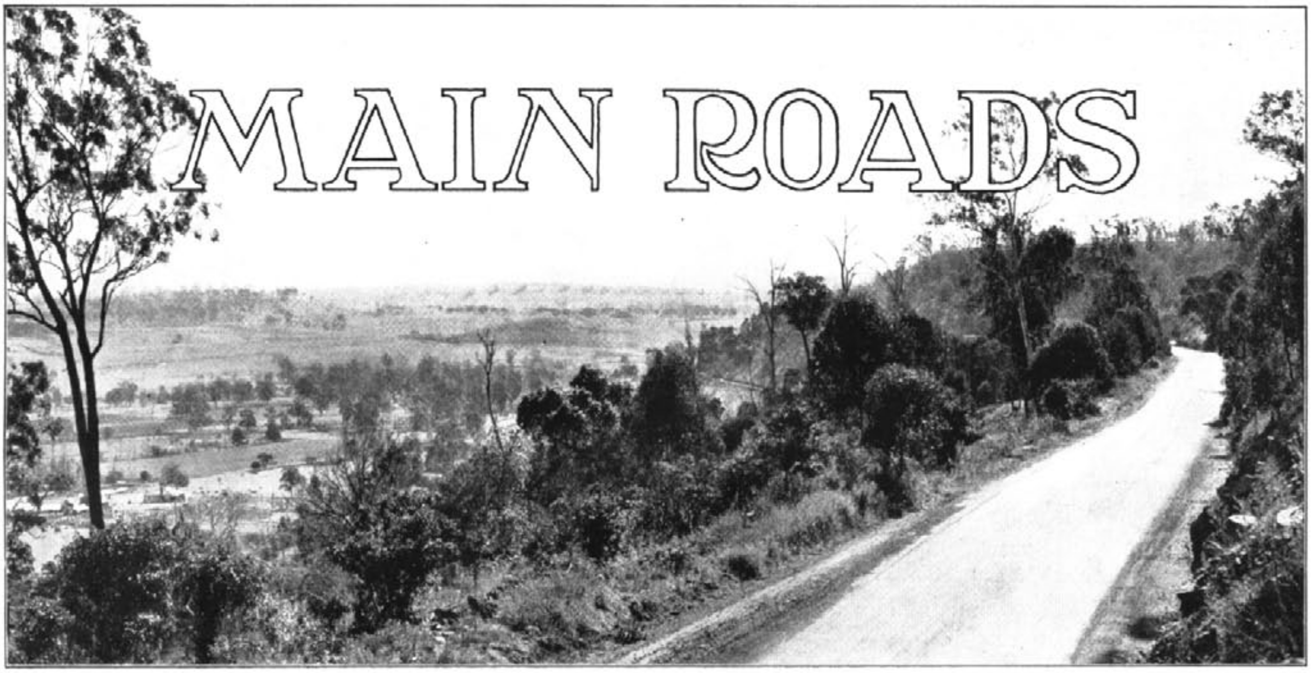


THE METROPOLITAN ROADS SYSTEM.

Designing Roads for Service and Safety.

The noted English writer, Hilaire Belloc,* defines a road in terms of its essential function as "a means to facilitate the movement of man between two points upon the earth's surface." The first element in the theory of the road, he says, is "to find a formula of minimum expense in energy for communication between two given geographical points under given conditions of travel and carriage." The application of these principles embraces the whole practice of road location as well as, in essential aspects, that of road design, construction, maintenance and even of traffic control.

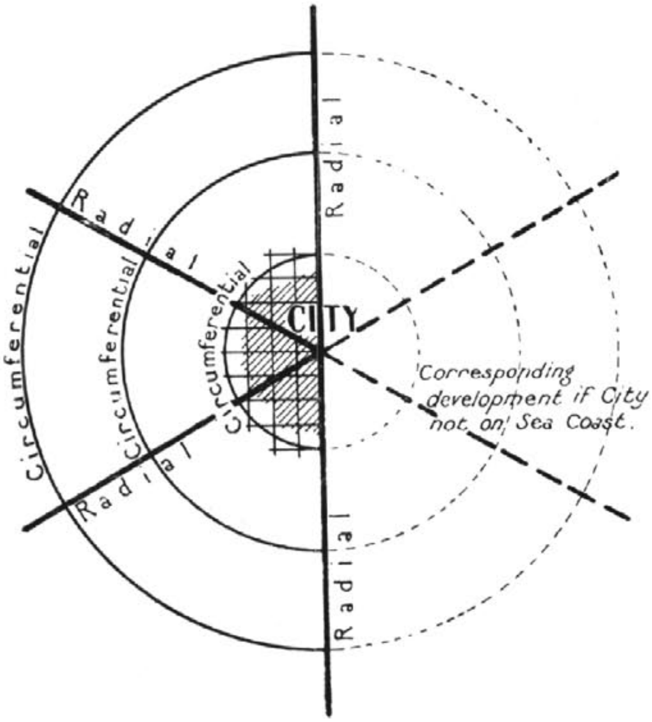
In order to fulfil their purpose in terms of the above principles, roads have to be located to give the straightest possible path between the points they connect, having regard, however, to the need for avoiding obstacles, such as rivers too wide to allow bridging to be economically feasible. They have to afford traffickable grades and convenient alignment without, however, undue expenditure on earthworks. In some cases secondary considerations, such as the need to take advantage of the presence of suitable material, or to avoid ground subject to flood or to landslide, may also affect the choice of a route.

These basic principles of location can usually be given effect to only in virgin country, as in settled areas, many, if not all of the purely functional considerations are frequently over-ridden by the fact that a previously established location is available, and the cost of re-location, including the acquisition of the land needed to enable the road to be constructed elsewhere would be prohibitive. This factor dominates the problem of city location, and it is only in order to meet the most pressing needs of traffic, or for other important reasons, that existing routes within the closely built-up areas of a City can be departed from.

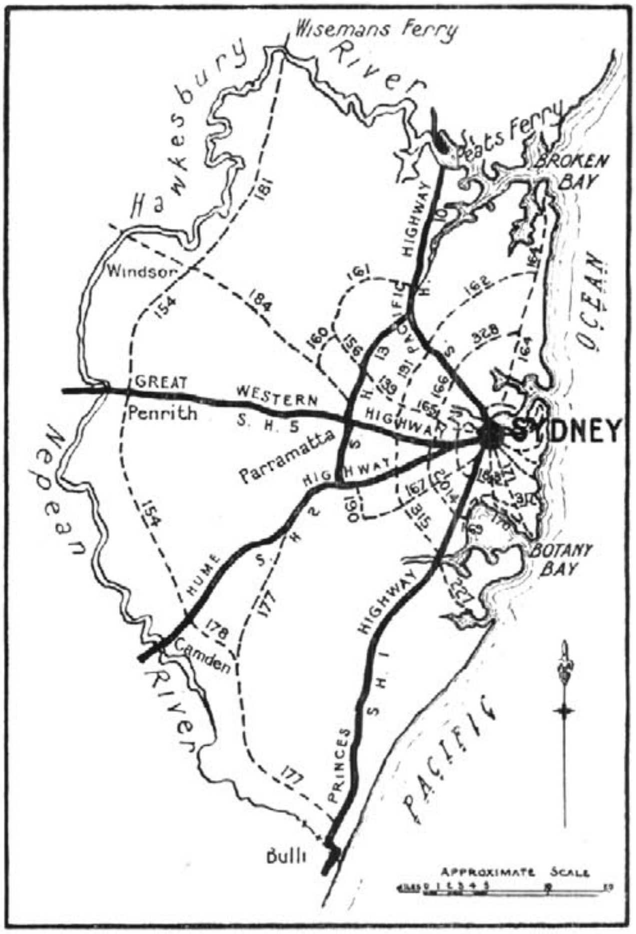
Notwithstanding the influence of restraining circumstances, however, the application of the first principle enunciated above has resulted in a system of roads of some character being constructed in all settled areas. From the point of view of this article, consideration only will be given to those routes which serve through traffic, i.e., as distinct from those required merely to give access to property.

* "The Road," by Hilaire Belloc, published by the British Reinforced Concrete Engineering Company, London.

To serve a modern City and to give the needed facilities for the transport of the thousands of people residing in suburban areas and working in the City, as well as to meet the general industrial and commercial transportation needs of the City and its environs, it has generally been sufficient so far to provide a system of main roads, radiating from the City, and linked by another system of roads, placed at suitable distances apart circumferentially to the City centre. Such a system, it may be noted, amounts in principle to a departure from—or, as is actually the case in practice, an addition to—the rectangular "gridiron" layout which has in the past frequently been adopted as the layout of a City or other fully developed area. Thus, the most common and generally suitable arrangement of the main routes in the environs of a city are as shown below:—



In practice the plan of any system of roads departs from the theoretical plan owing to the geographical situation of the City and the topographical features of the country. As mentioned above, there is also the need, in order to keep within economically practicable limits, to adapt existing routes wherever they are reasonably suitable rather than to choose completely new locations. On these lines, the Main Roads Board, and its successor, the Department of Main Roads, have developed a system of arterial and circumferential routes in the Sydney Metropolitan area, the general features of which are shown in the diagrammatic map appearing in the next column.



The completion of this system, by the construction of the many "missing links" and "missing ends" which existed when the Board was constituted, the bringing of the pavements to traffickable condition, and the widening of thoroughfares which in places were so narrow as to merit the term "bottle-necks," has been the chief work (in the Metropolitan area) towards which the activities of the Main Roads Board and Department have been directed during the past ten years.

In order to fulfil their function, the main routes of a system such as the above have to pass through and connect the various centres of population; they have to intersect each other, and are interwoven with the network of minor streets and roads which traverse the intervening areas and give access to the properties therein. If congestion is not to occur, the carriageway of each part of the system has to be wide enough to carry the volume of traffic using the route, and the elimination of curves, steep grades, etc., all facilitate the flow of traffic and increase the efficiency and safety of the system.

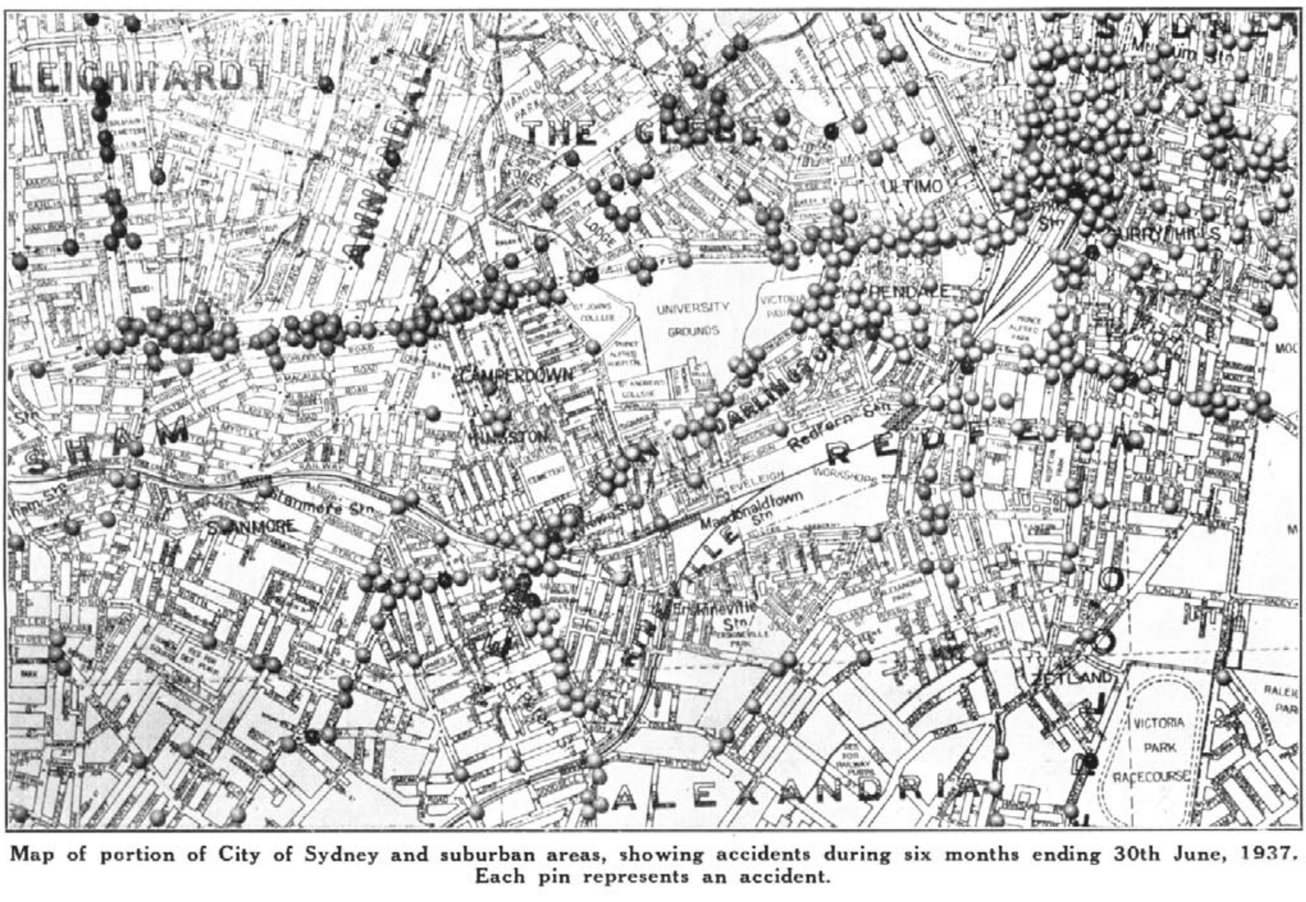
The existence of such a system is essential to the transportation needs of an area such as that surrounding the City of Sydney, but during the past few years new problems have arisen. These are due to two main causes: One is the increasing use of the road motor vehicle, in the form of either car, 'bus, or lorry, for transportation purposes, and the other is the fact that the modern motor vehicle has increased in efficiency and capacity for speed to an extent never contemplated by the earlier road designers.

Of the considerations arising out of these, that of safety is the most pressing. The road system, which is necessarily the result of earlier years of construction, has proved inadequate in certain respects, and unless the community is prepared to accept stringent restrictions on speeds, this will continue to be so to an increasing degree, with possibly aggravation on account of congestion due to the slower speeds.

In the meantime carriageways are being found to be inadequate, particularly in the busy shopping centres where a strip of the roadway is taken up by parked vehicles. There is also the problem of intersections, which, owing to the fact that the paths of vehicles either cross each other or interfere with the ordinary flow of traffic by joining it or leaving it, are points of potential danger, even at moderate speeds. The non-observance of the traffic regulations by careless drivers aggravates these conditions, but even when this requirement is fully met, intersections, on a busy and important route, constitute a definite impediment to the flow of traffic. Observations have shown that if such a road is intersected by a cross street carrying an equal volume of traffic, the efficiency of the routes, i.e., the number of vehicles they can carry with safety and convenience, as compared with their capacities without the intersection, is reduced to less than half, so that because of the intersecting streets, many of the traffic arteries could not function at their full capacity.

There is also the point of view of the pedestrian. People have to cross roads, but, with a heavy volume of fast traffic using the carriageway, and in the absence of properly controlled crossing places, this has become extremely difficult and dangerous. This is reflected in the number of accidents to pedestrians which occur where important traffic arteries pass through busy shopping areas such as the Parramatta Road through the Petersham-Leichhardt-Annandale area. A study of the "Accident Map" reproduced below will confirm this statement.

The obvious conclusion is that provision will need to be made for pedestrians other than by crossing fast motor traffic routes—or, alternatively, fast motor traffic will have to be taken by routes where it does not interfere with the safe movement of pedestrian traffic. This will require either the construction of pedestrian bridges or subways in order to permit pedestrians to cross over or under heavily trafficked routes—obviously an expensive thing to do—or the location of highways and other important traffic arteries in such manner as to by-pass busy shopping centres by going round them. Probably the latter proposal will at first call forth a protest from the owners and tenants of shops and other business premises in the areas affected on the score that they would lose the custom of the "through" traffic. When the whole position is reviewed, however, it will be

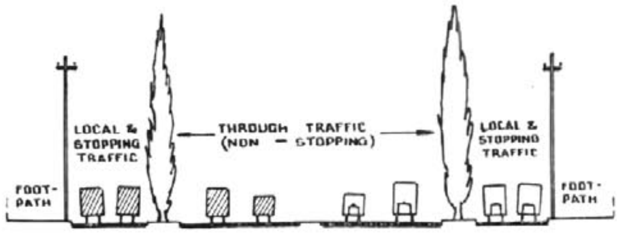


Map of portion of City of Sydney and suburban areas, showing accidents during six months ending 30th June, 1937. Each pin represents an accident.

recognised that the comparatively small benefit derived from this source is out of all proportion to the inconvenience and danger suffered by the ordinary shopping or business public on account of the passage of fast through traffic. People who desire to make purchases or to transact business within the shopping area would deviate from the Highway or other important routes in order to do so with the comparative safety and convenience of a street free from speeding vehicles. This has been the experience in other lands.

To revert to the aspect of the through traffic, it has to be recognised that with present-day speeds the existing type of roadway is less suitable than formerly. With moderate speeds of travel, the single carriageway carrying two lanes of traffic proceeding in opposite directions gives rise to no appreciable danger, but at speeds such as rule to-day, the need for the separation of the two lanes has become keenly felt. Until recently, it was the common practice to construct roads with dual carriageways separated by a kerbed medial strip which served to divide the traffic. Experience has shown, however, that under certain conditions there is danger in the presence of the kerb, which forms an obstruction in the case of an emergency and may cause accidents. On this account, there has been a move recently, particularly in the United States, towards the removal of kerbs and the separation of traffic merely by means of a neutral zone consisting of a strip of pavement of contrasting colour or by a double traffic line. A road on which this observation has been effected is illustrated below. The principle of dual carriageways has been adopted by the Department of Main Roads, many important Metropolitan roads having been designed in this manner, and such provision is likely to be embodied, wherever practicable, in all new designs for important routes.

Separation of the opposing streams of traffic removes the most pressing danger of present conditions, but for complete provision for safety it is necessary to provide for the separation of the stream of fast through traffic from the vehicles which either travel more slowly or have to stop. Thus the provision of four traffic lanes is finding favour in road design, and to meet this requirement the cross-section of the road becomes as shown in the diagram below.



Notwithstanding these improvements in design of the road, however, there still remains the inconvenience and danger of the uncontrolled intersection. Rigid observance of the present N.S.W. regulation* governing traffic movement at intersections and cross roads, would eliminate all danger, but would still leave the intersection as a serious impediment in the free flow of traffic. Improvements in design, such as the rounding or splaying of corners, go some way towards reducing accidents, but in built-up areas such improvements are costly and their effect is still dependent on the actual regulation of the movement of vehicles. The "through-route-stop" system of traffic control, by which all vehicles from a side street have to come to a stop before entering a proclaimed "through" route, and the installation of signal lights, have been adopted in places for the purpose of controlling cross traffic at intersections. Signal lights, actuated by the passage of vehicles as they approach the intersection, and showing green or red lights to denote that the vehicle

* No. 67 of Motor Traffic Regulations, 1936:—"When two motor vehicles are approaching each other at an intersection, so that if both continued the vehicles would arrive at the same point together and collide, the driver of the vehicle which has the other vehicle on his right-hand side shall slow up and allow such other vehicle to pass in front of his vehicle."

Example of Dual Road, Portland, Oregon, U.S.A. Division of traffic is effected by strip of pavement in contrasting colours and traffic lines.

may proceed or must stop as the case may be, with an amber light to indicate the change from one colour to the other, have already been installed by the Department of Road Transport at a number of important intersections in the City of Sydney, and their use is likely to be extended to other intersections in and around the City.

The safety and convenience of traffic is further advanced if intersections are designed in such manner as to cause traffic to take a rotary path around a large circular island (known in Great Britain as a "roundabout") or, under other conditions, to divide the traffic by some means into separate "streams," which, when they intersect, do so under conditions most conducive to safety.

In Australia the presence of isolated islands in roads, particularly if inadequately lighted or marked, is regarded by some as constituting a danger owing to the likelihood of collision by reckless or unobservant drivers, and the provision of such features at intersections, and their resultant effect in regulating the path and controlling the speed of traffic, is sometimes resented by the unthinking or impatient driver. There is, however, no doubt that roundabouts have become a feature in the design of intersections in many parts of the world, and in seeking to incorporate them, where desirable, in its road, design, as well as to eliminate the oblique intersection and adopt other measures for the better regulation of traffic at intersections, the Department is only keeping abreast of the trend in other countries. Two designs for intersections typifying the most recent British ideas, shown in the diagrams below, are taken from a Memorandum on the Lay-out and Construction of Roads recently issued by the British Ministry of Transport.

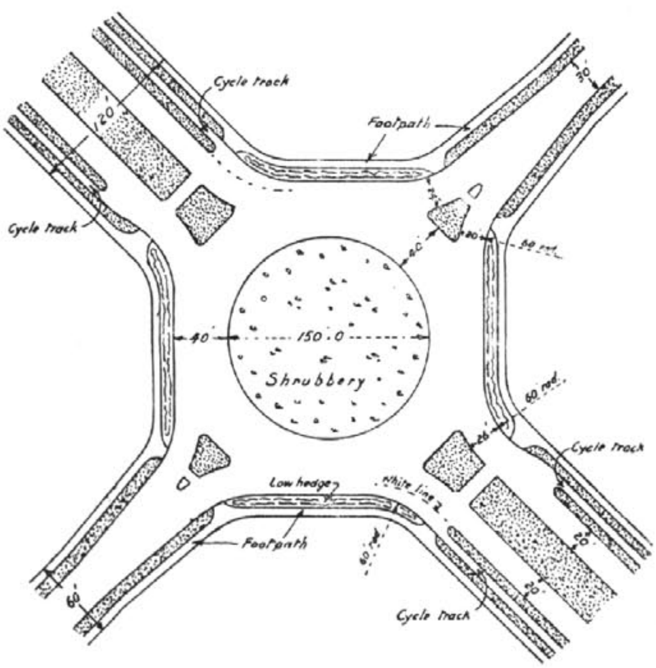
Supporting the foregoing remarks on the design of roads and the layout of intersections, it is of interest to note the views of the British Ministry of Transport, on the main principles which should be borne in mind in designing road junctions. These are set out in the abovementioned memorandum (p. 13) as follows:—

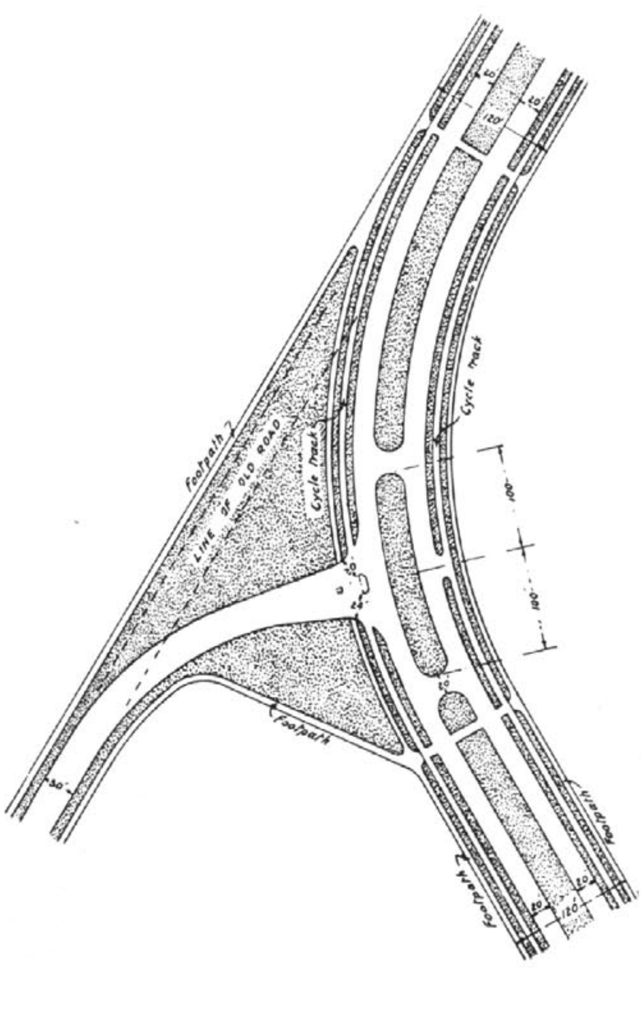
(1) The number of intersections or road junctions on main traffic routes should be reduced to a minimum and spaced not less than 440 yards apart.

