm of Hunter River.	W. D. Smith Constructions Pty Ltd.	11,440.00
Main Road No. 184	Municipalities of Blacktown and Windsor and Shire of Baulkham Hills. Bridge over First Ponds Creek. Manufacture and delivery of 70 prestressed concrete bridge planks 35 feet long.	Precasting and Prestressing Engineers Pty Ltd.	13,140.00



OXLEY HIGHWAY HIGHLIGHTS