(2) Major traffic routes should, where practicable, be rendered completely independent of local roads by being carried over or under them by bridges or subways.

(3) Road junctions in excess of four ways should be avoided except where there is ample space for a suitable "roundabout."

(4) All subsidiary roads should join main traffic routes as nearly as possible at right-angles. Acute angled junctions are to be deprecated.





(5) At three-way intersections of important roads to be treated on the "roundabout" principle, the roads should, as far as possible, meet at equal angles.

(6) Where a minor road crosses a major road constructed with a single carriageway the minor road should be staggered, preferably to the left, and space provided at its junction so that drivers can obtain the maximum vision before entering the major road. Where dual carriageways are provided, or intended, staggering is unnecessary if the minor road crosses the main traffic route at right-angles, but, in the case of an oblique crossing, staggering will result from the adoption of recommendation (4) above.

(7) At crossings of two or more major roads ample space should be provided for a "roundabout."

(8) At every road junction the requirements of pedestrian and all other types of traffic should be studied and as far as practicable suitable provision made for them.

Such arrangements are very costly and except in country where land is procurable at a reasonable price, could hardly be constructed at other than the most important intersections, always bearing in mind the nature and volume of traffic, both vehicular and pedestrian. Their use to some extent is, however, likely to become a feature of road design in the future.

The complete separation of one stream of traffic from another intersecting stream can, of course, only be achieved by grade separation, as it is termed in America, or the construction of bridges by which one road is carried over the other. Accompanying such facilities are usually inter-connecting roads to allow traffic to turn off from one road on to the intersecting route without disturbing the main flow of traffic. The arrangement necessary to effect this, sometimes termed a clover-leaf intersection, is naturally extremely costly and could only be justified in Australia in very exceptional circumstances.

To give effect to schemes of improvement of intersections by the construction of "roundabouts" or other comparatively expensive facilities, would require that the less important side streets (which would not justify the expense of improved intersection design) be blocked from joining the major route and vehicles desiring to stop would have to leave the through traffic. Traffic wishing to cross or join the major route would have to go to a place where a properly constructed or controlled intersection had been provided. No doubt such restriction of the privilege of joining or leaving a major route at any point, which the public at present enjoys — and in some cases abuses—would be considered a hardship by many, but it would be no different from the conditions obtaining at the crossing of railways. It is unquestionably one of the changes in road conditions which will have to be accepted if high speeds are to be employed with safety.

Such measures would have their advantageous effect on the safety and convenience of through traffic, but it has to be recognised that they would be difficult to give effect to on existing routes without serious disturbance of property, etc., and this will render them extremely costly. Moreover, in the case of busy shopping areas there would still be the need to provide for the pedestrian desiring to cross the road in safety, so that the problem cannot be solved by any one method. Under certain conditions in large cities, in order to provide in the future the required means of ingress and egress for the heavy volumes of fast traffic, consideration may have to be given to the construction of special express roads or super-highways connecting the City with suitable points in the suburbs. Such roads would altogether transcend the existing road system, i.e., they would run between or under or over the ordinary streets and connected thereto only at intervals of perhaps a mile or more where traffic from the side streets would be able to join the express route under strict control. It will be seen that such proposals amount in effect to the application in full of "railway" principles—the removal of fast-moving traffic from all contact with anything which may interfere with its passage, the separation of the streams of traffic, and the control of the movement of vehicles. It may be said that it will be long before the expense of constructing such express routes to serve the City of Sydney could be justified. Existing financial resources, based on present-day rates on property and vehicle taxation will certainly not meet the cost, but a recognition of the trend in traffic volumes and vehicle speeds, and an examination of the actual achievements or efforts being made in other countries to provide the means for meeting the demands of traffic, only lead to the conclusion that it is not too early to look ahead in this direction in respect of the traffic needs of the Sydney Metropolitan area.

When we come to the application of the safety principles herein outlined to the specific problem of Sydney metropolitan traffic, it is evident that even the principal highways cannot be transformed in a day. It may be many years before the growth in population will make possible a system of "railway" roadways for the rapid distribution of traffic entering or leaving the City proper. The Department's objective therefore is to make the roads as safe as possible with the funds available. It also seeks to provide for the future in the selection of new routes and in the treatment of existing routes by such means as are reasonably practicable.

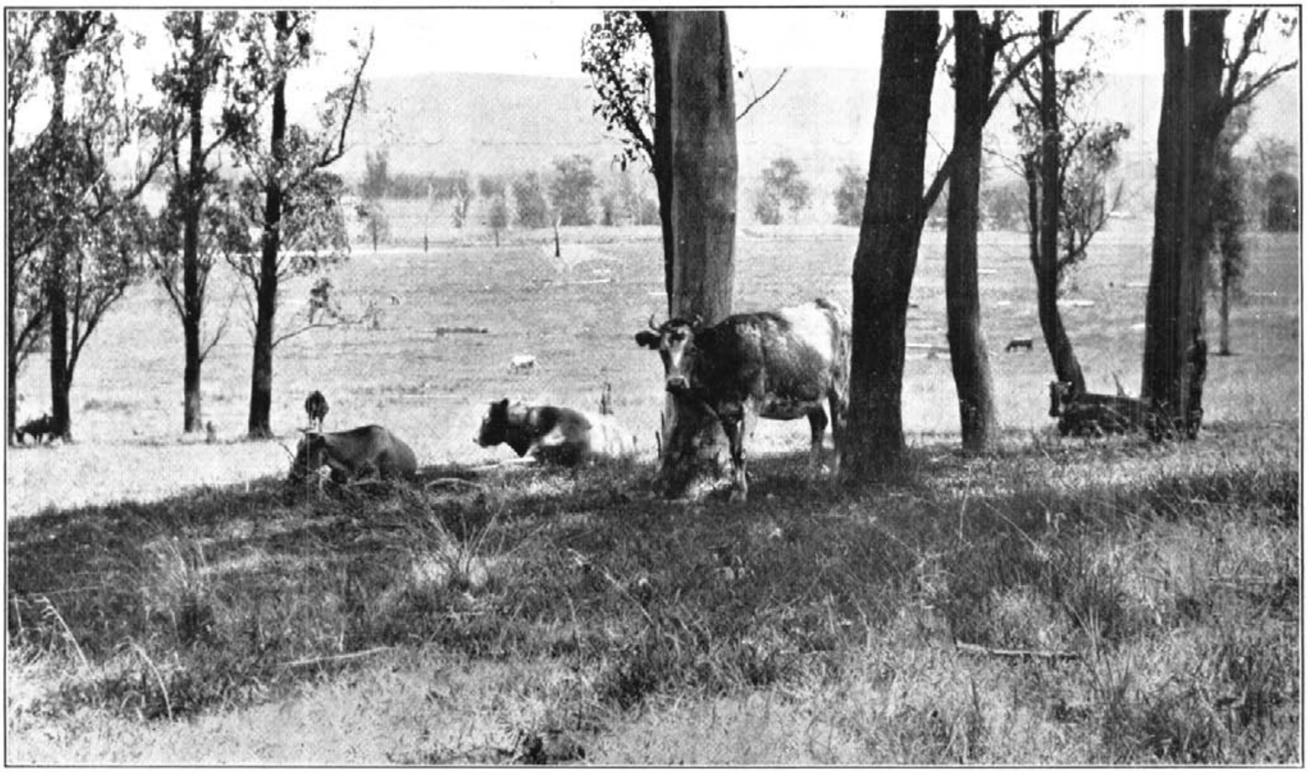
DEVELOPMENT OF THE UPPER CLARENCE AND RICHMOND RIVER VALLEYS.

A REVIEW OF THE EFFECT OF ROAD CONSTRUCTION.

NOT the least important of the functions with which the central road authority is charged under the provisions of the Main Roads Act are those relating to the construction of developmental roads. The definition of such roads contained in the Act is broad enough to include any road which will serve to develop or further develop a district, and it is the responsibility of the authority administering the Act to ensure the greatest benefit to the community as a whole in selecting the roads on which developmental road moneys are to be expended. As a matter of general policy, therefore, all developmental road proposals are examined in order to ascertain whether the likely benefits to the State in the form of increased production and settlement within the areas affected are commensurate with the cost of necessary construction works. The proposals are also considered in relation to present and future traffic requirements to ensure as far as practicable that the roads selected for proclamation will conform to a satisfactory design for the expansion of the general system of road communications, either as feeder roads or as connecting links in the Main Roads network.

Owing to the very backward condition of the means of access generally at the inception of a central road authority in 1925, the Developmental Road Fund provided for under the Act has never yet been sufficient to meet the needs of country districts in the matter of developmental roads, and in the allocation of available funds it has only been possible, in the great majority of cases, to provide for a gradual extension of many such roads by the construction of comparatively short lengths from time to time. Apart from the matter of road access and transport, however, there are many factors which influence the development of primary industries. World wide economic conditions as they affect overseas markets, improvements in the means of transportation, storage and handling of primary products, the seasonal conditions in this and other countries all play their part. As the construction of most developmental roads has been spread over a fairly lengthy period during which these factors have been operating in variable degree, it is not possible to obtain any exact measure of the extent to which expenditure on developmental road construction has been reproductive. There are a few cases, however, where owing to the provision of special funds by the Government, it has been practicable to complete the construction of certain roads within a comparatively short space of time. By considering the production over a period of years in the areas served by these roads with that of adjacent comparable areas subject to similar seasonal and marketing conditions, it is possible to obtain some idea of the extent to which development has been influenced by the road works in those areas. The district comprising the upper parts of the Clarence and Richmond River Valleys is the largest of the areas selected for development by means of road construction, and is one in which it has been practicable to carry to completion a comprehensive programme of road works within a period of eight years. This area has been the subject of careful investigation in connection with the proposals for its development, and records are available of the conditions obtaining before the provision of road access and transport facilities. In the course of a recent review, the position in regard to certain forms of production from this and adjacent areas has been examined in detail. It is the purpose of this article to relate something of the progress of this district as an indication of the extent to which the expenditure incurred on road works has been reproductive, and as a guide to the benefit of the State resulting from developmental road construction generally when undertaken in pursuance of a considered policy and in accordance with a preconceived plan.

Walled in on the west and north by broken mountain ranges, rising steeply to the New England Tableland and the Macpherson Range, the valleys of the Clarence and Richmond Rivers above their navigable limits offered little inducement to the small landholder in the days when horse-driven vehicles and bullock teams were the only means of transportation to rail or port. Being in a fairly high rainfall area, transport even by teams was very difficult owing to the hilly nature of the country, the numerous streams to be crossed and the unstable nature of the ground in parts. The possibilities of this extensive tract of country were not overlooked by the early settlers, however. About eighty years ago William Ogilvie travelled overland from the Hunter River and reaching the Clarence River established his home at Yulgilbar where he founded the pastoral holding of that name comprising nearly 250,000 acres. At about the same time other pioneer settlers penetrated the country along the Upper Richmond River and, within a few years, practically the whole of the land along both rivers and their tributaries, comprising nearly 2,000,000 acres, was occupied by twenty-two large pastoral holdings and stocked with cattle. In the earlier years these grazing properties were held under license from the Crown without any security of tenure except in respect of small areas which were



Typical dairying country in the Bonalbo district.

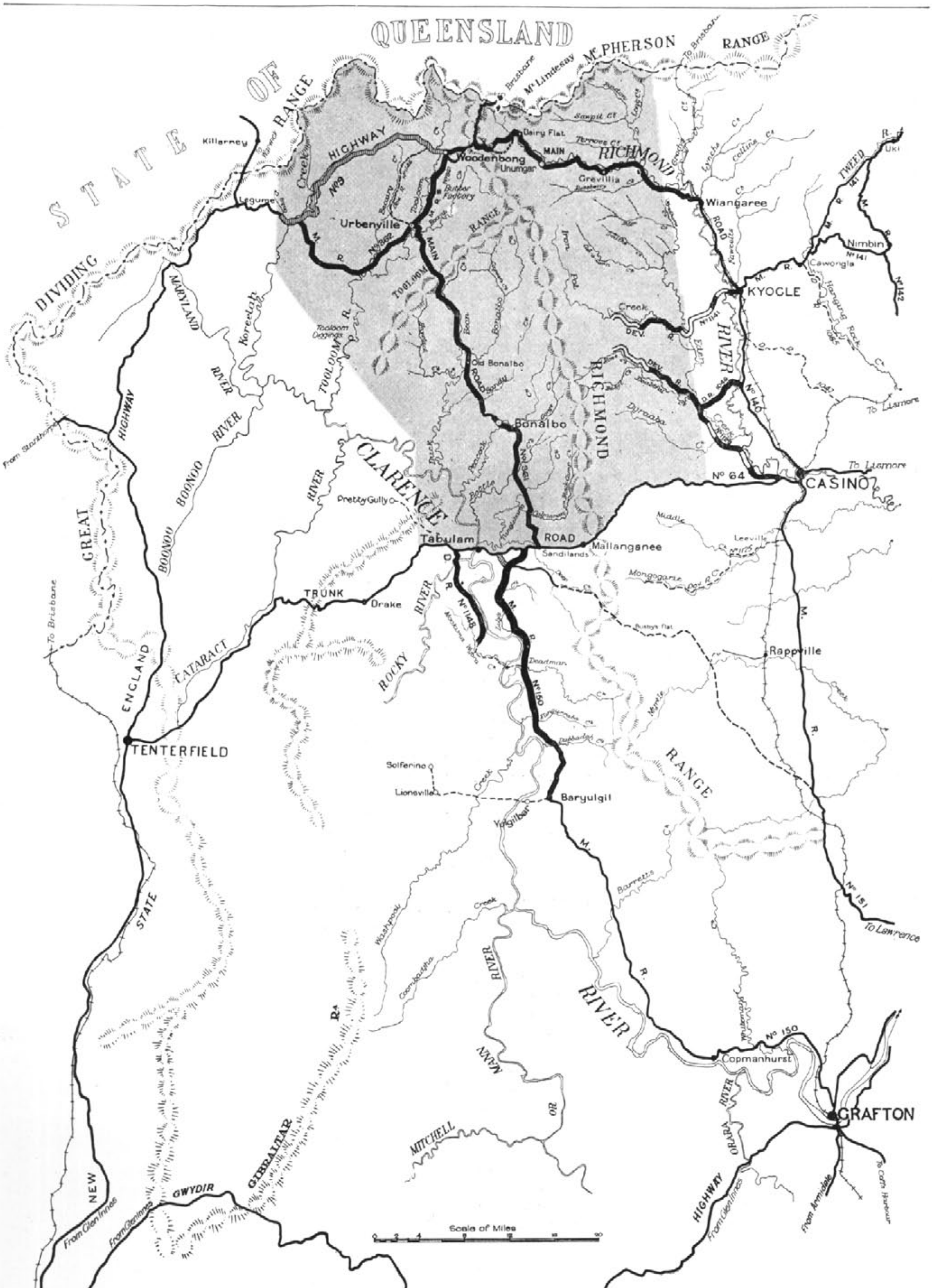
purchased to protect improvements. By the Crown Lands Act, 1884, parts of each holding, aggregating about half the total area, were placed on a leasehold basis thereby protecting the holder's interests, whilst the remainder became then available for free selection. In course of time substantial portions of most of these cattle stations were acquired by the owners by purchase from the Crown.

Whilst the country along the lower rivers with facilities for transportation by water was becoming closely settled as a result of the expansion of the dairying industry, there was little alteration in the occupation of the land above Copmanhurst on the Clarence and Casino on the Richmond River, until about the year 1906. The completion of the railway from Grafton to Casino in 1905 and its extension to Kyogle in 1910 gave an impetus to land settlement and to the timber industry, and, commencing about 1906, settlers began to take up the best of the available Crown land. Several of the large estates were subdivided about that time. Kyogle was established as a private township in 1905. Meanwhile the high country along the main watersheds, which was still in its virgin state was reserved for forestry purposes and the more accessible parts were being exploited. Both hardwood and softwood timbers were available in large quantities.

Within the next twenty years all the available Crown land of value had been selected and many of the large estates had been cut up and sold. Those remaining had been greatly reduced in area. During this period there had been a notable expansion of the dairying industry in the vicinity of Casino and Kyogle. This extended westerly to the settlement adjacent to the main road from Casino to Tenterfield, and butter factories were established at Mallanganee, 26 miles from Casino (1911), and at Bonalbo, 42 miles from Casino (1916). Except in the immediate neighbourhood of the factories, however, the absence of roads precluded the use of the land for any purpose other than cattle grazing. As evidence of the difficulties of transporting dairy produce, butter factories had been established also at Wiangaree and Ettrick, each distant only 8 miles from Kyogle, and at Dyraaba distant only about nine miles from Casino, although large factories were opening both at Kyogle and Casino.

When about 1923 consideration was given by the Government to proposals for the development of the district it was at first thought that the construction of one or more railways would be required owing to the remoteness of the greater part of the area from existing means of railway communications. The very considerable improvement in the means of motor vehicles led to the belief that the provision of suitable roads would meet the transport requirements of the whole area, at least during the earlier stages of its development.

In the earliest investigations carried out by the Main Roads Board for the selection of localities with possibilities for development by means of road construction, the upper parts of the Clarence and Richmond River Valleys attracted attention as a large tract of country, including much fertile land and

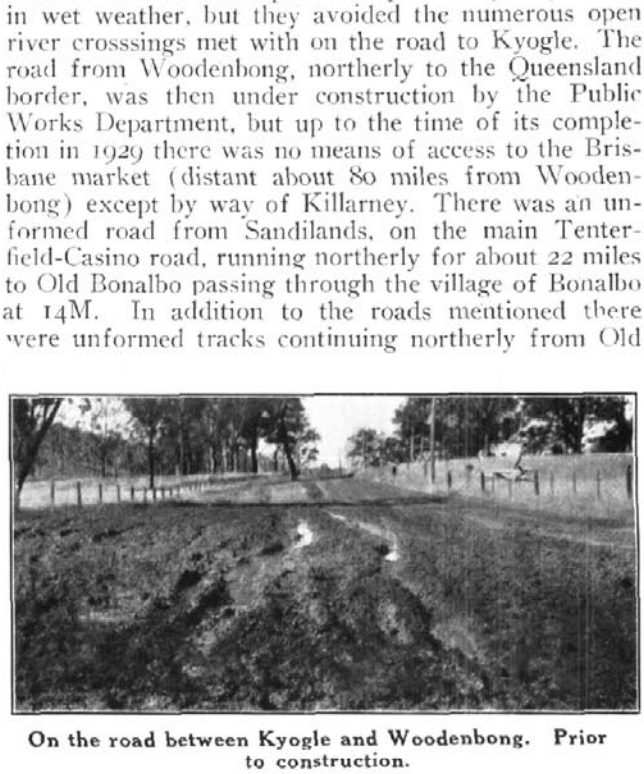


QUEENSLAND
STATE OF
McPHERSON RANGE
DIVIDING RANGE
GREAT
Killarney
Legume
Woodenbong
Urbenville
Dairy Flat
Unumgar
Grevillia
Wiangaree
KYOGLE
Nimbin
Cawongla
Uki
TWEED R.
RICHMOND
MAIN ROAD
HIGHWAY
No 9
Old Bonalbo
Bonalbo
Tooloom Diggings
TOOLOOM
MARYLAND RIVER
BOONOO BOONOO RIVER
CLARENCE
Pretty Gully
Tabulam
Sandilands
Mallanganee
Leeville
Mongogarie
CASINO
No 64
To Lismore
Drake
TRUNK
CATARACT
ROCKY RIVER
No 150
Rappville
TENTERFIELD
NEW ENGLAND HIGHWAY
STATE
Solferino
Lionsville
Baryulgil
Yulgilbar
RANGE
No 151
To Lawrence
RIVER
MANN RIVER
OR
MITCHELL
Copmanhurst
GRAFTON
ORARA RIVER
HIGHWAY
GIBRALTAR RA.
GWYDIR
From Glen Innes
From Armidale
To Coffs Harbour
To Brisbane
From Stanthorpe
Scale of Miles

Lemon Tree Crossing over the Richmond River now replaced by a timber beam bridge.

almost entirely lacking in roads. The area also came under the notice of the Commonwealth and State Governments as a likely field for development in connection with proposals for the settlement on the land of British migrants and, in 1928, on behalf of the State Migration Committee, the Main Roads Board undertook a topographical survey and investigation covering an area of about 1,250,000 acres within the Clarence Valley. The purpose of this investigation was to ascertain the possibilities of increased production and settlement within that area and the works required for its development. This and other investigations carried out in the adjacent areas in the Upper Richmond Valley disclosed that while much of the land was eminently suitable for dairy farming, its use was restricted almost entirely to cattle grazing and timber-getting owing to the absence of facilities for the carriage of products and supplies.

In 1925 the only trafficable roads in this district were those shown on the map by thin black lines. Excluding a strip of broken mountainous country extending easterly from the Great Dividing Range for an average width of 25 miles, and the country directly served by the road and railway from Grafton to Kyogle, there remained in between an area of about 1,750,000 acres within which the only trafficable roads were the main road from Tenterfield to Casino (86 miles) and the road running north-westerly from Grafton to Yulgilbar (about 54 miles). Apart from these, the roads within the area, where any existed, were of the most primitive kind. Main Road No. 140 from Wiangaree to Woodenbong followed the course of the Richmond River, and in its length of about 30 miles crossed that stream no less than thirty-two times. This road was entirely unformed and could be used only by bullock teams or horse-drawn vehicles under favourable conditions. In wet weather traffic was entirely suspended. So great were the difficulties of access by this route that road communication with Woodenbong and Urbenville districts was mostly by roads leading to Killarney, approximately along the present routes of State Highway No. 9 and Developmental Road No. 1055. Both these roads were unformed for the most part and practically impassable in wet weather, but they avoided the numerous open river crosssings met with on the road to Kyogle. The road from Woodenbong, northerly to the Queensland border, was then under construction by the Public Works Department, but up to the time of its completion in 1929 there was no means of access to the Brisbane market (distant about 80 miles from Woodenbong) except by way of Killarney. There was an unformed road from Sandilands, on the main Tenterfield-Casino road, running northerly for about 22 miles to Old Bonalbo passing through the village of Bonalbo at 14M. In addition to the roads mentioned there were unformed tracks continuing northerly from Old



On the road between Kyogle and Woodenbong. Prior to construction.

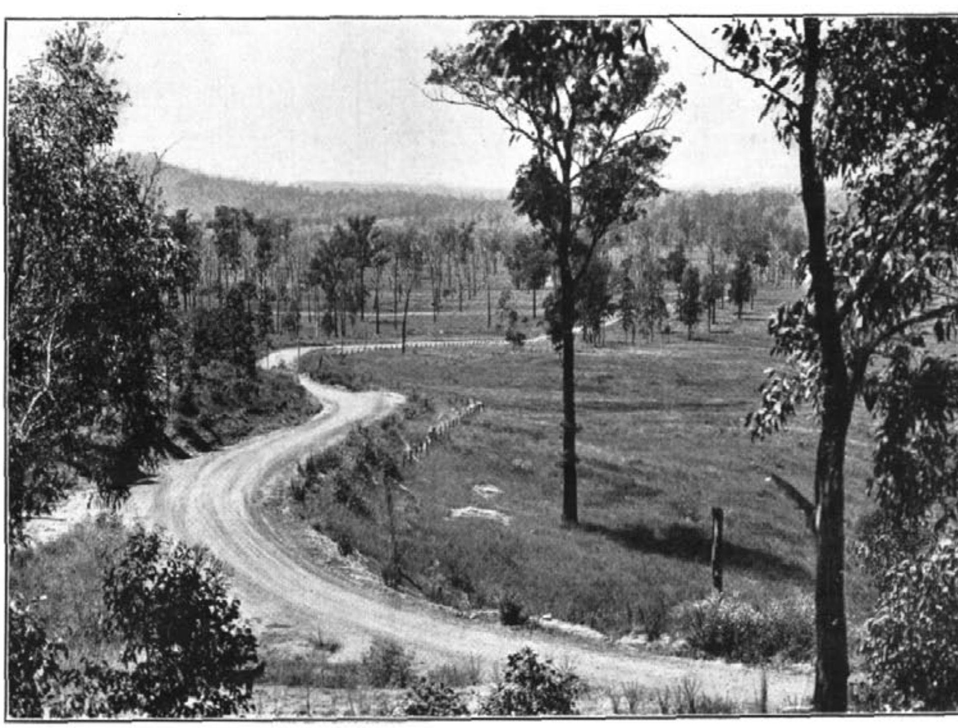
Bonalbo for a few miles, and along the large creeks where settlement had taken place. These tracks, and the Bonalbo road also, could be used with difficulty by motor vehicles in dry times, but in wet weather they became quite impassable for motor traffic and could then only be used with great difficulty by bullock teams or horse-drawn vehicles. There was no trafficable road from the Bonalbo area, in the south, to the Urbenville area, in the north. The Tooloom Range separating the two areas, was crossed by rough tracks and in one part involved a climb of about 900 feet in a little over a mile, the grades on the steepest points being about 1 in 3. The passage of the Tooloom Range was rarely attempted except on horseback.

Having ascertained the situation and extent of the areas suitable for agriculture, dairying and grazing and the topography of the country generally, it was practicable to formulate a plan for the roading of the whole area to provide, firstly, the main arteries for collecting the traffic from the whole of the area and linking up with existing means of road and railway communication; and, secondly, the feeder roads required to serve each part of the area.

By the time these proposals had been formulated the Migration Agreement had lapsed owing to the world depression, and for a time no large-scale operations could be undertaken on account of the general financial stringency.

As a result of the earlier investigations, however, Developmental Roads had been proclaimed in the Clarence Valley from Baryulgil northerly to Woodenbong (No. 1050), and from Urbenville westerly to

Old road over the Tooloom Range, between Bonalbo and Urbenville (grade 1 in 4). Superseded by new road.



New Construction between Bonalbo and Urbenville.

Koreelah Creek (No. 1055), whilst in the same year, 1928, the road from Legume via Woodenbong to the Queensland border became part of the route of the New England Highway (State Highway No. 9). In the Upper Richmond Valley the road from Kyogle to Woodenbong, though mostly unformed, was already part of Main Road No. 140, and Developmental Roads were proclaimed from Casino along Doubtful Creek to Sextonville (D.R. No. 1129) and from Kyogle westerly along Ironpot Creek (D.R. No. 1141). These various roads, in common with others throughout the State, had participated in the allocations made from the Federal Aid and Developmental Roads Funds, and construction was proceeding in sections from year to year till, at 30th June, 1932, an amount of £180,096 had been expended and the following lengths constructed throughout the whole district comprised in the upper valleys of the Clarence and Richmond Rivers:—

Road.	Length Constructed. Miles.
D.R. No. 1050 from Baryulgil northerly	10
D.R. No. 1050 from Sandilands to Bonalbo ..	14
D.R. No. 1055 from Koreelah Creek easterly	8½
D.R. No. 1129 from Casino towards Sextonville	1
D.R. No. 1141 from Kyogle westerly	1
M.R. No. 140 from Wiangaree towards Woodenbong	11
Total	45½

Except in the case of Developmental Road No. 1055 (Koreelah Creek to Urbenville), on which the work was undertaken directly by the Main Roads Board, the construction work referred to above was carried out by the Councils of Kyogle, Copmanhurst and Tomki Shires in expenditure of funds provided by the Main Roads Board, and an amount of £7,595 provided by Kyogle Shire Council towards the work on Main Road No. 140.

In 1932 it became necessary for the Government to consider proposals for works to relieve the widespread unemployment then existing, and the Department of Main Roads submitted to the Unemployment Relief Council a proposal for relief works in this district. This provided for the completion of the construction of the roads considered essential as the basis of the general plan for the roading of the area, and it was anticipated that an early return for the expenditure would be obtained in the form of increased production The area served by the roads included in the proposal embraced about 670,000 acres, lying mostly to the north of the Tenterfield-Casino road, the roads to be completed being Developmental Road No. 1050 from Bonalbo to Woodenbong; Main Road No. 140 from Grevillia to Woodenbong; Development Road No. 1055 from Urbenville towards Koorelah Creek, and Developmental Road No. 1148 a spur road from Tabulam southerly along the Clarence River, the length of construction involved being 64 miles 2,956 feet, and the estimated cost £267,578. Following approval by the Unemployment Relief Council the work was carried out by the Department of Main Roads as an unemployment relief work and completed early in 1935 at a cost of £247,630. Later on developmental road construction was extended in the area to the south of Tenterfield-Casino Road (Trunk Road No. 64) in continuation of unemployment relief works.

A full account of the unemployment relief works as they affect the area in question, with a description of the conditions obtaining at the time they were undertaken is contained in "Main Roads" for August, 1935, and November, 1936.

The lengths of roads constructed in accordance with the proposals for the development of the Upper Clarence and Richmond River Valleys are those shown on the map by broad black lines. The lengths of Developmental Roads Nos. 1129 and 1141 shown by double lines are as yet unconstructed. The construction of that part of the New England Highway (shown by hatching on map) from Koreelah Creek to Woodenbong was undertaken primarily for the purpose of completing the Highway connection between Sydney and Brisbane, via the New England Tableland, and the work was carried out as part of the State Highway construction programme during the years 1928-34. As the greater part of the construction carried out to the south of the Tenterfield-Casino road (Trunk Road No. 64) is of very recent date, no useful comparisons can be drawn in respect of that area. For the purpose of the following review of production, therefore, consideration has been confined to an area of about 750,000 acres to the north of Trunk Road No. 64—the shaded area on map. Particulars of expenditure on developmental road construction in this area during the period 1926-1936 are set out in the following table:—

EXPENDITURE ON DEVELOPMENTAL ROAD CONSTRUCTION, 1926-1936

Year.	D.R. 1050.	D.R. 1055.	M.R. 140.	D.R. 1129.	D.R. 1141.	Total.
	£	£	£	£	£	£
1926–27 ...	3,500	...	3,750	...	...	7,250
1927–28 ...	9,450	...	5,958	...	...	15,408
1928–29 ...	22,446	2,914	3,561	...	...	28,921
1929–30 ...	25,438	18,505	9,899	3,000	...	56,842
1930–31 ...	20,401	10,342	3,014	4,001	2,790	40,548
1931–32 ...	3,609	16,218	1,000	...	152	20,979
1932–33 ...	29,922	106	29,743	800	1,000	61,571
1933–34 ...	50,598	5,045	45,722	20	1,415	102,800
1934–35 ...	49,889	13,124	1,777	3,852	2,882	71,524
1935–36 ...	...	...	...	1,007	...	1,007
Totals ...	215,253	66,254	104,424	12,680	8,239	406,850
Miles of road constructed	44¼	17½	27¼	6¾	6¼	102

NOTE.—On Developmental Roads Nos. 1129 and 1141, lengths totalling 8 miles and 11¼ miles respectively, have not yet been constructed.

As previously stated the possibilities of development in this area were fully investigated before carrying out such a large construction programme. The works were undertaken with a fairly complete knowledge of the capabilities of the area and in the belief that the substantial expenditure involved would be highly reproductive. An examination of the position in regard to production and review of the conditions generally over the period of ten years ending with 1936 shows this belief to have been fully justified.

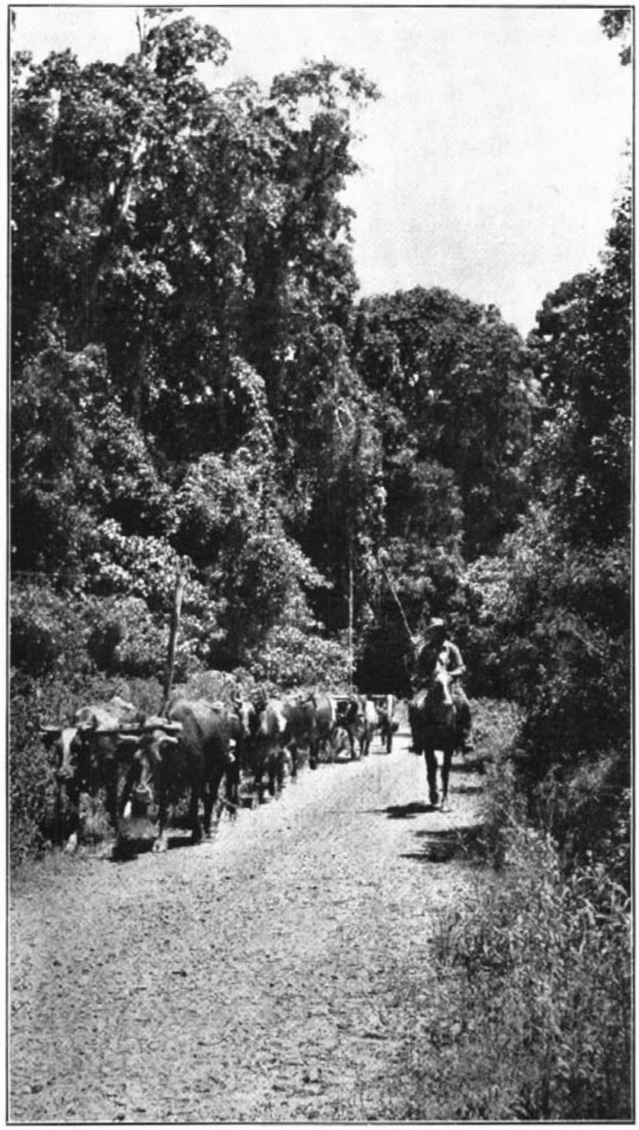
Butter Production.

The butter factories operating within and adjacent to the area under review were considered the most reliable source of information relating to butter production, and the returns and other records have been examined by courtesy of Norco Ltd., whose factories are operating at Ettrick, Kyogle, Wiangaree, Bonalbo and at Lindesay, in the Woodenbong-Urbenville area, and the Co-operative Dairy Co. Ltd., Casino, operating at Casino and in Dyraaba and Mallanganee centres. The supplies received by these factories from areas outside the influence of the developmental road works have been separately compiled for the purpose of comparison. In the following statements are shown particulars relating to butter production (A) from areas directly affected by the road works and (B) from representative areas in the locality outside the influence of these or other similar works.

A. Number of dairy farmers and quantity and value of butter produced within areas affected by developmental road construction, served by butter factories at Ettrick, Wiangaree, Lindesay, Bonalbo and Casino.

Year.	No. of Dairy Farmers.	Production. lb.	Average Price per lb.	Value.
			d.	£
1926	210	1,280,004	15·96	85,120
1927	215	1,355,290	16·00	90,352
1928	264	1,798,511	16·25	121,773
1929	275	1,923,767	17·25	138,270
1930	292	2,174,162	13·80	125,014
1931	321	2,479,315	12·68	131,042
1932	355	2,498,226	10·86	113,044
1933	380	2,997,169	9·00	112,393
1934	400	3,462,819	8·97	129,422
1935	394	3,025,025	10·69	134,739
1936	397	2,576,953	12·25	131,531
Totals, 1927–36, inclusive		24,291,237	...	1,227,580

B. Number of dairy farmers and quantity and value of butter produced in areas adjoining developmental road areas, but not served by them. (Includes areas served by the butter factories at Kyogle, Ettrick and Wiangaree.)

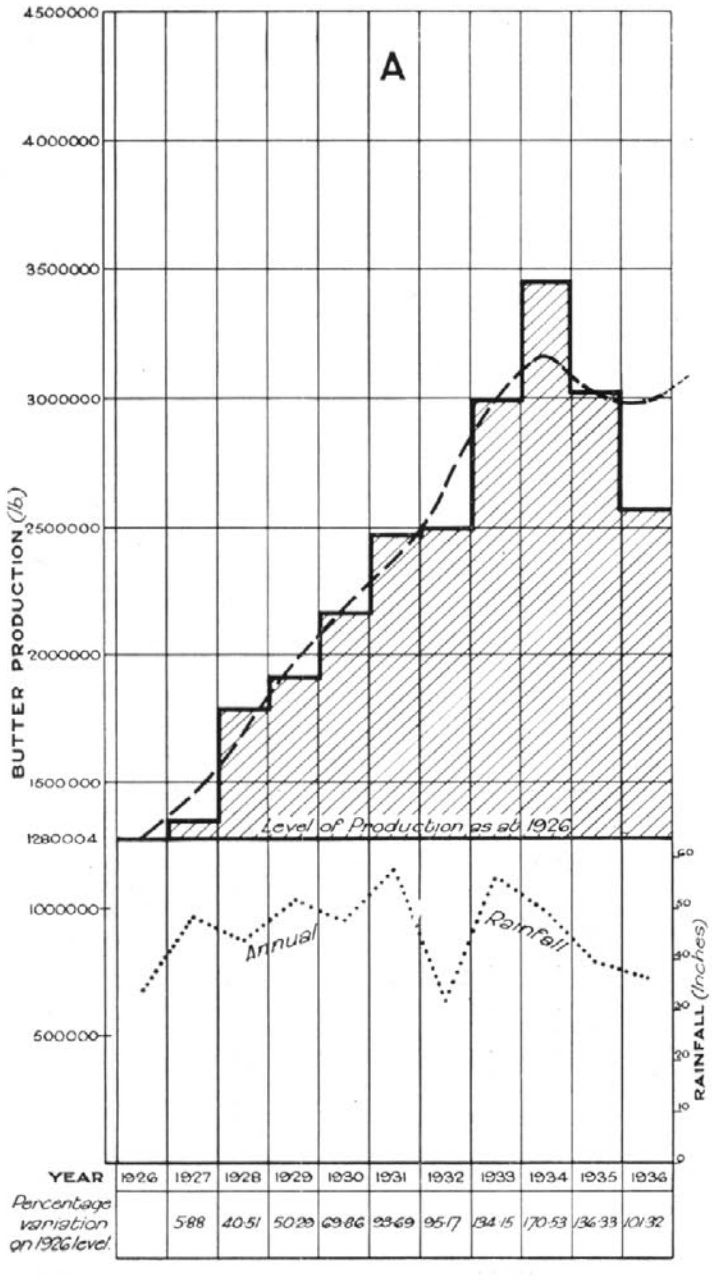


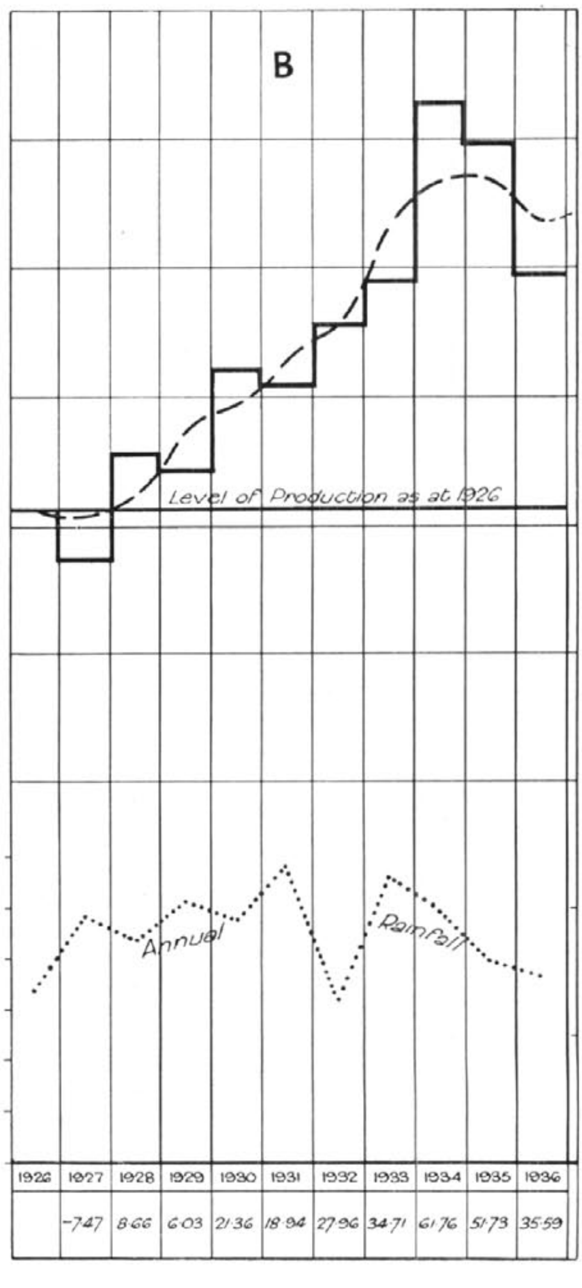
Road through the State Forest on Beaury Range. Showing bullock team now superseded by mechanical transport.

Year.	No. of Dairy Farmers.	Production. lb.	Average Price per lb.	Value.
			d.	£
1926	361	2,568,012	15·96	170,773
1927	350	2,376,309	16·00	158,421
1928	370	2,790,493	16·25	188,940
1929	381	2,722,862	17·25	195,706
1930	386	3,116,470	13·80	179,197
1931	408	3,054,521	12·68	161,381
1932	424	3,286,039	10·86	148,693
1933	434	3,459,280	9·00	129,723
1934	440	4,153,955	8·97	155,254
1935	436	3,896,407	10·69	173,552
1936	431	3,482,006	12·25	177,727
Totals, 1927–36 inclusive		32,338,342	...	1,668,594

The variation of dairying settlement and production as set out in above statements are shown graphically on Diagrams A and B respectively. The broken line in each case shows trend of settlement and production computed on three-year averages to eliminate temporary variations due to seasonal conditions. The dotted line on both diagrams represents the mean of the annual rainfall registrations at Casino and Kyogle. The effect of rainfall on production, however, is only partially indicated by the difference in the rate of increase in yearly totals. In some years long spells of dry weather were followed by abnormally heavy rains.

Owing to drought conditions, 1926 was a year of low production, and in order to provide a truer base figure for the purpose of comparison, the average of the figures for the three years preceding 1927 has been quoted as for the year 1926. Production for 1936 was also adversely affected by severe drought, and an average of the figures for the three years, 1934-1936, may be accepted as a representative figure for the end of a ten-year period for purpose of comparison with the figures quoted for 1926, and this basis of comparison will be used throughout unless otherwise stated.





It will be observed that in the area affected by developmental road construction the number of settlers increased from an average of 210 for the three years 1924-26, to an average of 397 for the three years, 1934-1936; a difference of 187=89 per cent. For the same periods, butter production increased from 1,280,004 lb. to 3,021,599 lb., a difference in annual production of 1,741,595 lb.=136 per cent. The figures for the corresponding periods relating to adjoining areas, not directly affected by the roadworks, show an increase in dairying settlement from 361 to 436, a difference of 75=20.77 per cent., and an increase in annual production from 2,568,012 lb. to 3,844,122 lb., a difference of 1,276,110 lb.=49.77 per cent.

The rate of increase in butter production varied in different parts of the area, according to the road conditions and the situation of the butter factories. The area served by Developmental Road No. 1129 includes the Dyraaba Soldiers' Settlement, on which the settlers were engaged in dairy farming previous to 1926, and had the benefit of a butter factory in close proximity to their farms. Developmental road construction on this road was not commenced until 1930, and has not yet been completed. The yearly production of butter in this locality during the ten years increased from 519,968 lb. to 738,467 lb.=42.57 per cent. At the other extreme, production on the area served by Main Road No. 140 has been influenced by developmental road construction since 1926, the whole length of about 30 miles from Wiangaree to Woodenbong having been constructed during the period 1926-1934. In this area butter production increased from 158,118 lb. in 1926 to 494,218 lb. in 1936, an increase in the amount of production of 210 per cent. The number of settlers engaged in dairy farming on this area increased from twenty-two in 1926 to seventy in 1936=218 per cent.

In the Bonalbo area, where a butter factory had been established since 1916, the average annual production for the three years, 1924-1926, was 473-945 lb., whilst for the three years, 1934-1936, the average annual production was 1,078,836 lb., an increase of 604,891 lb.=127.63 per cent. The number of settlers engaged in dairy farming in this district increased during the period from 83 to 122=47 per cent.

In the adjoining areas, covered by Table B, conditions in regard to access and transport, though by no means entirely satisfactory, had already been improved to some extent and sufficiently in the case of a number of roads to permit of all weather access to the butter factories; further improvements were being effected by the Shire Council throughout the period. In the area covered by Table A, little or no road improvement had been effected previous to 1926, and the conditions in this respect were so bad that it is probable that the rate of increase in production within this area would have been substantially less than that for adjoining areas (49.77 per cent.) if no road improvements had been effected. As seasonal and market conditions were the same in both cases, it seems reasonable to assume that the difference in the rate of increase in this area over and above that which took place in adjoining areas is due mainly to the altered conditions in respect of road access. This difference expressed in terms of production amounts to 8,172,533 lb. of butter over the period of ten years, 1927-1936 (inclusive). Applying the average price paid by the factories each year, this is equivalent to an amount of £395,890. On the same basis, the difference in the value of calves and pigs produced amounts to £171,345. The combined total, £567,245, represents the amount paid to dairy farmers in the area during this period in excess of what could reasonably have been expected in the absence of the special measures taken to improve the means of access.

Apart from the very substantial increase in dairying settlement and butter production within the area during the period under review, the investigations disclosed that the provision of the road facilities has been accompanied by an appreciable improvement in the quality of the butter produced within the area.

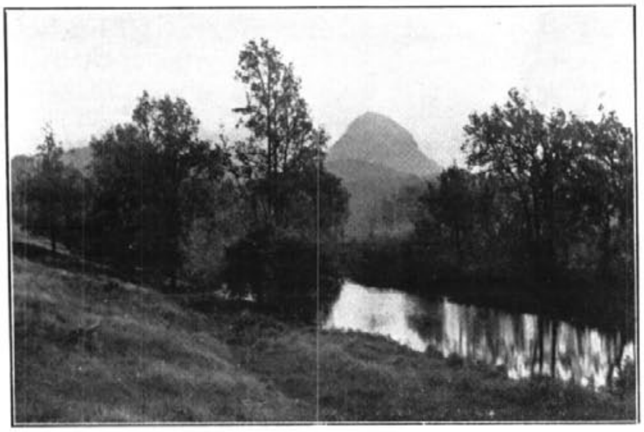
The earlier road conditions were such that it was not practicable for farmers to maintain daily delivery of their cream to the factory, and the occurrence of wet weather invariably caused delays in the less frequent deliveries. The deterioration due to enforced storage on the farm was increased by carriage over the rough bush tracks, with the result that a proportion of the butter produced was graded second class. The construction of roads made it possible for cream lorries to collect supplies daily in many cases, and deliveries were then effected rapidly and with a minimum of deterioration. The figures relating to Bonalbo factory, which are set out below, may be regarded as representative.

Bonalbo Butter Factory—Production 1926-1936.

Year.	Total lb.	Choicest and First-class Butter, lb.	Second-class Butter. lb.	Second-class Butter. Percentage of Total Production.
1926	447,508	418,426	29,082	6·49
1927	535,625	508,149	27,476	5·12
1928	590,461	555,293	35,168	5·95
1929	634,540	602,130	32,410	5·10
1930	734,652	693,977	40,675	5·53
1931	910,767	890,124	20,643	2·26
1932	865,105	861,868	3,237	0·37
1933	1,007,172	999,581	7,591	0·75
1934	1,149,336	1,142,811	6,525	0·56
1935	996,889	993,022	3,867	0·38
1936	784,119	780,385	3,734	0·47

It is safe to say that the total quantity of second-class butter produced over the whole area has been reduced by 5 per cent. to about half of 1 per cent.

The difference in value of first and second class butter to the farmer would not be less than 1d. per lb. Assuming improvement of 5 per cent. and applying this to the total production from the whole of the area the improvement in grading would be worth about £630 per year. It is reasonable to assume also that a proportion of the higher grades of butter produced improved from first-class to choicest, and from bare



Tooloom River with South Obelisk (Beehive Mountain) in the background.

choicest to sound choicest grades. While it is not to be presumed that the improvement in quality is entirely due to better facilities for transport, it is beyond question that improved road conditions are by far the greatest contributing cause.

Livestock—Production of Calves and Pigs on Dairy Farms.

The market for young calves for human consumption did not develop to any appreciable extent until 1930, when Sydney firms and a local meat company engaged in the industry. Previous to that year it was customary for calves in excess of the number required for the maintenance of the dairy herd, to be slaughtered for their hides, which were worth about 2s. each. With this new demand, surplus dairy calves became more valuable, realising 10s. a head on the average. The marketing of calves, however, depended entirely on facilities being available for collection and rapid carriage by motor lorries, as such young animals could not be driven to market. Under the conditions obtaining in the subject area prior to the construction of roads the marketing of the calves would have been quite impracticable. Even in areas where, by reason of proximity to the butter factories, dairying could be carried on, the cost of transporting calves over unmade roads would have been prohibitive.

Pig raising is a usual accompaniment of dairying in this as in other localities. In the earliest days of dairying in this locality, the marketing of pigs entailed driving them long distances to points where they could be picked up by motor lorries. Pigs ready for market in the Woodenbong-Urbenville district used to be driven forty to fifty miles to Kyogle, accompanied by a cart loaded with feed. The journey occupied from one to three weeks, and pigs lost considerable weight and value, whilst in summer time many perished on the road through heat stroke. Later on, and at about the time developmental road construction was undertaken, pigs were transported from the farms to market by motor lorry when favourable weather conditions permitted. High freight charges and difficulties of transport, however, seriously affected the profits derived from the sale of pigs. The production of calves and pigs has expanded roughly in proportion to the expansion of butter production. The amount and value of production of calves and pigs are shown in the following statement:—

Production of Calves (in excess of number required for Herd Replacements) and Pigs.

Year.	Calves.		Pigs.	
	Number.	Value. £	Number.	Value. £
1926	6,276	627	11,550	40,225
1927	7,893	789	12,440	43,218
1928	9,523	952	13,840	47,847
1929	11,119	1,111	14,235	48,400
1930	11,158	4,464	15,202	52,234
1931	12,447	5,238	16,923	33,667
1932	12,958	4,743	18,748	31,121
1933	14,642	5,430	19,840	30,443
1934	15,759	6,303	20,834	44,061
1935	14,245	5,762	20,508	36,824
1936	13,227	5,953	20,524	44,827
Totals since 1926 ...	122,971	40,745	172,894	412,642

During the years 1926 to 1929, young dairy calves from the area were not saleable for human consumption, and the values given for calves for those years is the worth of the hides at 2s. each. The values given for pigs are based on the average market value for each year at Kyogle and Casino. It will be observed that, whilst the number of pigs marketed annually increased by about 9,000 during the ten years period—about 78.6 per cent.—the increase in annual value was only about £1,679—about 0.4 per cent. This is due to the fall in the market value of pigs during that time.

Summarising the increase in dairy production during the period of ten years ending with 1936, the yearly production of butter has increased by 1,741,595 lb., equal to 136 per cent.; at an average price of 1s. per lb., this is worth £87,079 per annum. The annual production of calves (compared with 1926) has increased by 8,134 head, based on the average for 1934-36, a gain of 129 per cent., worth about £4,067 (at 10s. per head). The number of pigs sold from the area has increased by 9,000 per year, a gain of 78.6 per cent., worth about £18,000 per annum (at £2 per head). The total value of the increased annual dairy production of the area, as compared with 1926, is therefore about £109,146

Grazing.

Prior to 1926 practically the whole of the area of 750,000 acres was used for grazing. Although the dairying industry has been established in the more accessible parts for from ten to fifteen years, it was carried on mainly by the holders of grazing areas who depended largely on the breeding or fattening of beef cattle, dairying being regarded more or less as a side line in many cases. Enquiries were made to ascertain what had been the effect of the expansion of dairying on the cattle grazing industry within the area. It was not practicable to obtain precise information as to the number of beef cattle depastured on the area from year to year, but available information goes to show that despite the greater use of the land for dairy farming there has been a steady increase in the number of beef cattle. This has been possible owing to the fact that prior to 1926 much of the occupied land was in its virgin state or in the early stages of improvement. With the provision of better facilities for access, and the consequent improvement of the means of transport and of conditions generally, an impetus was given to all primary industries, and further improvement of grazing land by ringbarking, etc., has increased the carrying capacity of the area as a whole.

The beef cattle industry has benefited as a result of the provision of road access in that graziers are now able to dispose of their stock to greater advantage than formerly. Before the roads were constructed, few buyers would undertake journeys which were arduous and costly, and attended by the likelihood of being held up in the district through the roads becoming impassable. Under these circumstances there was not much competition for stock in the paddock or in local saleyards, and the owners were obliged to travel their cattle long distances for sale elsewhere, or accept the prices offered by occasional visiting buyers. At the present time, buyers visit the locality from numerous centres on the North Coast and also from Brisbane and Sydney. The resulting competition stimulates prices and enables the producer to receive the best market value.

The Timber Industry.

As previously mentioned, the high country along the main watersheds within this area has been reserved for forestry purposes. In 1926 the State Forests comprised an area of about 190,000 acres. This has since been reduced by about 5,000 acres, certain parts having been withdrawn for settlement after the commercial timber had been cut out. For the most part, however, the large quantities of hardwood and softwood timber which have been removed from this district have been obtained from the alienated land where supplies were more readily procurable. This source of supply is becoming exhausted, and sawmillers are now operating to a much greater extent on the State Forests. Ten years ago there were eleven sawmills drawing supplies from the area in question. Most of them were working on a reduced output, whilst some were nearing the end of their economic life on account of the cutting out of the timber on nearby accessible areas and the difficulty of obtaining supplies from farther afield. The delivery of logs to the mill by means of bullock teams—the only means of transport that could be used—had become costly and uncertain on the long hauls. The Veneer Co. Ltd., manufacturing veneers and plywoods at Kyogle, was obliged to obtain supplies of solftwoods by rail from other districts and from abroad and in consequence of the high landed cost, this industry, which employs about 100 men, exclusive of field employees, was in a precarious position. The saw mills drawing supplies from the area—there are now fourteen—have been given a new lease of life, which, in the case of some, is likely to continue indefinitely. The use of motor transport, which has been rendered possible by the construction of the roads, enables logs to be hauled up to 50 miles to the mills. The Veneer Company now obtains its softwood requirements from forests in the area, transporting the timber from 40 to 60 miles to Kyogle by means of motor lorries. It has been estimated that existing supplies will meet the needs of the factory for about thirteen years.

The supplies of hardwood timber which have been made accessible have been availed of largely by the Department of Railways. During the four years, 1st July, 1933, to 30th June, 1937, sleepers and girders (mostly ironbark) to the value of £25,000 and £12,400, respectively, have been obtained from forests adjacent to the Woodenbong-Kyogle Road (Main Road No. 140). Previous to 1926 motor transport from that source of supply was not practicable, as the timber was beyond the economic limit of haulage by bullock teams.

The annual turnover of the sawmills, and including the value of timber being obtained by the Department of Railways, is now about £260,000, and the industry provides employment for about 650 men. The output of the sawmills does not show an appreciable increase over the preceding ten years, but it is beyond question that but for the roads recently constructed in the area, a continuance of the industry would only have been possible on a diminishing scale of operations, with loss of State revenue in the form of timber royalties and railway freights, and of local employment.

Probably the most important advantage to the community, insofar as the timber industry is concerned, will result from the measures to be taken for forest conservation. With diminishing timber resources, the softwood and hardwood forests of this district represent a State asset of great potential value, the realisation of which is dependent on their economic management. This requires the systematic removal of trees as they reach maturity and their replacement either by natural regeneration or artificial plantings. Under the conditions previously obtaining, timber for milling purposes could only be taken in quantity from the fringes of the State Forests nearest to existing roads. As a result of over-cutting on the readily accessible parts, these areas, probably the most valuable as a source of continuous supply on account of their proximity to points of distribution, were steadily being withdrawn from the forests in response to an insistent demand for land for settlement, their immediate usefulness as timber areas having been destroyed. On the other hand, neglect of the great bulk of the forest areas on account of their remoteness from existing roads resulted in enormous wastage, due to over-maturity of the standing timber which, while it remained, prevented natural regeneration to the extent necessary to maintain continuity of supply. With the construction of the arterial roads, the greater part of the State Forest of this area have been brought within a workable distance, and the Forestry Commission is now dealing with the matter of roading of the forest areas in conjunction with proposals for their economic exploitation and conservation on the basis of perpetual supply. This has been rendered practicable as a result of the developmental road works, the whole scheme of forest access being dependent on those roads.

Road Transport and Haulage.

In formulating proposals for the development of the subject area by means of roads, it was necessary to take into account the situation of every part of the area in relation to the established means of transportation. When the matter was first considered, the main North Coast Railway had been completed as far north as Kyogle, and its extension to Brisbane was then contemplated. In the adjoining State of Queensland, branch railways extended to Killarney, within three miles of the border, and to Rathdowney, about fifteen miles from the border, at Mt. Lindesay. It was necessary, therefore, to design the layout of the arterial roads so as to bring every part of the area within the limits of economic road haulage in respect of the various rail heads. The locations adopted for the various roads which have been constructed provide for a maximum distance of about fifty miles by road to railhead from any part of the area. Before the practicable advent of the motor vehicle as a means of transportation in this area, bullock teams and horse-drawn vehicles were used, their low speeds rendering them unsuitable for the marketing of perishable dairy produce. The haulage of timber and carriage of non-perishable supplies and materials was costly and uncertain. The forty-mile journey from Woodenbong to Kyogle by horse team frequently occupied a week or more, and the cost of carriage by that means was £6 per ton. When the dairying industry was started, cream was carried to the factory with horse and cart, and, in some cases, by pack horses.

For some years before the completion of the road works, motor transport was being used to a limited extent, but was only possible under dry weather conditions. Previous to the construction of Main Road No. 140, the traffic between Woodenbong and Kyogle averaged less than three vehicles per day during the dry weather when the road could be used. On the length of eight miles, between Woodenbong and Urbenville, the traffic in 1926 was limited to perhaps a dozen vehicles per week, whilst between Urbenville and Bonalbo traffic by road was practically non-existent. There was no road communication between these centres and Brisbane, except by a difficult and roundabout route, via Killarney. In 1936 the Woodenbong-Kyogle road was carrying more than seventy vehicles per day, whilst the number using the road between Woodenbong and Urbenville exceeded 100 per day. Motor mail and passenger services now operate both ways daily between Casino and Brisbane, via Bonalbo, Urbenville and Woodenbong, and between Urbenville and Kyogle, via Woodenbong. Freight lorries carrying butter, pigs, calves and timber, ply continuously between Bonalbo and Casino and between the Woodenbong-Urbenville district and Kyogle.

Transportation charges decreased on all classes of goods, as shown in the following summary:—

	Cost of Carriage. 1929.	Cost of Carriage. 1936.
	Per ton. £ s. d.	Per ton. £ s. d.
Woodenbong to Kyogle—40 miles—		
Boxed butter ...	4 15 0	1 17 6
Other goods ...	4 10 0	1 15 0
Backloading ...	4 5 0	1 15 0
	Per head.	Per head.
Calves ...	0 5 0	0 2 6
Pigs ...	0 5 6	0 3 0
Bonalbo to Lismore—63 miles—	Per ton.	Per ton.
Boxed butter ...	5 10 0	2 0 0
Bonalbo to Casino—43 miles—		
Goods ...	5 0 0	1 15 0
Backloading ...	5 0 0	1 0 0
	Per head.	Per head.
Calves ...	0 5 0	0 2 6
Pigs ...	0 6 0	0 3 0

Cheese manufactured near Urbenville in 1929 cost £6 per ton for carriage to Kyogle, 56 miles. In 1936 the cost was £1 10s. per ton, whilst carriage by road direct to Brisbane, 86 miles, cost £2 10s. per ton. The passenger fare for single journey from Woodenbong to Kyogle had been reduced from £1 in 1932 to 8s. in 1936.

Social Conditions.

Prior to the construction of good roads, the settlers in this locality lived in a state of isolation, a condition which is perhaps the primary cause of the drift of rural population to the cities, where the conditions of life are more attractive. Any attempt to describe the roads formerly existing in this area can convey but a slight impression of the difficulties of travel. Roads which are unformed and rough are to be found in many parts of the State where travel, though difficult and uncomfortable, can be accomplished at the cost of time and convenience. Here, however, it is a peculiarity of the clayey ground that it will readily absorb and hold a great deal of water. After a light shower of rain the road surfaces became exceedingly slippery; after heavier falls the bearing value of the ground was reduced to the condition of a sticky quagmire, while the numerous creek and river crossings became impassable. As wet weather is of very frequent occurrence in this district, travelling, even on horse back, was attended with difficulties in wet times; with motor vehicles it was practically impossible. Attempts to maintain essential communications by motor lorries or teams left such deep ruts and bog holes that when dry conditions returned travelling was exceedingly rough, and attended at every stage by the risk of breakdown. It is easy to appreciate that under these conditions visitors from outside districts were few and far between, and travelling by the settlers themselves was rarely undertaken, except in case of pressing need. The delivery of supplies was frequently delayed for periods up to six weeks in wet seasons. The fear of isolation from medical assistance in time of need was ever present in the minds of settlers with families, and such educational facilities as there were could not be readily availed of. Even the advantages of wireless were denied many of the settlers, who were unable to have batteries and accumulators charged when required.

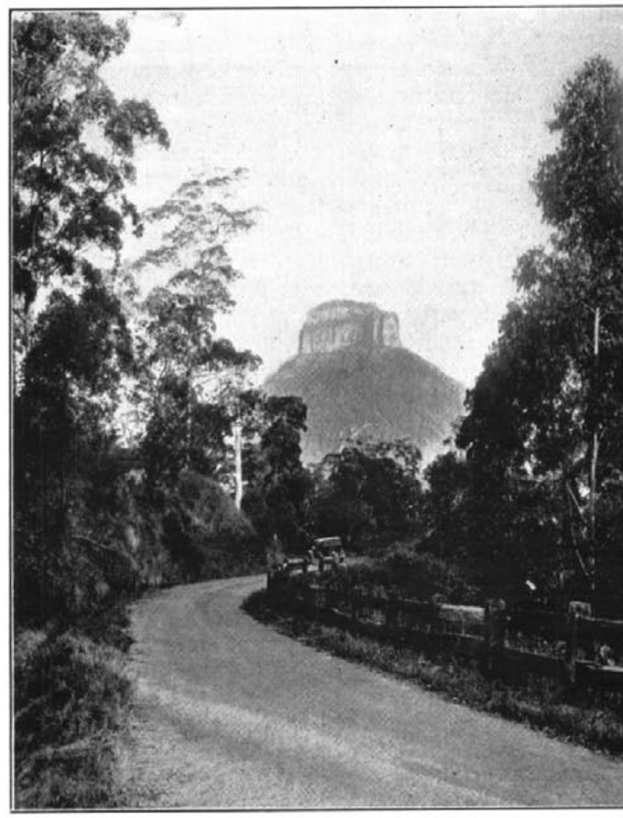
While the settlers away from the constructed roads still have difficulties to contend with, the facilities already provided for travelling under all weather conditions have brought about a remarkable change in the social conditions of the area. There is frequent interchange of visits by members of social and sporting bodies of this and of surrounding districts. The seaside and holiday resorts of the North Coast are now within easy reach, whilst the journey to Brisbane by road occupies only a few hours. Medical aid is readily available. Provision has been made for super-primary education at Bonalbo, and the daily two-way motor services enable students to attend the High School at Casino at little cost. The radio, and newspapers which are delivered from Brisbane and elsewhere on the date of issue, are now an established feature of the life of this rapidly-growing community.

As the boundaries of the area in question do not coincide with those which have been adopted for statistical purposes, figures relating to the growth of population cannot readily be obtained. An indication of the extent to which it is increasing is contained in the following figures relating to the three townships within the area:—

	Population.		Children attending School.	
	1929.	1936.	1929.	1936.
Woodenbong	102	401	27	62
Urbenville	93	278	31	50
Bonalbo	266	513	72	100
Totals	461	1,192	130	212

Tourist Attractions.

Intended at the outset as the means of access necessary for the development of primary industries, the roads constructed in this area have opened to the tourist scenic attractions of great variety and interest. After leaving the Tenterfield-Casino road, the traveller going north passes through valleys with a vista of farms and pastoral lands against a background of tree-clad ranges. For twenty-five miles the road continues by hill and dale, but rising slowly to the foothills of the Tooloom Range. Here the nature of the scene changes. The winding road ascends through hardwood forest merging towards the summit, with the softwood brush, where the dense growth of trees and vines make a wall of dark foliage relieved by the light green of the ferns and the occasional blaze of the flame tree. Emerging from the timber as the road descends again, there comes into view a unique picture of undulating farm lands surrounding the survivals of earlier mountain ranges, now isolated peaks. The aptly-named Edinburgh Castle rises high above the ranges to the east. Passing through Urbenville, which lies in the shadow of the Crown Mountain, and going west towards Legume, the road passes within a mile of the Tooloom Falls, and, skirting the base of the South Obelisk, enters a tropical jungle. No word picture can bring to mind the profusion of growth that lines the road over the Beaury Range. Closed against timber getters, and permanently reserved for the preservation of native flora and fauna, this strip of country contains a wealth and variety of timber, ferns and orchids not to be found elsewhere in the State in accessible situations. Abruptly the jungle ends at the Koreelah Lookout, from which point the view extends over timbered range and open valley for many miles to the south. Joining the New England Highway a little farther on and turning east again, farm lands and forest alternate for about twenty miles till, approaching Woodenbong, the jagged peaks of the Macpherson Range come into view with Mount Lindesay rising solitary 2,000 feet above the pass where the highway crosses the border into Queensland.



Mount Lindesay on the Queensland Border near the New England Highway.

Conclusion.

Reviewing very briefly the development that has taken place following the expenditure of £406,850 on developmental road works within this area of 750,000 acres—the northern part of the district comprised in the Upper Clarence and Richmond Valleys—it is found, after making liberal allowance for development which might have taken place under any circumstances, that the value of dairy production due to the accelerated progress of the district over the ten years period amounts to about £567,000; whilst the average annual dairy production for the three years, 1934-1936, was worth £10,900 more than the average annual production for the three years, 1924-1926, based on the rather low prices ruling in 1936. The grazing industry has been placed in a better position as regards the marketing of beef cattle. The timber industry has been given a new lease of life, enabling it to maintain a turnover in the vicinity of £250,000 per year, and the economic exploitation and conservation of the valuable timber resources of the area has been rendered practicable. Besides relieving the disabilities and hardships of the existing settlers and their families, the provision of road access has led to a substantial increase in the number of settlers engaged in dairy farming, and has brought about conditions under which a very much larger increase in settlement is assured. Added to this, scenery of a high order, attractive alike to the tourist from at home and abroad, has been made available. In this connection it may be mentioned that provision has been made within the boundaries of the roads for camping and parking places for travellers at numerous suitable points.

In considering the development which has already taken place, due regard must be paid to the comparatively recent date of completion of the more important road works. The substantial progress made practically during the period of construction affords some indication of the capabilities of the area and the returns which may be anticipated at a later stage. Much remains to be done by the local authorities in the way of improvement of the numerous feeder roads to provide suitable access throughout the area, but the construction of the arterial roads provides the essential means of communication and the main framework of the system of roads required for the development of this district.

Acknowledgments.

The Department desires to place on record its sincere thanks and appreciation of the courtesy and valuable assistance extended to its officers in the collection of much of the data incorporated in this article by Mr. A. M. Williams, F.C.I.S., A.F.I.A., Secretary and Assistant Manager, Norco Co-op. Ltd., Byron Bay; Mr. James Simes, Accountant, Norco Co-op. Ltd., Byron Bay; Mr. W. H. Penhey, Manager, Casino Co-op. Dairy Society Ltd.; Mr. F. J. Brown, L.I.C.A., Secretary, Casino Co-op. Dairy Society Ltd.; Mr. P. J. Carey, Director, Casino Co-op. Dairy Society Ltd.; Mr. Watson, Manager and Secretary, Northern Meat Coy. Ltd., Casino; Mr. Ern Smith, Auctioneer, Kyogle; Mr. W. Lever, Veneer Coy. Ltd., Kyogle; and Mr. Norman Johnston, Auctioneer, of Bonalbo.

RECONSTRUCTION ON THE MITCHELL HIGHWAY BETWEEN WELLINGTON AND DUBBO.

The following account of recent reconstruction on the Mitchell Highway between Wellington and Dubbo covers the work done since 1932 between the bridge over the Macquarie River at Wellington (231 m. 3,648 ft.) and the Dubbo Municipal boundary (260 m. 697 ft.). The road traverses the Shires of Cobbora and Talbragar, the common boundary being at 249 m. 3,504 ft.

Cobbora Shire.

Prior to the inception of the Main Roads Board, the Wellington-Dubbo road in Cobbora Shire crossed the railway four times between Wellington, and Geurie. Reconstruction, including deviations, was undertaken in the early years of the Main Roads Board, resulting in the elimination of the railway crossings and attendant sharp bends. The new work on these reconstructed lengths consisted of fairly heavy earthworks, a Telford base course and a 3-inch thick pre-mixed bituminous macadam surface course, and was carried out by Council by day labour. It extended from Wellington to 236 m. 1,155 ft. and from 242 m. 2,425 ft. to 244 m. 1,908 ft., a total length of approximately six and a half miles. The remainder consisted of old waterbound macadam blinded with a thin surface layer of gravel. The alignment and grades generally were reasonable, but there were many open water crossings. Three of these blocked traffic after rain, viz., two at Maryvale and one at Pile Creek between Geurie and Wongarbon.

The first more recent improvement work to be undertaken was the construction of a bridge over Pile Creek. The former causeway was washed out in 1929, but, owing to the limited funds available at that time, the construction of the bridge could not be put in hand until early in 1932. The new bridge consists of a single timber beam span of 27 ft., 18 ft. wide between kerbs. It was completed in July, 1932, under contract to the Department by Messrs. Wallace and McGee at a cost of £792. During 1932-33 a commencement was made with the elimination of other open crossings. One 2-cell 6 ft. x 3 ft. box culvert was built at 246 m. 949 ft. under contract to the Council by Mr. R. T. Kelly at a cost of £292 9s. 6d. At the same time a group of eight 24 in. and 36 in. diameter concrete pipe culverts was built throughout the length by Mr. H. M. Graham under contract to the Council at a cost of £307 1s.

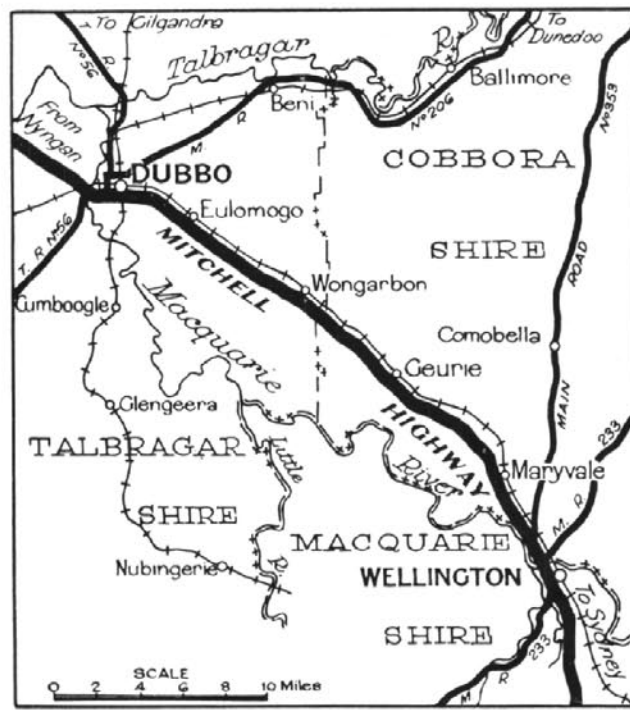
Under the Council's 1934-35 Maintenance Programme a further group of 5 culverts, ranging in size from 24 in. diameter pipes to a two-cell 6 ft. x 4 ft. concrete box culvert, was constructed by Mr. R. O'Neill under contract to the Council at a cost of

£713 15s. 5d. At the same time, one of the old railway cuttings between Maryvale and Geurie was widened to give a formation width of 26 ft. at a cost of £203. It is one of the interesting features of this road that the length from Maryvale to within 3 miles of Geurie occupies an abandoned railway location. Upon the deviation of the railway to secure improved grades, the old railway location was taken over for road purposes, the old ballast providing an excellent foundation, and the wide sweeping curves and long regular railway grades giving a standard of alignment and grading not often met with in road work through hilly or undulating country.

Two new concrete bridges at Maryvale designed to eliminate the open crossings referred to above were constructed during 1935 by Mr. L. Delatorre under contract to the Department at a cost of £5,087 12s. 11d. The bridge nearer to Wellington consists of a 3-span rigid frame structure with slab type deck, having spans of 19 ft., 22 ft., and 19 ft., and a width between kerbs of 20 ft. The bridge is founded upon tight gravel at a depth of approximately 10 ft. below the level of the old causeway. The second structure consists of a 3-span reinforced concrete slab bridge 61 ft. long, 20 ft. wide between kerbs. The site is somewhat unusual in that ordinary flows are small, but occasional high floods had to be provided for. The approaches are therefore fairly high and extensive involving a total quantity of 13,854 cub. yards of earthworks and 6,500 sq. yards of new gravel pavement.

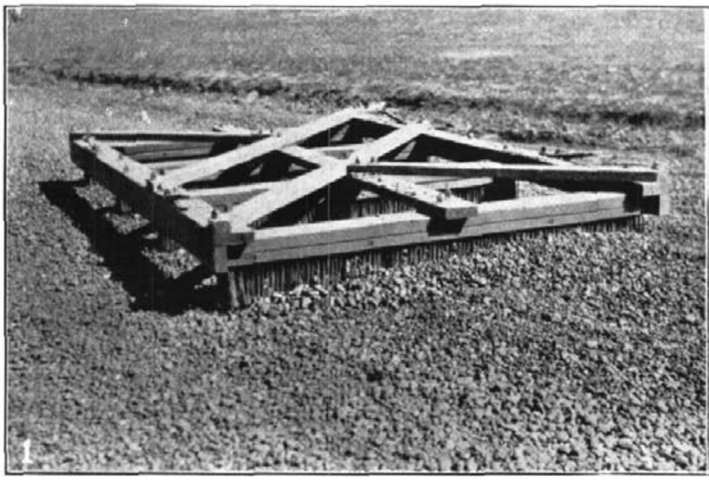
During 1935-36 a further group of culverts to eliminate open crossings was constructed by Mr. R. Wheeler under contract to the Shire Council at a cost of £863. Six culverts were built, ranging in size from an 18-in. diameter pipe to a 2-cell 4 feet x 3 feet concrete box culvert. Under the same programme, the old formation between Maryvale and Geurie was reconstructed by one of the Department's heavy tractor-grader plants at a cost of £663, and a second old railway cutting was widened by the Council at a cost of £76. Towards the end of this programme, five short sections were regraded by the Council on the Geurie-Wongarbon section at a cost of £673, in order to improve visibility over vertical curves, to improve riding qualities and to superelevate the curves.

During September, 1936, the length from Geurie to Wongarbon (from 245 m. 2,300 ft. to the Shire boundary at 249 m. 3,584 ft.) was surface treated by the Department's spraying plant. Prior to spraying, the road was gravelled, and reconstructed by the Department's heavy Diesel tractor grander plant, at a cost of £1,324. The section runs through red to black soil, one length of approximately half a mile being through particularly poor black soil (from a road making point of view). The pavement here consists of not more than 3 inches of mixed ironstone and quartz gravel. Although the shoulders are open and friable (showing the poor qualities of the soil) the thin pavement since surface treatment has carried traffic very satisfactorily. Fluxed bitumen on Duratenax primer was used. The aggregate was screened ridge quartz and was spread in one application, *i.e.*, the coarse and fine were not separated. The cost of this work was £1,866 for 44,900 sq. yards. = 9¾d. per sq. yard. One of the points learned from this particular job was that only limited fluxing of bitumen should be allowed if satisfactory adherence of round smooth gravel is to be obtained and that heavy broom dragging during the setting-up period is harmful, because it dislodges some of the round gravel which does not appear to adhere again until broken and crushed by traffic. This job completed the reconstruction of the road on this particular section.



Locality Sketch.

During 1936-37, further reconstruction was carried out on the section of existing gravel between Maryvale (236 m. 1,155 ft.) and Geurie (242 m. 2,425 ft.). The biggest job was carried out by contract to the Council by Mr. J. Lighezolo at a cost of £2,052. It consisted of the construction of 16 culverts, ranging in size from 18 in. diameter pipes to a 5-cell 7 ft. x 4 ft. box culvert, together with two small sections of regrading and realigning. These works completed the elimination of open water crossings on this section, as well as the replacement of several inadequate culverts. At the same time the Council constructed protection fences over the long embankments at the two bridges at Maryvale at a cost of £276, and gravelled the full length with approximately 12 cub. yards of gravel per chain at a cost of £770. In the preparation for surfacing this length, one rather novel experiment was tried. There are no local sources of suitable aggregate. The gravel being put out on the road consists of water-worn quartz in a clay matrix. It cannot be screened satisfactorily in the pits on account of the clay content so, taking a lesson from the quick and troublesome ravelling of the material on the road, it was planned to apply the gravel in greater quantities than would



1. Standard Drag Broom. 2. Fantail Spreader in operation.

normally be required, and then, as it ravelled, to grade the harsh material to the side in a windrow and screen it through small portable screens ("wheelbarrow" screens) to give surface treatment aggregate. This scheme was put into effect towards the end of last summer. First-class hard, clean material was obtained, but the work of screening proved to be rather slow, and in view of its intermittent nature, required first-class supervision for maximum economy. The winter put a stop to this screening and the balance of the material required is being obtained from an outside source. The type of portable screen evolved has proved to be very useful for special minor jobs such as dressing small quantities of aggregate for maintenance, cleaning up dumps, etc. The spraying of this length will be undertaken during the summer of 1937-38.

At the conclusion of the work just mentioned, the only job remaining to be done to complete the reconstruction of the Highway through the Shire will be the construction of a section of approximately 1 mile through Geurie township which will be carried out at an early date. This section has some special difficulties, mainly due to the fact that the township lies at the junction of several fairly large watercourses. Flooding of the main street, along which the Highway passes, occurs at intervals. The problem is to pass the water and raise the road sufficiently to provide traffic facilities without disturbing too much the normal business traffic in the street, but it is hoped to prepare a design meeting these conditions. Further work to be undertaken before the length through the Shire can be considered as meeting entirely present-day requirements, is reconditioning of the old premixed bituminous lengths referred to above, both in respect of riding quality and in respect of alignment. The first job to be done will be the elimination of a right angle bend just north of Wellington bridge and its replacement with a widened curve of ample visibility. There are three other short radius curves which will be treated similarly. Some of the wide curves at present are unsuperelevated and the old sections generally are not up to modern standards as regards cross section and riding qualities. The necessary work to bring these sections up to standard will be commenced this year and continued as funds become available. Improvement of riding qualities of premixed pavement will be undertaken in conjunction with resealing.

Talbragar Shire.

Prior to 1933 no substantial improvements were effected to this road, the work consisting only of routine maintenance. At the request of the Shire Council, the maintenance of this road has been carried out directly by the Department since December, 1932. The first improvement to be undertaken was the construction of a bridge over Eulomogo Creek at 255 m. 2,044 ft. The open crossing over this creek had been a source of trouble to traffic for many years. Traffic was held up, in extreme cases, for up to three days, and was often delayed for from three or four hours. A timber bridge 120 feet long and 18 feet wide between kerbs was constructed by Mr. H. Woodward under contract to the Department and was opened to traffic during January, 1934. The bridge cost £2,073 8s. 5d.

During the 1933-34 Maintenance Programme a 10-ft. x 5-ft. box culvert was constructed near the Shire boundary at 249 m. 4,611 ft. by Messrs. Wallace and McGee under contract to the Department at a cost of £339 15s. 2d. This eliminated another troublesome open crossing. During the same programme three small 18 in. and 21 in. diameter concrete pipe culverts were constructed by day labour at a cost of approximately £300. During this period, heavier equipment was used for routine maintenance and a commencement made with widening and reshaping the formation and building up the gravel surface.

Towards the end of 1934, a special allocation was made for the purpose of eliminating further open crossings and was spent principally in providing two concrete culverts at 251 m. 3,145 ft. and 251 m. 3,675 ft., where two branches of the head of Eulomogo Creek cross the Highway. At the former site a 4-cell 6 ft. x

3 ft. skew concrete box culvert was constructed, and at the latter site a 4-cell 5 ft. x 3 ft. concrete culvert was built. These structures, together with an 18 in. diameter pipe culvert opposite Eulomogo Siding, cost £1,059.

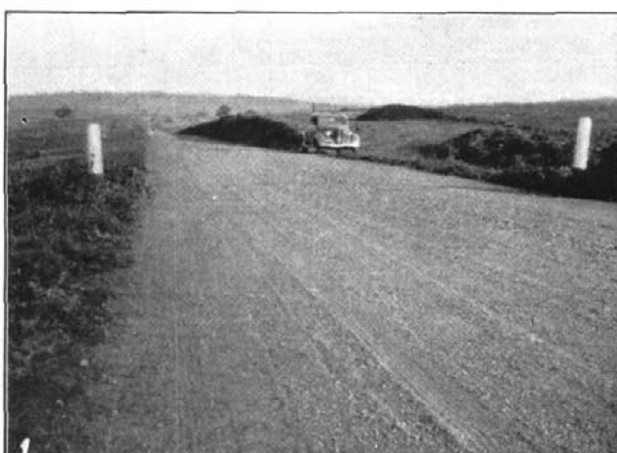
During the 1934-35 Maintenance Programme, maintenance of the gravel pavement and formation by heavy machines was continued and the general shape of the road much improved. The remainder of the open crossings were eliminated by the construction of six small concrete box culverts ranging in size from a single cell 6 ft. x 3 ft. to a double-cell 6 ft. x 2 ft., at a cost of £1,749. This work was carried out by the Department's maintenance gang.

During 1935-36, the final steps in bringing the length up to modern standard were taken. The road was gravelled throughout at an average rate of 7.4 cub. yards per chain, a total of 6,176 cub. yards of gravel being put out at a cost of 4s. 4d. per cub. yard, the total cost being £1,328. Having in mind the intention to bituminous surface at an early date, the local materials were mixed in order to give the best surface for spraying. About 5 cubic yards per chain of fairly soft red ironstone having exceptionally good binding qualities was put out. This material binds together very well under dry weather conditions, but is apt to be slightly greasy when wet and wears fairly rapidly under traffic and maintenance grading. On top of this gravel, an average quantity of 2 cub. yards to the chain of water-worn, fine gauge, ridge quartz was spread. Under maintenance and traffic this material fractured and become mixed with and embedded in the ironstone, hardening the latter and enabling a very true, dense, "sandpaper" surface to be prepared prior to spraying. The principal operation in preparing the road was regrading and reshaping with the Department's heavy Diesel tractor-grader plant, consisting of a 12-feet blade grader weighing 6¾ tons, usually operated with two 2-feet extensions to the blade and hauled by a crawler-type tractor. This plant was manned by an experienced crew who did their own pegging out. The plant crew tested the cross fall and lateral symmetry with camber board, level and straight edge. The ultimate result was a pavement having riding qualities of a very high standard. The work carried out by the Diesel plant cost £328, equal to 8s. per chain. This rate would be an average only, as little work was required at the many sites where new culverts had been constructed, while heavier work was required on sections of the old road not included in any of the new culvert work. This applied also to the gravelling, the average rate of application being practically double on weak sections of the old road and reduced correspondingly over the new culvert approaches.

The new section, 10 m. 34 chs. long, was maintained in good shape by a combination of the heavy Diesel plant, planer drag and horse-drawn graders as necessary according to weather conditions. Bituminous spraying was put in hand in February, 1936. The materials used were fluxed bitumen, coke oven tar primer and local screened quartz, ridge gravel.

One work remains to be done to complete the construction of this section, namely, the construction of a small bridge at a crossing over Eulomogo Creek at 253 m. 611 ft. This creek crosses the road three times, the first and third crossings having already been bridged. This work will be carried out during the present financial year. The alignment and grading of the Highway through the Shire are now excellent. The country passed through is undulating, red soil, wheat land, providing a first-class subgrade and making possible the light type of construction which has been adopted.

With the completion of the reconstruction of the road and surfacing the pavement, as described, during 1938, a bituminous or other dustless pavement will have been provided from Sydney to Dubbo, a distance of 262 miles, with the exception of a few short sections aggregating 26 miles in length.



1. Reconstructed road between Maryvale and Geurie, prior to surface treatment. 2. Section of highway west of Geurie after surface treatment.

ROAD DESIGN STANDARDS, 1937.

Instructions for Design of Two-lane Rural Highway.

(Continued from November, 1937.)

8. Benching, Clearing, Obstructions.

Where it is necessary to improve the sight distance on horizontal curves, recourse may be made to benching on the inside. The width of benching shall be determined by plotting the curves to scale and drawing a series of sight lines between points on the centre of the inside traffic lane, the distance along the traffic lane between each pair of points being the sight distance required. The level of the bench (at horizontal curves without vertical curves only) shall be 4 feet above the centre of the inside lane.

This method shall also be used to determine the extent of clearing required for sight distance in timbered country, the location of trees in tree-planting schemes, and whether buildings, etc., obstruct the line of sight.

It should be noted that benching is expensive and, where benching would be required, it is often possible to adopt an improved alignment requiring no benching at little or no extra cost. Benching is unsightly and roads with benching require additional maintenance expenditure all their useful life for the clearing of vegetation, earth, stones, etc. from the benching, and careful consideration should be given to alternative alignments in every case.

For combined horizontal and vertical curves benching is a more complex problem. The horizontal distances of the edge of the benching from the road centre line is the same as for a horizontal curve only, but the level of the benching is greatly altered (see clause 9c).

9. Combination of Horizontal Curves with Grades and Vertical Curves.

(a) Grade Compensation.

Grades shall be compensated for curvature in accordance with the following table:—

Radius of Horizontal Curve in feet.	Equivalent Additional Grade due to Curvature, at Design Speed—miles per hour.			
	30	40	50	60
2,500 or more ...	Nil.	Nil.	Nil.	Nil.
1,600–2,000 ...	Nil.	Nil.	Nil.	¼%
1,300–1,500 ...	Nil.	Nil.	¼%	¼%
1 000–1,200 ...	Nil.	Nil.	¼%	½%
800– 900 ...	Nil.	¼%	½%	......
650– 750 ...	Nil.	½%	½%	......
500– 600 ...	¼%	½%	......	......
400– 450 ...	½%	¾%	......	......
300– 350 ...	¾%	......	......	......
220– 250 ...	1%	......	......	......

The above additions shall be made to the grades along the nominal centre line (see clause 2) for the full length of curve and transitions in computing the grading of hills as specified in clause 4.

(b) Minimum Curves on Steep Grades.

The normal minimum horizontal curves are permitted on level sections or on sections with light grades only. For steep grades the minimum curves shall be increased as follows:—

(i) Earth, Gravel or Stone Surfaces.

Grade in per cent.	Minimum Radius in feet for Design Speed in miles per hour.			
	30	40	50	60
1	250	500	800	1,200
2	250	500	800	1,200
3	250	500	800	1,300
4	300	550	850	1,300
5	300	550	850	......
6	300	550	900	......
7	300	550	......	......
8	300	550	......	......
9	350	......	......	......
10	350	......	......	......

(ii) Bitumen, Tar or Concrete Surfaces.

Grade in per cent.	Minimum Radius in feet for Design Speed in miles per hour.			
	30	40	50	60
1	220	400	650	1,000
2	220	400	650	1,000
3	220	400	700	1,100
4	220	400	700	1,100
5	250	450	750	1,200
6	250	450	750	1,200
7	250	500	800	......
8	250	500	800	......
9	250	500	......	......
10	300	550	......	......
11	300	......	......	......
12	300	......	......	......

(c) Combined Horizontal and Vertical Curves.

Combinations of horizontal and vertical curvature are undesirable, and shall be avoided if practicable.

Where such combinations are unavoidable, the normal minimum radius of horizontal curves shall be increased as follows:—

(i) Earth, Gravel or Stone Surfaces.

Value of R/W. (see Cl. 8).	Minimum Radius (feet) for Design Speed in miles per hour of—			
	30	40	50	60
5% or less	250	500	800	1,200
Over 5% to 10% ...	300	550	850	1,300
„ 10% to 15% ...	300	650	900	2,000
„ 15% to 20% ...	Not allowed in combination with any horizontal curve.			

(ii) Bitumen Tar or Concrete Surfaces.

Value of R/W. (see Cl. 8).	Minimum Radius (feet) for Design Speed in miles per hour of—			
	30	40	50	60
5% or less	220	400	650	1,000
Over 5% to 10% ...	250	450	700	1,100
„ 10% to 15% ...	250	500	800	1,200
„ 15% to 20% ...	300	550	900	1,300

Where such combinations occur at summits and sight distance is a controlling factor attention is drawn to the following points:—

1. The line of sight is inside the path of the car and usually off the pavement altogether, frequently therefore the level of the pavement near the centre of the combined curves does not affect the sight distance and the longitudinal grading can be designed for riding qualities and economy irrespective of sight distance.
2. Where benching is used, the level of the bench required will be fixed by the road levels some distance from the bench and the bench will not be horizontal.

Such combinations are unusual and very variable and each will require separate treatment. For details of design see article by E. F. Mullin in Main Roads, vol. 8, No. 4 (Aug. 1937), page 146.

10. Grading at Causeways and Culverts.

Short causeways present a special case of adjacent vertical curves in which the length of each curve is so short that the shock or rebound on entering the first curve has not died away when the next curve is reached.

As short causeways are only used on straight roads, and as the appearance of the roadway and the marking posts indicate to the occupants of vehicles that the sudden vertical movements are to be expected, considerably greater vertical accelerations are permissible for short causeways than for long vertical curves at breaks of grade. The minimum lengths of vertical curves for short causeways (based on experiments) are given in figures 12 and 13.

Short causeways shall only be used on straight sections of road, as the rapidly fluctuating road reaction and the "bounce" of the car would make steering difficult and dangerous if such causeways were used on curves. Where a horizontal curve is placed near a short causeway the minimum length of straight between the end of the last vertical curve of the causeway and the end of the transition for the horizontal curve shall be:—

Design Speed ... m.p.h.	30	40	50	60
Length of Straight ft.	50	60	80	100

Grades on causeways are very short, and can easily be ascended as "momentum grades," therefore the grade requirements given in clause 4 do not apply, and maximum instantaneous grades for all speeds are:—

Earth, gravel, or stone surfaces ...	10%
Bitumen, tar, or concrete surfaces ...	12%

All causeways on or near horizontal curves shall be designed in accordance with clauses 7 and 9 of this instruction. Large causeways shall be similarly designed if practicable.

In all cases the causeway shall be graded so as to interfere as little as possible with the natural waterway. In deep causeways sight distance shall be considered, and ample braking distance to prevent a vehicle running into a concealed obstruction in the bottom of the causeway shall be provided.

In many cases, particularly in flat country and where culverts are constructed to replace causeways, it is necessary to raise the road surface above the general level of the road on each side at pipe and/or similar culverts to provide the necessary cover. In such cases the road surface shall be graded as shown on figure 14.

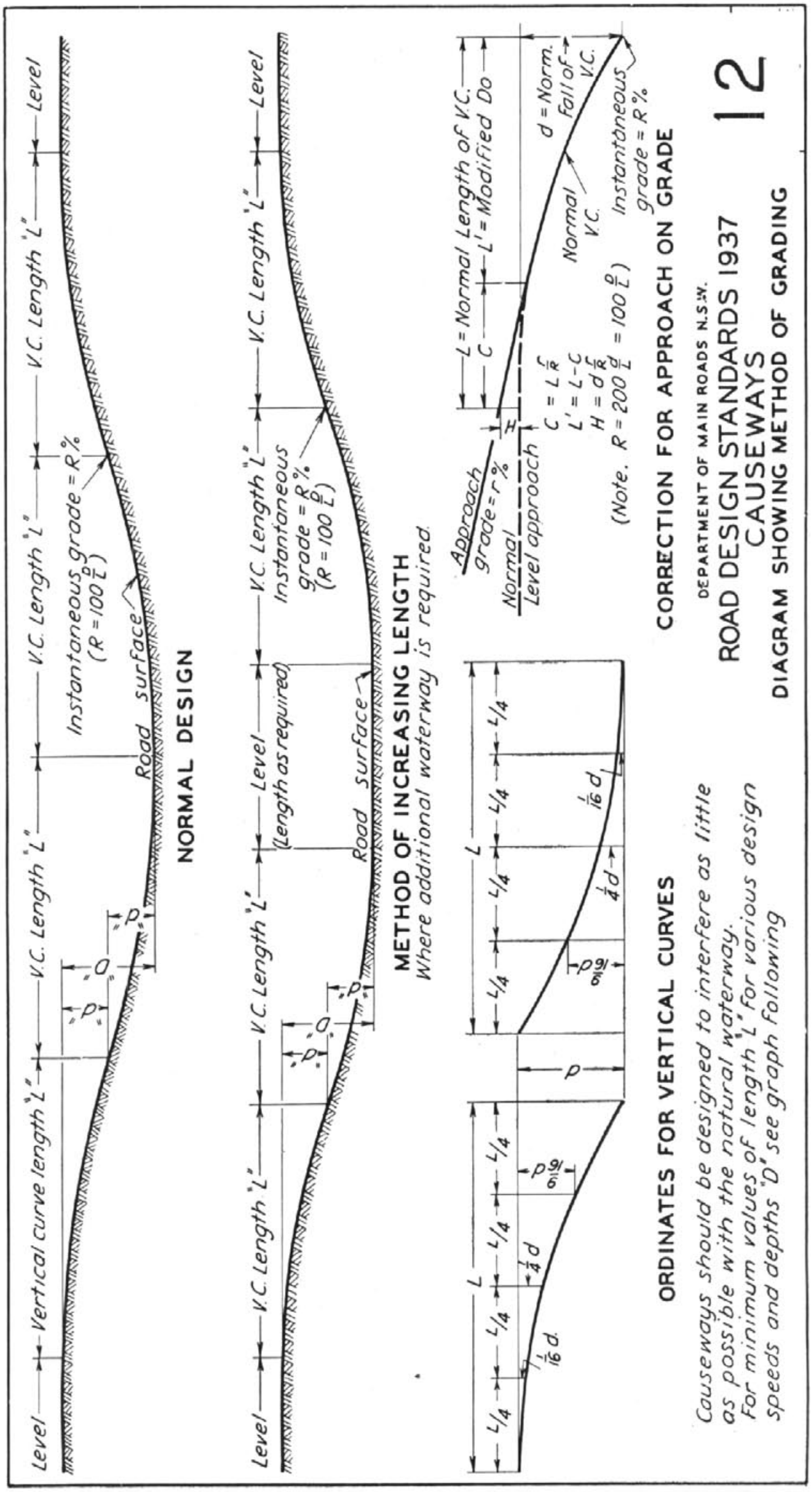
Supplementary Notes.

The following notes supplement, and, to a minor extent, amend the preceding instructions:—

(1) *Grade Compensation for Curvature.*—It should be noted that curves need only be compensated for grade when the effective grade (*i.e.*, the actual grade along the nominal centre line plus the additional equivalent grade due to curvature given in clause 9A) would be greater than the values allowed in clause 4. Unless these ruling grades are infringed compensation is not necessary.

(2) *Maximum Grades.*—Under very special circumstances, the maximum grades given in clause 4 may be increased, subject to special approval for each grade.

(3) *All Curves to be Super-elevated*—The superelevations quoted herein are the appropriate values for the design speed. It is desired, however, that all curves be super-elevated, regardless of radius, the cross falls and transition tables herein being used as far as applicable, and the cross fall and the superelevation transition for the last curve given in each table used for all greater radii.



NORMAL DESIGN
Level
Vertical curve length "L"
V.C. Length "L"
Instantaneous grade = R%
(R = 100 D/L)
Road surface
METHOD OF INCREASING LENGTH
Where additional waterway is required.
Level (Length as required)
ORDINATES FOR VERTICAL CURVES
1/16 d
1/4 d
L/4
CORRECTION FOR APPROACH ON GRADE
L = Normal Length of V.C.
L' = Modified Do
d = Norm. Fall of V.C.
Normal V.C.
Instantaneous grade = R%
Approach grade = r%
Normal Level approach
C = L r/R
L' = L - C
H = d r/R
(Note. R = 200 d/L = 100 D/L)
Causeways should be designed to interfere as little as possible with the natural waterway.
For minimum values of length "L" for various design speeds and depths "D" see graph following
DEPARTMENT OF MAIN ROADS N.S.W.
ROAD DESIGN STANDARDS 1937
CAUSEWAYS
DIAGRAM SHOWING METHOD OF GRADING
12

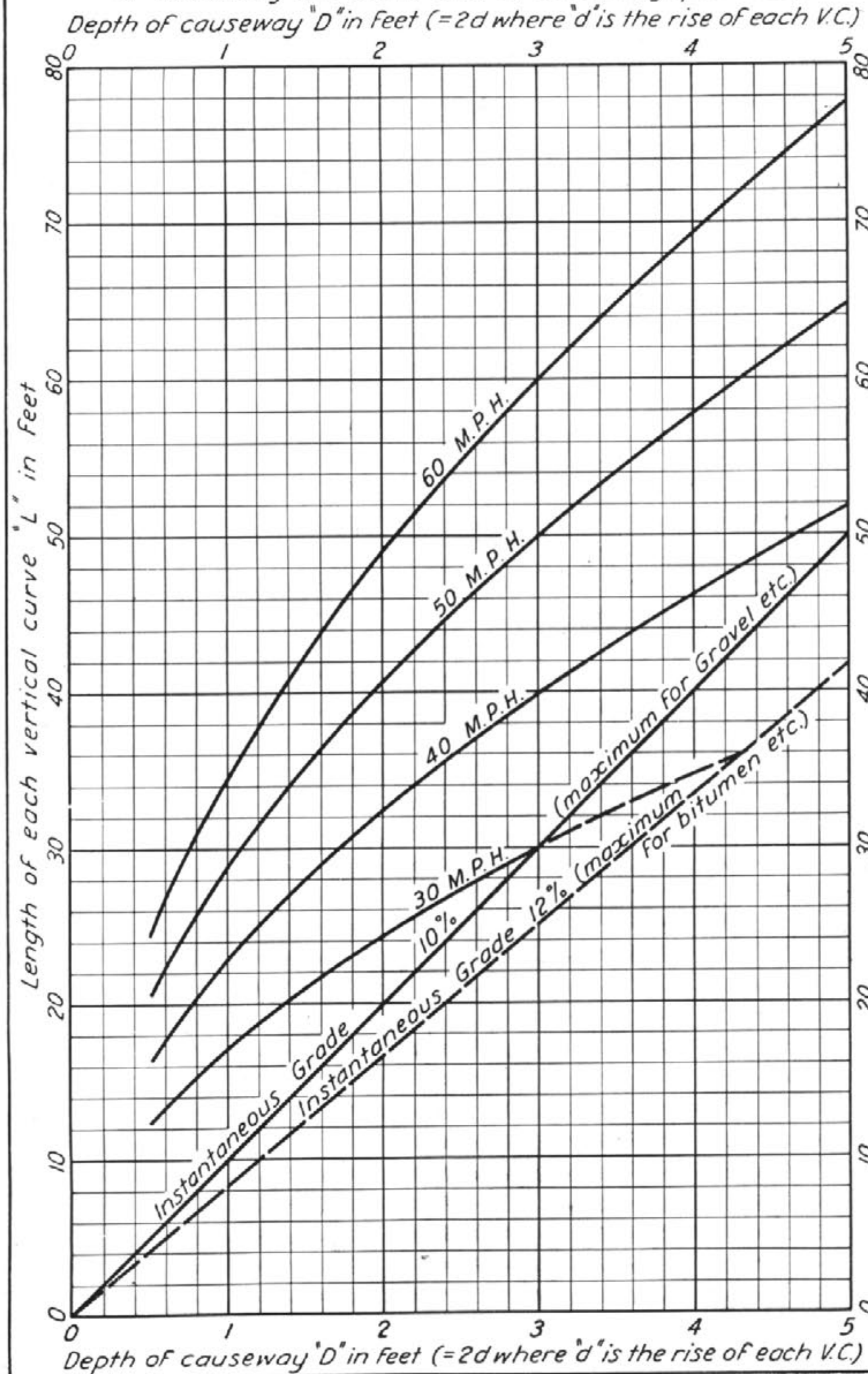
DEPARTMENT OF MAIN ROADS N.S.W.

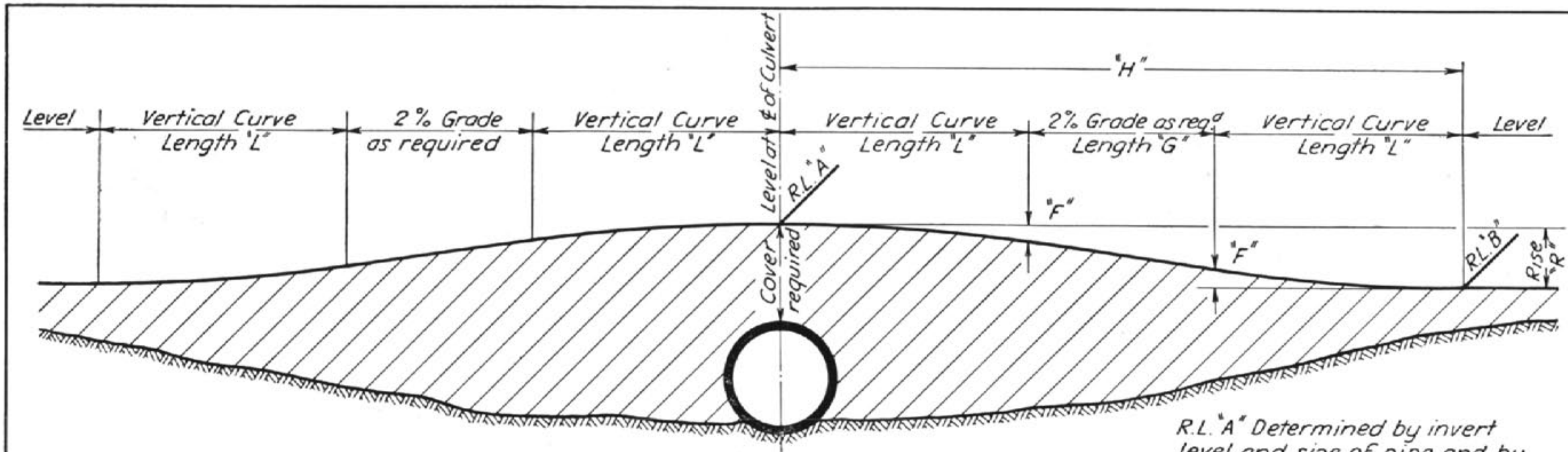
ROAD DESIGN STANDARDS 1937 **13**

CAUSEWAYS

MINIMUM LENGTHS OF VERTICAL CURVES

Lengths shown are minimum allowed. If conditions permit longer curves shall be used. (Note that the longer the curves for the same depth of causeway the better will be the riding qualities.)





Not to Scale

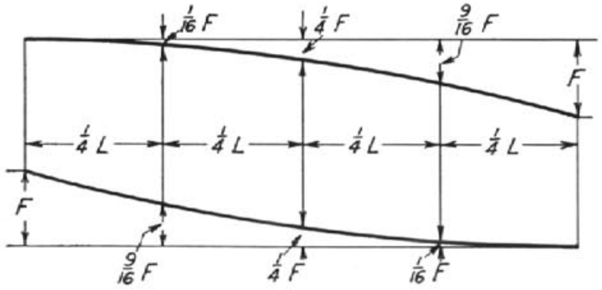
R.L. "A" Determined by invert level and size of pipe and by the cover required

R.L. "B" Determined by level of approach roads

Rise "R" = R.L. A − R.L. B

Then for various speeds:-

Dimension	30 M.P.H.	40 M.P.H.	50 M.P.H.	60 M.P.H.
L	25 ft.	30 ft.	40 ft.	50 ft.
F	0·25 ft.	0·30 ft.	0·40 ft.	0·50 ft.
G	50R−25 ft.	50R−30 ft.	50R−40 ft.	50R−50 ft.
H	50R+25 ft.	50R+30 ft.	50R+40 ft.	50R+50 ft.



DETAILS OF VERTICAL CURVES

DEPARTMENT OF MAIN ROADS N.S.W.

ROAD DESIGN STANDARDS 1937

GRADING TO PROVIDE COVER REQUIRED AT PIPE CULVERTS ETC.

14

THE CONSTRUCTION OF THE COCKWHY RANGE DEVIATION OF THE PRINCE'S HIGHWAY.

The opening of the Cockwhy Range Deviation to traffic in December of last year eliminated one of the most winding sections of the Prince's Highway. The length of the section eliminated was 11 miles 1,901 feet, its northern end being at the village of Termeil, about 16 miles south of Milton, while its southern end was about 1¼ miles south of Cockwhy Creek. The corresponding length of the deviation is 9 miles 4,807 feet.

The old route of the Highway, with its bad alignment and narrow formation, followed generally the line of an original bush track which passed through steep and broken country around the sides of spurs, across saddles and along ridges, and heading a number of narrow gullies, crossing, *en route*, hills locally known as Cockwhy Range.

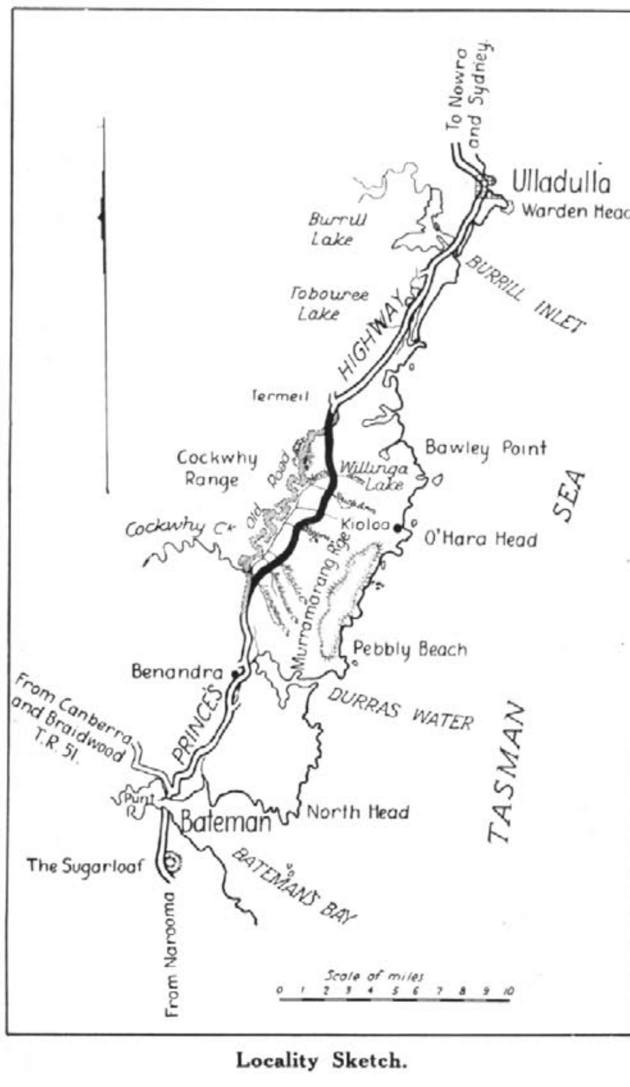
From inquiries among old residents, it appears that the bush track referred to was the only means of access along this section of the South Coast until about the year 1883, when Surveyor Bundock was sent to the district. He ascertained that a deviation could be obtained to avoid the ascent and descent of the Cockwhy Range by following lower levels along the Cockwhy Creek Valley, thereby obtaining a route through fertile country and near a permanent water supply, which was lacking on the route through the hills.

It was found, however, that the new route would necessitate the construction of several bridges, and numerous culverts, and the cost could not be financed at the time. Further, he met opposition from owners who had cleared and cultivated certain properties.

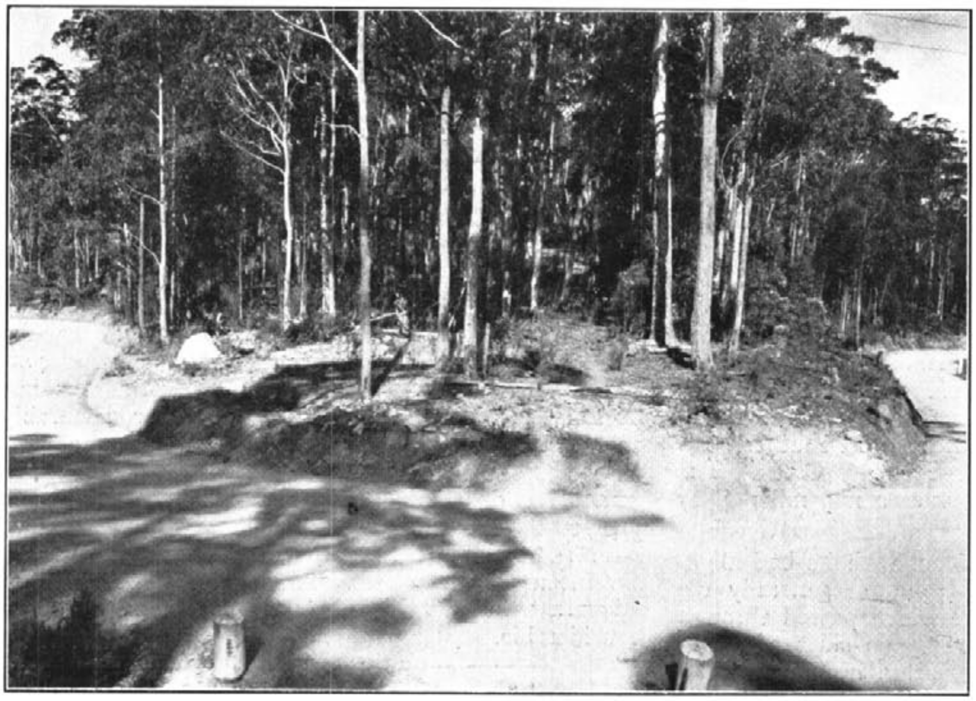
As a result, it was decided to adhere to the then existing route subject to minor improvement, and this has remained in use until December, 1937, further minor improvements having been made from time to time.

The old road, like most of the Prince's Highway, passed through well timbered country with an abundance of palms and ferns, creepers and undergrowth in the gullies, and during the hours of daylight the traveller was invariably welcomed by the notes of bellbirds which frequented certain localities. These to some extent compensated him for the winding and narrow character of the road.

It was decided in 1930 to carry out two preliminary surveys, the first to follow the existing road with a view to determining whether it would be practicable, at a reasonable cost, to improve the existing location, the second to ascertain whether a deviation providing first-class alignment, eliminating the whole length of the original road, was obtainable. The preliminary survey along the original road indicated that while considerable improvement over the then existing conditions could be made, first-class alignment was not possible, as radii of curves would still be considerably below the requirements of modern traffic. Surveyors' reports indicated that fifty-seven curves having radii of 200 feet or less could not be avoided without excessive cost. Included in the number were one curve with radius of 75 feet, fifteen with 100 feet, and seventeen with 150 feet. Also, even to obtain such alignment the quantities in earthworks would be very considerable.



Locality Sketch.



View showing typical hair-pin bend on the old road.

The trial survey for a deviation revealed, however, that a satisfactory line could be obtained generally along the Cockwhy Creek valley to the east of the original road, which would provide excellent alignment and grades, and effect reduction in the length of the Highway by at least 1 mile. Further, it was found that the line would improve the access to certain settled farming country *en route*, and to the beach settlements of Kioloa, Bawley Point, and Pebbly Beach. In addition, ample permanent water supplies were available along the deviation.

The deviation also passed through the Kioloa State Forest for a distance of about 5 miles. This forest, covering 18,300 acres, contains spotted gum, blackbutt, red mahogany, and blue gum, and was first exploited about eighty years ago, a saw mill having been established about 1857 at Bawley Point, followed subsequently by mills at Kioloa and Pebbly Beach. Timber was drawn through the forest to each mill by horses along wooden tram lines, and during the trial survey for the deviation occasional sections of the old tram tracks were found, together with the re-

New reinforced concrete bridge over south arm of Cockwhy Creek.

(1) and (2) showing tortuous alignment on old road. (3) and (4) Showing work in progress and improvement of alignment on new deviation.

mains of rough timber bridges over creeks. A resident of Kioloa recalled that, in his youth, it was the practice of timber-getters to haul the logs to the beach and then float them out to ships anchored off shore.

The alignment of the deviation is excellent, the sharpest six curves (mainly at or near the approaches to bridges) having radii of 800 feet, one other curve is of 850 feet radius, eleven curves are of 1,000 feet radius, and the remaining curves, sixteen in number, vary from 1,100 feet to 10,000 feet radius. The maximum grade is 7.5 per cent., the greatest depth of cutting is 11.26 feet, and the highest bank is 23.33 feet above natural surface level. Whereas the original road crossing the Cockwhy Range ascended to a point 463 feet above an assumed datum, the maximum rise on the deviation is 235 feet. A formation width of 28 feet was adopted, with pavement width of 20 feet.

Construction was commenced by the Department by day labour in January, 1936, employment being given to 100 men at award wages, who were selected from agencies of the State Labour Exchange at Milton and Bateman's Bay. This organisation continued at work until the following October, when the men were transferred to other works on the same Highway to permit the employment of 300 single unemployed men from the Newcastle district, and from towns on the South Coast between Stanwell Park and Kiama, under special unemployment relief conditions. Each man worked for a maximum period of twenty-four hours per week, the working day being divided into two shifts, morning and afternoon respectively. The weekly hours were increased from time to time as required to make up lost time due either to wet weather or to public holidays, the extra hours being worked on either Fridays or, for a period not exceeding five hours, on Saturdays. By this method all time lost by each man was made up, and the amount of his weekly earnings maintained. This organisation continued until December, 1937, when the work had sufficiently advanced to permit of opening the deviation to traffic.

As the deviation for much of its length passed through densely timbered country, the work of clearing was heavy, the width being kept to a minimum. It was necessary to provide fencing through private property as early as possible, and, as clearing proceeded, timber for fence posts, droppers, etc., was obtained from trees felled during the progress of the work, splitting being carried out by experienced men. Care was exercised to ensure that, wherever practicable, healthy growing trees, and in particular, cabbage tree palms, were preserved.

The earthworks comprised a total of 108,500 cubic yards, an average of about 10,960 cubic yards per mile of road, and were generally through earth, soft sandstone or shale, the quantity of hard rock met with being comparatively small. Tractor-drawn ploughs and horse-drawn buckscrapers and scoops were used to a considerable extent, while for the haulage to banks, horses and drays, or motor lorries were engaged, compressors and jackhammers being used for drilling. Precast pipe concrete culvert sections, 48 inches diameter being the largest, were obtained by contract and delivered to the ports of Ulladulla and Bateman's Bay. Six reinforced concrete box culverts were also required, varying from a single-cell 5 feet x 2 feet to a double-cell 10 feet x 10 feet. Fine and coarse aggregate for concrete culverts were not available along the line of the deviation, but was obtained from deposits of sand and river gravel near Durass Lake and towards Bateman's Bay, about 5 miles—8 miles south of the deviation. The deviation involved the construction of six bridges, contracts for which were let by the Department as under:—

Bridge.	Contractor.	Contract Price. £ s. d.
Over north arm of Cockwhy Creek a single span concrete structure 40′ clear between abutments. Over south arm of Cockwhy Creek a 3 span concrete structure 2/25′ spans with a central span of 50′.	W. D. McDonald	2,990 5 0
Over Hapgood's Creek a concrete structure 40′ between abutments.	W. D. McDonald	1,092 9 0
Over Higgin's Creek a 4 span concrete bridge having 2/30′ and 2/48′ spans.	do ...	3,427 4 0
Over Sandy Creek a single span concrete structure 40′ between abutments.	R. G. Cram ...	1,387 1 0
Over Backhouse Creek a single span concrete structure 60′ between abutments.	R. B. Cram ...	2,006 3 6

Three of the structures described were on curves and super-elevated, viz., those at the north and south arms of Cockwhy Creek to a radius of 1,000 feet and that at Sandy Creek to a radius of 800 feet.

The deviation has been provided with a gravel pavement of 6 inches consolidated thickness, the bulk of the material being hauled from Broomen, about 8 miles from the deviation, and the remainder from Meroo, about 3½ miles from the deviation. The gravel was obtained by day labour and hauled by lorries working under contract.

After the new formation and pavement have thoroughly consolidated, a bituminous surface will be provided throughout. It is anticipated that this will be applied during next summer.

The estimated cost of completion of the deviation excluding the six bridges and bituminous surfacing is £69,000.

RECONSTRUCTION OF THE NEW ENGLAND HIGHWAY BETWEEN BRANXTON AND SCONE IN THE LOWER NORTHERN DIVISION.

The New England Highway (S.H. No. 9) carries the great bulk of the traffic from Sydney and Newcastle to the north-west and the Tablelands, and is part of the alternative through route to Brisbane. It commences where the Pacific Highway turns north to cross the Hunter River at Hexham, 114 miles from Sydney and 10½ miles from Newcastle. The section of which the reconstruction is described in this article is that extending from Branxton (140 miles from Sydney) to Scone (198 miles from Sydney) in the Shires of Patrick Plains, Muswellbrook and Upper Hunter, and the Municipalities of Singleton, Muswellbrook and Aberdeen. The accompanying sketch map shows the location of the Highway and the relative locations of the various lengths of reconstruction. The works were all carried out under the direct supervision of the Main Roads Board, and subsequently of the Department, partly by day labour and partly by contract. At the time reconstruction commenced on the several lengths, the Main Roads Board (or the Department) was directly controlling the maintenance of the Highway, as it then existed, from the Kearsley-Patrick Plains Shire Boundary immediately north of Branxton to Scone, with the exception of the length through the Municipality of Singleton and through the town portion of the Municipality of Muswellbrook. Following the reconstruction, the Department has continued to maintain the full length stated above, there being a local office at Singleton.

Conditions Prior to Reconstruction.

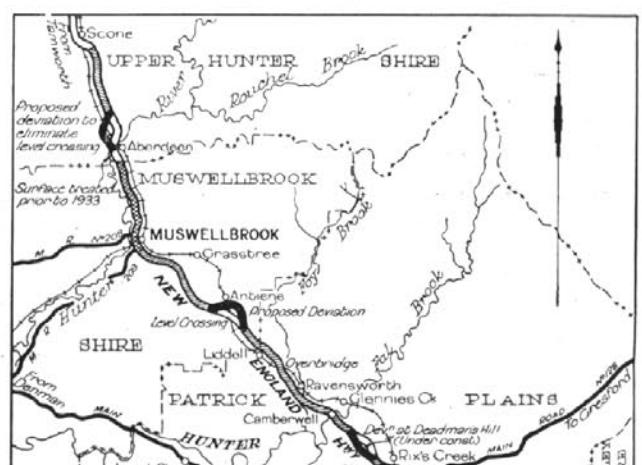
Throughout the area the climate is dry and the unsurfaced gravel was difficult and costly to maintain with a suitable surface for fast-moving traffic. In addition, the alignment and sight distance were in parts very poor, and the pavement narrow. Over the full length the excessive dust, particularly during the summer months, was most disagreeable, and a menace to traffic. Generally, the conditions were such that entire reconstruction and bituminous surface treatment were required.

For the first 7¾ miles commencing at Branxton, the old road was very narrow, with alignment poor, and grading irregular. The pavement was weak, rapidly developed potholes, and was difficult to keep reasonably free of corrugations. On the remaining 4¼ miles extending to the previously surfaced pavement at about half a mile south of Singleton, the road was comparatively flat, and the pavement of a particularly loose and sandy gravel.

From Singleton to Muswellbrook the conditions were such that excellent alignment could be obtained, but there were a large number of points where conditions were dangerous, due to abrupt corners and crests on lengths of road where motorists might be tempted to travel at fairly high speeds. The pavement was narrow and the grading irregular. There were a number of causeways and two railway level crossings, one at Gowrie's Gates just west of Singleton, and one at Antiene.

From Muswellbrook to Aberdeen the pavement was of a rather coarse gauge gravel, narrow, and difficult to keep in reasonable running condition. The alignment and grading, while being not first-class, were better than on the lengths between Branxton and Muswellbrook. The culverts were in poor condition.

Several lengths of the road between Aberdeen and Scone were subject to inundation during heavy rains, and due to this and the loose and coarse nature of the gravel in the pavement, the maintenance of the pavement in satisfactory condition was difficult ,and grades, although easy, were irregular. A level crossing at about one mile north of Aberdeen was also an objectionable feature.



Locality Sketch.

Plan of Reconstruction.

In 1931, although the position regarding funds was such that general reconstruction between Branxton and Scone could not be commenced, it was desired to make a start with the provision of a bituminous surfaced pavement. The plan adopted was as follows:—

(a) The prompt reconditioning and surface treatment of the length of 5.8 miles between Muswellbrook and Aberdeen, where alignment and grading were better than existed on other lengths, in order to conserve maintenance expenditure and to give immediate benefit at a minimum cost. This surfaced pavement is to serve for some years, and at least until the remainder of the section between Branxton and Scone has been reconstructed and surface treated.

(b) Reconstruction and surface treatment first from Branxton to Singleton, and then from Singleton to Muswellbrook, working outward from the towns.

(c) Reconstruction of the length from Aberdeen to Scone—to be carried out concurrently with (b).

It was decided to provide first-class grading, alignment and sight distance, and to depart from the existing pavement only where needed to meet these requirements.

Branxton to Singleton.

Over the full length, from the Patrick Plains Shire boundary (140 miles from Sydney) to the surfaced pavement (152 miles from Sydney), at about half a mile south of the Singleton Municipal Boundary, the road was entirely reconstructed. Many small deviations were made, and the alignment and grading improved to the required standard. A formation width of 28 feet was adopted, and the pavement constructed to a width of 20 feet with local ridge gravel surface treated Contracts were let for the supply and delivery of the gravel for the pavement, and for the surface treatment work. All other work was carried out by the Department with direct labour. It was commenced early in 1933 and completed a year later.

It was decided to surface-treat nine of the twelve miles with liquid bitumen on a suitable primer. The first 3.8 miles were treated with gasworks tar primer, then 2.6 miles with coke oven tar primer, and on the remaining length of 2.6 miles the primer was omitted altogether and the liquid bitumen sprayed direct on the gravel pavement. Regarding the section primed with gas tar, it was found that two weeks after spraying the liquid bitumen had lost part of its original adhesiveness. When a small section of the mat was lifted from the pavement, it could be readily crumbled without staining one's hands or a piece of paper. It was found, however, that although the surface mat was dry and non-flexible, the primer and binder had penetrated to such a depth as to form an unusually thick crust which withstood the effect of traffic fairly well. All three sections of surfacing proved to be satisfactory in use.

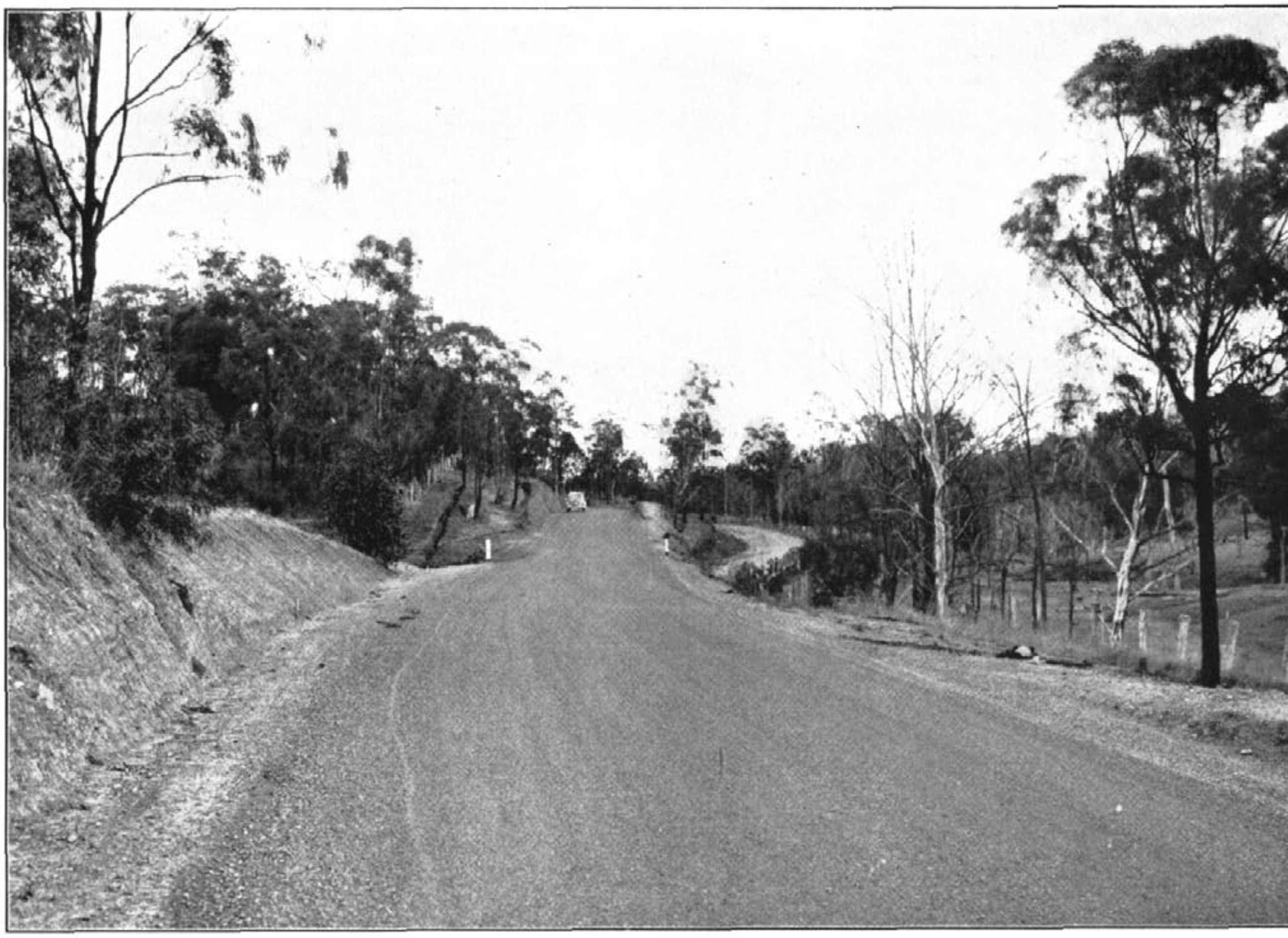
On the 3 miles at the Singleton end where subgrade conditions and the class of gravel were uniform over the full length, there were laid down fifteen test sections of surface treatment, using various combinations of primers and seal coats. The total cost of the reconstruction, including culverts, and surface treatment of the section from the Patrick Plains Shire boundary to .6 mile south of Singleton (total length 12 miles) was £29,040.

Singleton to Muswellbrook.

The reconstruction of this length was commenced with the section between the top of Grass Tree Hill and Muswellbrook, a length of 5.7 miles, of which .8 mile is in the Municipality of Muswellbrook, and the balance (4.9 miles) in the Shire of Muswellbrook.

The old gravel pavement was very weak and narrow, and culverts were in bad condition. In the reconstruction work, which was commenced in July, 1934, the road was regraded and the alignment improved at a number of points. Prior to April, 1936, the standard formation width north of Singleton was 26 ft., and the pavement width 18 ft. On this work, however, the gravel pavement of 7 in. consolidated thickness was constructed 20 ft. wide, and surface treated 18 ft. wide with 85-100 penetration grade bitumen on a gasworks tar primer. The construction of the gravel pavement to a width of 2 ft. greater than the surface treatment was undertaken with a view to providing a strong shoulder and support for the edge of the surfaced pavement. The strong shoulder has been successful in keeping to a reasonable figure the cost of maintenance of shoulders, and has saved the surfaced pavement from fretting and cutting. The cost of gravel in this area is not much greater than good filling, and when there is taken into consideration the fact that less careful trimming of edges of boxing is necessary when the extra width of gravel is spread, it is found that the practice results in economy.

In the early stages of the work difficulty was experienced in obtaining deliveries of suitable gravel at a sufficiently rapid rate to allow reasonable progress to be made in the reconstruction work. Following an examination of all deposits of gravel within 10 miles of the work, it was decided to use gravel from Muswellbrook Common. This gravel had been used on roads by the local councils some years previously, but it was found to be rather clayey and to corrugate badly, and the pit had been converted to a garbage dump as the gravel was considered unsuitable for any purpose other than footways. The Department considered that the gravel would be quite satisfactory for use in a pavement to be surface treated, and this has proved correct, for, after being surface treated for two years, there was not a single break in the 5.7 miles of pavement. The pavement was primed with gasworks tar and sealed with 85-100 penetration grade bitumen covered with screened local river gravel. The supply and delivery of gravel, and surface treatment, were carried out by contract, but all other work was by day labour under the direct control of the Department.



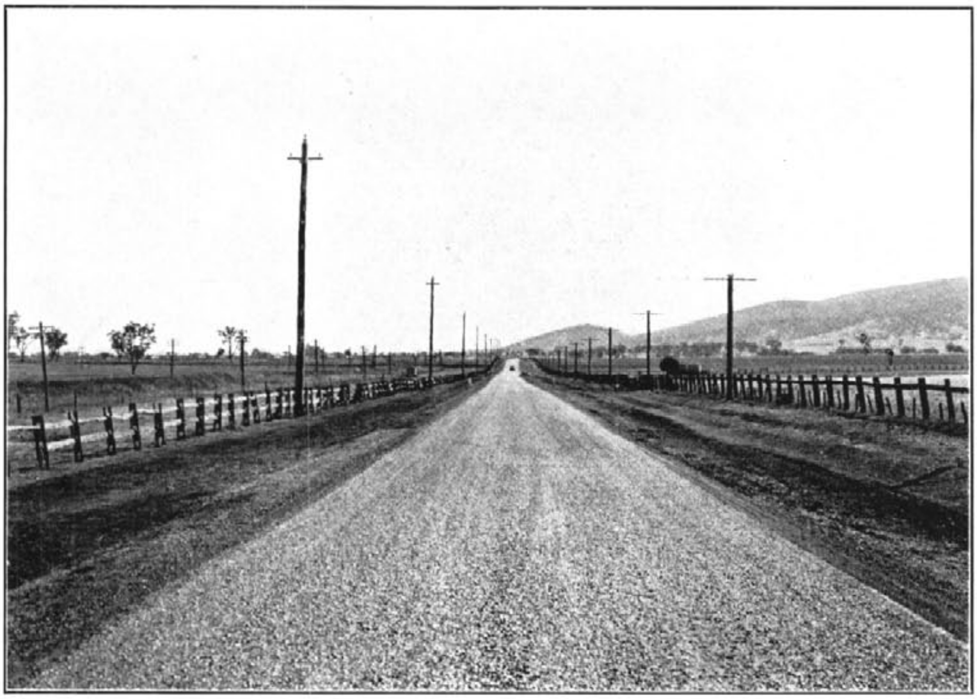
Muswellbrook Shire—Showing new construction near Grasstree Hill. Portion of old road can be seen on right.

The total cost of the work was £11,907, including surface treatment. This work was commenced in July, 1934, and completed in March, 1935.

Concurrently with the work between Grass Tree Hill and Muswellbrook there proceeded work near Singleton. The first work here was the construction by contract for the sum of £1,250 a deviation .6 mile in length to eliminate three bad curves on the southern approach to Camberwell Bridge, 8 m. north of Singleton. The curves constituted danger spots, and the reconstruction was expedited on that account. The width of the gravel pavement was 18 ft. and the depth 6 in. Surface treatment was not carried out at this stage. There proceeded also the general reconstruction work over the full length between Gowrie's Gates level crossing about 1½ miles west of Singleton to the top of Grass Tree Hill. Here, as in the case of the work to the north of Grass Tree Hill, the gravel pavement was constructed to a consolidated depth of 7 in. Following on the satisfactory results obtained in extending the gravel pavement one foot outside the surface treatment, it was decided that on those sections where gravel was obtainable at very low rates the full width of shoulders on embankments should be constructed in gravel. The difference in cost of earth shoulders and gravel shoulders is small, and, as the cost of maintenance of surfaced pavement edges and shoulders is much lower where gravel is used, the gravelling of shoulders makes for ultimate economy. Those sections reconstructed prior to April, 1936, have been surfaced to a width of 18 feet, and those sections reconstructed since that date have been surfaced to a width of 20 feet.

In surface treatment work opportunity was taken to lay down a number of test sections, using various binders, with and without primers, and with various kinds and gradings of aggregate, and valuable information should be obtained from these.

Contracts were let for the supply and delivery of all gravel required, and for the heating and spraying of binder on approximately half the length of the pavement. All other work, including the heating and spraying of binder on the latter part of the work, was carried out with direct labour by the Department. The total cost of reconstructing and surface treating the 18.9 miles of Highway between Gowrie's Gates and the top of Grass Tree Hill was £57,340.



Upper Hunter Shire—Showing reconstructed pavement after bituminous surfacing, between Aberdeen and Scone.

Between Singleton and Muswellbrook, reconstruction work has been completed, except for three short sections on each of which a deviation is necessary. These are:—

(a) Deviation and subway to eliminate level crossing at Gowrie's Gates, about 1½ miles west of Singleton. The length of the work is about 1¼ miles. The proposed deviation has been surveyed and this Department is negotiating with the Railway Department regarding the commencement of construction work.

(b) Deviation at Deadman's Hill to eliminate the exceptionally bad alignment. Whereas the existing road has eighteen sharp curves, the new road will have three curves of 1,500 ft. minimum radius. The length of the deviation is 1.5 m., and a contract for the work has now been entered into.

(c) Deviation at Antiene to eliminate the existing level crossing. A survey has been carried out and negotiations are in progress with the Railway Department, with a view to having the deviation constructed when funds become available. As a temporary measure the existing road of a length of .8 mile is being surface treated, for the proper maintenance of such a short length of open gravel road would be difficult and uneconomical.

Muswellbrook to Aberdeen.

The work on this length, carried out in 1931-32, was the first step in the provision of a reasonably long length of surfaced pavement. A number of concrete culverts were constructed, and the pavement over the full length of 5.8 miles was resheeted with gravel and treated with tar to a width of 18 ft. Practically throughout, existing grades and alignment were followed, and the work should not be classed as reconstruction, but as an improvement work designed to give immediate improvement at a minimum of cost. In the future, reconstruction involving regrading and improvement of alignment, will be necessary on some sections in order to provide a pavement altogether satisfactory for high speed travel.

Aberdeen to Scone.

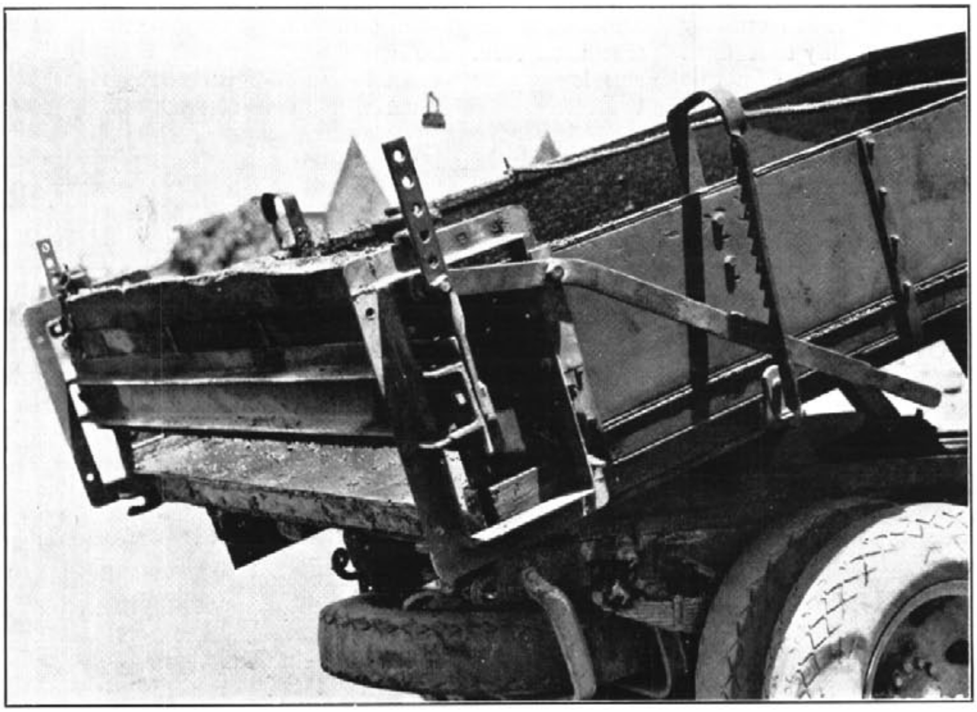
In October, 1934, there was commenced the reconstruction of the Highway between these two towns, but omitting the section of road 1.7 miles long affected by the proposed deviation to avoid the level crossing. Here, as in the case of the work between Grass Tree Hill and Muswellbrook, the formation width was 26 ft., the gravel pavement 20 ft., and the surface treated width 18 ft. In order to raise the low sections of road it was necessary to obtain approximately 20,000 cubic yards of filling from outside the road boundaries. Contracts were let for the supply and delivery of filling as well as for the supply and delivery of gravel, and for the heating and application of gas tar primer and tar-bitumen mixture seal coat. Apart from this, the work was carried out by day labour under the direct control of the Department. The work, 5.6 miles in length, was completed in February, 1936, at a cost of £16,100.

The construction of the deviation to avoid the level crossing about 1 mile north of Aberdeen will next be put in hand.

General Features.

Visibility and Alignment.

Throughout the work, care was given to the provision of ample sight distance and of curves of large radii, and a high average road speed has resulted. It



Detachable Tail Gate for lorry.

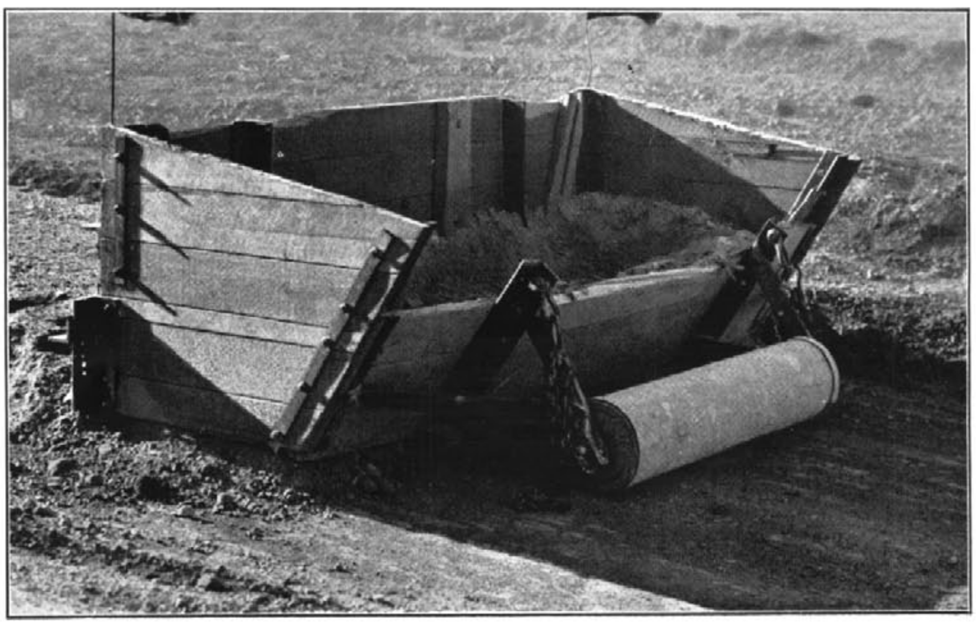
is of interest to note, however, that within the three years that the work has been proceeding the standard of alignment and visibility aimed at has been progressively raised to keep pace with the gradually increasing average speed of travel.

Smooth Riding Quality.

As with sight distance and alignment, the standard of smooth riding aimed at has been progressively raised. The pavements surfaces treated in 1936 and 1937 have superior riding qualities to that treated in 1934 and 1935.

The consolidation of embankments has been thorough, and particular attention has been given to the edges of the embankments, where intensive rolling has been insisted upon. This rolling of the edges was facilitated by ensuring that all filling was placed and rolled in uniform layers not exceeding one foot in depth, and extending right across the embankment.

In the early stages of the work gravel was spread to guide blocks, but in order to obtain more accurate and uniform spreading, templates resting on sideboards were used subsequently, and improved results were obtained. However, in order to obtain still more



General view of Gravel Spreading Hopper used on these works.

uniform spreading a gravel-spreading hopper was designed and locally constructed. This proved entirely successful, and was used for spreading many thousands of cubic yards of gravel. One man operating this spreading hopper has regularly spread over 200 cubic yards of gravel per day as delivered in contractor's motor trucks, and, apart from the uniformity of the spreading, the method will commend itself on the score of economy.

As part of the consolidation and preparation of the pavement, extensive scarifying, blading and dragging with watering was carried out. This is essential for the production of a gravel pavement having really smooth riding at high speeds. Various drags were used, but by far the most successful in achieving smooth riding quality, and incidentally, in doing it most economically, was a specially designed and locally constructed planer-hopper drag. This drag, due to its long base and the absence of skids alongside the planer blades, bites well into "humps" in the pavement, and the hopper arrangement carries the loosened material forward and deposits it in a hollow. This type of drag is very effective in eliminating those long sags and humps which, while hardly noticeable at 35 miles per hour, are most objectionable at 50 and 60 miles per hour. Throughout the dragging process the pavement was kept well watered.

Care was taken to ensure that embankments were well consolidated under traffic and weather before surface treatment was undertaken. Except in the very early stages of the work at least six months, and up to eighteen months, elapsed between the construction of embankments and the surface treatment of the pavement over them.

Surface Treatment.

As previously stated, various test sections of surface treatment were laid down using different primers, binders, and aggregates. Full use was made of locally screened river gravel, and some locally crushed basalt was used also. Both are very durable, and generally satisfactory aggregates. In the early stages where the surface treatment work was carried out by contract the spreading of aggregate was by hand. Then in the work done by the Department the aggregate was loaded into motor lorries, and spread through a rotary spreader driven by a road wheel. This method of spreading was not entirely satisfactory, and on the bulk of the later work spreading was done with the aid of fantail spreaders fitted to five-ton motor lorries. One disadvantage with the fantail spreaders was the cost of fitting a control on the tailboard to regulate the speed of flow of aggregate, but a satisfactory and cheap tailgate has been evolved and was first used on the surface treatment between Singleton and Muswellbrook.

Alignment Markers.

The alignment and grading are such that high speed travel is quite general, and in order to improve conditions for night traffic, white painted concrete blocks have been erected at short and appropriate intervals on the outside shoulders of curves.

Tree Planting.

Following the construction and surface treatment of the pavement and shoulders, and the provision of proper drainage, the next logical stop is the improvement or beautification of the roadside. In keeping with this, tree planting has been commenced just south of Muswellbrook. Next season the work will be extended. To improve the roadside, and also to help protect batters of cuttings, a number of flowering runners have been planted.

Sydney Harbour Bridge Account.

Income and Expenditure for the period 1st July, 1937, to 31st December, 1937.

INCOME—		£
Road Tolls		125,233
Contributions for Railway Passengers		54,394
,, Tramway Passengers		26,689
,, Omnibus Passengers		1,555
Contributions by Councils		33,221
Rent from Properties		3,647
Miscellaneous		6
		£244,745
EXPENDITURE—		
Cost of Collecting Road Toll		4,434
Maintenance and Minor Improvement		17,975
Maintenance of Properties		134
Administrative Expenses		600
LOAN CHARGES—	£	
Interest	148,000	
Exchange	19,500	
Sinking Fund	19,750	
		187,250
		£210,393

PROMOTION OF HIGHWAY SAFETY BY THE UNITED STATES NATIONAL SAFETY COUNCIL.

(Extracted from Reports by Sidney J. Williams, Director, Public Safety Division, United States National Safety Council, published in the Proceedings of the Highway Research Board (U.S.A.), volume 15).

In view of the establishment of a National Road Safety Council in New South Wales, it is thought that the following extracts from a short review of the work of the United States safety organisation should prove of special interest.

The first thing we have learned is that there is no one cause of accidents in traffic or anywhere else. If there were, these unhappy occurrences would not be accidents at all; and, furthermore, if there were but one cause, or even one main cause, it would have been discovered and corrected long ago.

What we call an accident is, in fact, an accidental coincidence of two or more wrong things which in themselves are not accidental at all. Take the simple case of the motorist who drives through intersections at excessive speed, depending on others to keep out of his way. He may do this for a long time, and get away with it—until he happens to meet another driver doing the same thing. There is nothing accidental about the excessive speed; but the meeting of these two drivers, at the same instant in time and the same point in space, is an accident. It may occur to-morrow or next year, or never.

Take a more complicated case, but not unusual, where a car with faulty brakes, with a tipsy driver at the wheel, skids on a slippery pavement and hits a pedestrian with his head behind his umbrella. Here are four wrong things—the car, the highway, the driver and the pedestrian each contributed to the accident. Any three of them might have been wrong, and without the coincidence of the fourth at that particular time and place, there would have been no tragedy.

We cannot control nor predict these individual coincidences, but we can and do predict them in the mass, just as an insurance actuary can predict how many males of age 32 will die in the United States next year from tuberculosis. What is more important, we can find out, and we *have* found out, what are the wrong things which chiefly contribute to these coincidences—and we can remove or control them.

We know in great detail what are these wrong things, in the car or in the highway. They are most dangerous when unexpected. Generally speaking, one can drive a car with bad brakes, on a road with hairpin turns, if he knows what he is up against. But if the car develops brake or tyre trouble suddenly, or a sharp curve appears without warning on an otherwise modern highway, then the driver is in a tough spot indeed. From the safety standpoint, the unexpectedness of the defect is more serious than the defect itself. That, incidentally, explains the discrepancy between the high percentage of vehicles that are found defective at testing stations and the low percentage of accidents that can be charged to such defects.

In the driver or pedestrian, the wrong things that contribute to death or injury on the highway are easily placed in three main groups. First are the serious defects of mind or body, such as epilepsy or poor vision. Second is the lack of skill—the inability instantly to do the right thing. Third is the faulty attitude—the taking of chances, the optimistic belief in good luck, the assumption that the other fellow will get out of the way. In practically every accident you will find one or more of these factors. You will also find them in many persons who have never yet had a serious accident, simply because the accident has not yet caught up with them—the coincidence with other wrong things has not yet happened.

Secondly, knowing the things that contribute to accidents, we know how they may be avoided—simply by avoiding all of these wrong things. As to the car and the highway, this means building and maintaining them to a reasonably high standard and, above all, avoiding the unexpected and the unreliable. As to the individual, it means a combination of fairly good mental and physical health, a fair degree of skill, and also a fair degree of foresight, caution and consideration for others. Any one of these personal qualities may compensate for the others. A greater degree of caution may compensate to a large extent for lack of skill, or even infirmity.

An individual having these qualities of a safe driver, or a safe walker, can positively avoid any possibility of accident except those which result from other wrong things entirely outside of his control. The latter happens sometimes, as when a car hits a pedestrian peacefully standing on the sidewalk, or when two vehicles collide and are thrown into the path of a third—but not very often. The possibilities of personally avoiding accidents is proved by the remarkable no-accident records that have been made by many drivers and by most of us pedestrians. The point is equally proved by the records of numerous high accident drivers—people who are so persistently wrong, in one or more of the ways I have mentioned, that they simply can't seem to keep out of trouble. On the other hand, it is a mistake to believe that these relatively few high accident drivers are responsible for most of our casualties. The fact is that a great many, probably a majority of drivers involved in accidents have had no previous accident record at all. They are drivers who are not bad enough to go looking for trouble but not quite good enough to keep away from it.

Third, we have learned that groups of people can by group action greatly reduce the sum total of wrong things in and around them, and thus greatly reduce the coincidences of these wrong things which we call accidents. A well known example is the group of children in our grade schools whose average level both of skill and of caution on the streets has been raised, with the result that the accidents to them have been reduced, even where the external hazards have remained the same. Another group is the drivers in numerous large fleets, where again the great improvement of both their skill and their attitude has almost eliminated the possibility of accident, other than those due to outside factors. The increasing safety programs of bodies like the American Trucking Associations, as well as the growing membership and activity of the National Safety Council's Vehicle Fleet Section, show that these employers have come to regard safety as good business, and as a practical and necessary feature of operation.

Still more important, certain states and cities have honestly and persistently tackled the job, simple in theory, difficult but not impossible in practice, of eliminating these wrong things in their streets and highways, in the vehicles on them, and in their drivers and their pedestrians. By so doing, year after year, they have lowered their deaths and their death rates far below the national average. Among many cities and states where this is true, in greater or lesser degree, I mention only a few—Rhode Island, Massachusetts, Minnesota, Milwaukee, Rochester, Providence, Grand Rapids, Wichita, Evanston, and others which have won awards in the National Safety Council's annual contest. If all states and cities had had as good a record as these scattered places did, not only this year but last year and the year before, do you know how many lives we would have saved? Nearly 50 per cent.—between ten and fifteen thousand a year.

Fourth, we know *how* these states and cities, as well as these schools and these fleets have saved so many lives. Anyone who visits them, studies their activities, talks with their public officials and their safety leaders, finds at once the same basic pattern in each. It is the pattern of the three E's you have so often heard about—good Engineering of the streets and highways, honest and intelligent Enforcement, and persistent, constructive Education of all the people, young and old.

In no one of these places does one find a traffic paradise. In none has a new race of angels come down from Heaven to drive and walk upon the streets, to wear the blue uniform of the police department, to fill with sweetness and light the swivel chairs of state-house and city hall. Each of them is a good ordinary American community. Each has its problems. None is free of ignorance and selfishness, in high places and in low, any more than the purest spring water is completely free of the germs of deadly disease. But in the city or state that is safer than its neighbors, just as in the water that is pure enough to drink, the germs of ignorance and indifference have been held in check, have been filtered out or neutralised to a level at which they no longer threaten the entire body politic. In every place I have mentioned, and in others which might well be added, the leaders of safety would be the first to disclaim perfection; they would be the first to insist that they have only made a beginning, that they are fighting every day to hold what they have won, that they have gone just far enough to know how much farther they can go and will go in the years to come, to remove the dangers that still threaten, and avert the tragedies that are still too many. Through the Council's Street and Highway Traffic Section these community leaders are constantly exchanging information and helping one another to continued progress. As in any other field, the more they know and the more they have done, the more anxious they are to learn still more and to do still better.

I hope I have been able in this short space to convince you that we know how to greatly reduce accidents, both as individuals and as communities, if we really want to. It follows that our greatest need to-day is to arouse all our public officials and other leaders, and all our people, to do these things that we already know. To do this, we must touch the springs that make men act—the motives of self preservation, of preservation of one's family, the profit motive in the business man, and in the public official and public leader the ambition to win public approval. If there is any one thing, more than others, that we need to-day to bring this about, it is a definitely organised safety program, backed by the best official and civic leadership, in every state and every city. We know enough already to do this without fear of failure or of wasted effort.

PAYMENTS FROM THE ROADS FUNDS FOR THE PERIOD 1st JULY, 1937, TO 31st DECEMBER, 1937.

Heading.	Payments from 1st July, 1937, to 30th September, 1937.	Payments from 1st October, 1937, to 31st December, 1937.	Total Payments for six months ending 31st December, 1937.
COUNTY OF CUMBERLAND MAIN ROADS FUND—	£ s. d.	£ s. d.	£ s. d.
Construction of Roads and Bridges ...	47,228 2 3	74,930 10 0	122,158 12 3
Cost of Land Resumptions ...	7,166 0 4	12,069 12 2	19,235 12 6
Maintenance of Roads and Bridges ...	59,540 6 10	89,452 6 6	148,992 13 4
Interest and Repayment of Loans ...	21,291 6 9	97,459 6 2	118,750 12 11
Survey, Design, Supervision and Administration ...	11,894 6 0	11,599 2 2	23,493 8 2
Total ...	147,120 2 2	285,510 17 0	432,630 19 2
COUNTRY MAIN ROADS FUND—			
Construction of Roads and Bridges, including Resumptions ...	190,024 18 3	299,751 0 4	489,775 18 7
Maintenance of Roads and Bridges ...	223,551 13 8	308,561 0 8	532,112 14 4
Interest and Repayment of Loans ...	24,977 5 11	40,850 4 3	65,827 10 2
Survey, Design, Supervision and Administration ...	34,402 16 0	40,188 12 11	74,591 8 11
Total ...	472,956 13 10	689,350 18 2	1,162,307 12 0
DEVELOPMENTAL ROADS FUND—			
Construction of Roads and Bridges ...	15,668 17 9	25,247 1 7	40,915 19 4
Survey, Design, Supervision and Administration ...	900 0 0	328 17 11	1,228 17 11
Total ...	16,568 17 9	25,575 19 6	42,144 17 3
SUMMARY ALL FUNDS—			
Construction of Roads and Bridges, including Resumptions ...	260,087 18 7	411,998 4 1	672,086 2 8
Maintenance of Roads and Bridges ...	283,092 0 6	398,013 7 2	681,105 7 8
Interest and Repayment of Loans ...	46,268 12 8	138,309 10 5	184,578 3 1
Survey, Design, Supervision and Administration ...	47,197 2 0	52,116 13 0	99,313 15 0
Grand Total ...	636,645 13 9	1,000,437 14 8	1,637,083 8 5

Tenders Accepted.

The following Tenders (exceeding £300) were accepted by the Department during the months of October, November, and December, 1937:—

Council.	Road No.	Work.	Name of Accepted Tenderer.	Amount of Accepted Tender.
		METROPOLITAN DIVISION.		£ s. d.
Alexandria M. ...	2008	Construction of O'Riordan-street between Bourke-street and Gardener's-road.	Road Constructors Pty. Ltd.	5,930 15 4
Ashfield M. ...	5	Reconstruction in cement concrete, etc., between Rogers-avenue and Wolseley-street.	Concrete Constructions (Roads) Pty. Ltd.	22,006 8 8
Warringah S. ...	164	Construction of deviation between Old Pittwater-road and William-street.	G. E. Bryant Pty. Ltd.	5,308 0 0
Warringah S. ...	328	Supply of 2,500 cub. yds. gravel between Roseville Bridge and Brookvale.	W. J. Staples ...	375 0 0
Willoughby M. & Nth. Sydney M.	...	Supply and cutting stonework for facing of concrete abutments for bridge over Long Bay, Northbridge.	Saunders (Bondi) Quarries Pty. Ltd.	2,941 18 3
		SOUTH COAST DIVISION.		
Bibbenluke S. ...	288	Forming and gravelling between 14m. and 16m. ...	E. I. Armstrong ...	1,063 11 10
Clyde S. ...	1	Construction of bridge over Cockwhy Creek ...	R. G. Cram ...	1,466 17 0
Dalgety S. ...	286	Supply and delivery of screenings, etc., between Hotel Kosciusko and Smiggins Holes.	Farley & Lewers ...	5,775 6 3
Eurobodalla S. ...	1	Supply and delivery of 3,840 cub. yds. gravel between Mogo and Moruya.	R. Veitch ...	552 0 0
Eurobodalla S. ...	1	Supply and delivery of 2,640 cub. yds. gravel between Moruya and Bodalla.	E. G. Nichus ...	467 6 8
Imlay S. ...	1 & 4	Supply and delivery of coarse and fine aggregate ...	E. I. Armstrong ...	1,292 7 0
Imlay S. ...	1	Supply and delivery of 7,400 cub. yds. gravel ...	M. J. Shelley ...	1,225 0 0
Imlay S. ...	1	Formation and paving of deviation through Bega Common	W. D. McDonald ...	4,069 3 8

Tenders Accepted—*continued.*

Council.	Road No.	Work.	Name of Accepted Tenderer.	Amount of Accepted Tender.
		SOUTHERN DIVISION.		£ s. d.
Gundagai S. ...	2	Supply and delivery of steelwork for bridge over Hillas Creek.	Clyde Engineering Co. Ltd.	789 0 0
Gundagai S. and Demondrille S.	2	Supply and delivery of screenings for Deep Creek Deviation and between 4m. and 10m.	Downes Bros.	1,339 4 0
Yass M.	2	Construction of footway on bridge over Yass River ...	A. T. Trautman ...	368 3 2
		WESTERN DIVISION.		
Bourke District ...	68	Clearing, grubbing, etc., Contract 3–37/38. Bourke-Brewarrina.	W. G. Colless	643 12 9
,, ...	313	Clearing, grubbing, etc., Contract 4–37/38. Brewarrina–Golgongon.	,, ...	564 19 6
,, ...	68	Clearing, grubbing, etc., Contract 8–37/38. Brewarrina–Walgett.	,, ...	459 18 6
,, ...	68	Clearing, grubbing, etc., Walgett–Brewarrina	,, ...	770 0 0
,, ...	69	Construction of culverts in two sections between 47m. 4,500 feet and 50m. 3,000 feet.	W. Hamilton	370 12 8
,, ...	...	Construction of bridge over Burban Creek at its junction with Culgoa River.	H. Woodward	1,970 12 0
,, ...	68	Clearing, formation, etc., between Collarenebri and Mungindi.	R. McMullen	738 12 2
Broken Hill District.	14	Supply and delivery of gravel between 4·1 m. and 8·1 m. from Wentworth.	G. Grenfell	315 5 0
Hay District ...	14	Construction of formation and culverts between 4m. 3,073 feet and 9m. 4,060 feet.	F. Sylvester	1,654 1 3
		LOWER NORTHERN DIVISION.		
Manning S. and Taree M.	110	Supply and delivery of steelwork for bridge over Manning River at Taree.	Clyde Engineering Co. Ltd.	31,103 0 0
,,	110	Construction of bridge over Manning River at Taree ...	Monier Industries Ltd.	42,018 10 7
Patrick Plains S. and Muswellbrook S.	9	Supply and delivery of 590 tons aggregate between Singleton and Muswellbrook.	N. Bailey	309 15 0
,,	9	Supply and delivery of 1,665 cub. yds. aggregate between Singleton and Muswellbrook.	P. Keegan	1,040 2 6
,,	9	Supply and delivery of aggregate	W. A. Smith	1,000 0 0
Stroud S. ...	10	Construction of bridge over Limeburner's Creek	Beattie & Frost ...	2,754 6 0
		SOUTH WESTERN DIVISION.		
Gundagai S. ...	2	Construction of bridge over Hillas Creek	E. V. Mather	5,867 3 6
Mitchell S. ...	14	Supply of 3,520 cub. yds. aggregate between 12¼ m. and 32¼ m.	W. C. French	3,080 0 0
		NORTH EASTERN DIVISION.		
Kyogle S. ...	64	Construction of reinforced concrete bridge over Reid's Creek.	E. L. Lawson	2,184 0 0
Orara S. and Ulmarra M.	10	Supply and delivery of 2,650 cub. yds. fine crushed rock between 7 m. and 23½ m. from Grafton.	H. W. Gibbins ...	1,921 5 0
Orara S.	10	Construction of 3 reinforced concrete culverts between 9 m. and 13 m. south of South Grafton.	J. Meenan and J. Olivera	749 4 0

The following Tenders (exceeding £300) were accepted by the respective Councils during the months of October, November and December, 1937 :—

Council.	Road No.	Work.	Name of Accepted Tenderer.	Amount of Accepted Tender.
		SOUTHERN DIVISION.		£ s. d.
Mulwaree S. ...	256	Construction of culvert and approaches at 3m. 64 chns. ...	A. T. Trautman ...	631 12 0
Tallaganda S. ...	51	Reconstruction and surfacing from Braidwood towards Tarago.	Austral Tar & Bitumen Sprayers.	1,472 15 1
Wingecarribee S.	260, 261 & 266.	Supply of screenings	Blue Metal & Gravel Ltd.	430 5 3

Tenders Accepted—*continued.*

Council.	Road No.	Work.	Name of Accepted Tenderer.	Amount of Accepted Tender.
		SOUTH COAST DIVISION.		£ s. d.
Bibbenluke S. ...	53	Reconditioning and surfacing with bitumen	G. Warne	1,436 6 7
,, ...	53	Gravelling between 30 m. and 31 m.	G. J. Mawson	373 13 9
Dalgety S. ...	286	Construction of Culberts between 15 m. and 17 m. ...	,, ...	795 13 6
,, ...	286	Construction of culverts between 10 m. 380 feet and 27m. 3,100 feet.	,, ...	735 11 9
Imlay S.	1045	Construction between 10 m. and 13 m. 1,721 feet... ...	G. Warne	3,177 19 2
Monaro S. ...	52	Construction of reinforced concrete culvert at 29 m. 530 feet.	F. Mawson	413 11 6
		NORTH WESTERN DIVISION.		
Cockburn S. ...	63	Surfacing with bitumen between 12 m. 4,261 feet and 18 m. 4,752 feet.	B.H.P. ByProducts Pty. Ltd.	1,912 4 8
,, ...	9	Tar surfacing	,, ,,	1,240 1 3
,, ...	9	Reconstructions between 35 m. 2,100 feet and 39 m. 160·7 feet.	Reid and Marshall ...	5,372 15 11
,, ...	9	Resurfacng	B.H.P. By-Products Pty. Ltd.	1,647 10 8
Coonabarabran S.	129	Construction of pipe culverts at 3½ m.	J. Lighezolo	368 5 4
,,	334	Construction of bridge over Spring Creek at 14 m. ...	F. C. Jackson	1,276 19 6
,,	129	Gravel resheeting in sections between 13¾ m. and 25¾ m.	H. V. Hardy	412 12 6
,,	205	Construction of culverts	A. Dorin	434 15 7
,,	129	Resheeting and boxing between Coonamble and Quirindi	W. C. Bridges	892 7 9
Liverpool Plains S.	1112	Construction between 14½ m. and 15 m. 19 chns. ...	J. White	897 8 0
,,	11	Surfacing between Gunnedah and Mullaley	W. J. Lawler	1,018 17 6
,,	11	600 cub. yds. screenings	,, ...	487 10 0
Merriwa S. ...	62	Resurfacing between 0 m. and 4½ m.	D. S. Lawrence Pty Ltd.	1,002 15 10
,, ...	62 & 209.	Surfacing between 0 m. and 2 m. on Main Road No. 209 and between 4½ m. and 5 m. on Trunk Road No. 62.	,, ...	812 2 6
Namoi S.... ...	72	Boxing and gravelling between 23·5 m. and 26·9 m. ...	Griffiths & Campey ...	875 10 10
Nundle S. ...	9	Supply of crushed metal in stock piles	R. C. Barber	1,280 0 0
Peel S.	11	Supply and delivery of 5,200 cub. yds. screened river gravel	A. R. Prince	1,127 10 0
,, ...	11	Supply and delivery of 1,800 cub. yds. screenings ...	Sulphide Corporation Ltd.	984 0 6
Tamarang S. ...	72	Reconstruction between 4½ m. and 7½ m. from Quirindi	J. White	1,894 13 0
,, ...	72	Surfacing between Willow Tree and Quirindi	G. E. Bryant Pty Ltd.	519 11 10
Upper Hunter S.	62	Construction between Bunnan and Halls Creek	L. Eipper	1,285 0 0
Walgett S. ...	123	Construction (180 chns.) from Grawin towards Pokataroo	N. Brain	1,516 2 7
		UPPER NORTHERN DIVISION.		
Bannockburn S.	12	Supply and delivery of 5,580 cub. yds gravel between 152·2 m. and 166·05 m.	D. L. Anderson ...	744 0 0
Bingara M. ...	63	Reconstruction through the town of Bingara	Model Homes Ltd. ...	3,857 2 9
Boomi S. ...	12	Gravelling on black soil between Moree and Collarenebri...	E. G. Muggleton ...	1,240 0 0
,, ...	12	Gravelling on black soil between Moree and Collarenebri	,, ...	582 13 4
Glen Innes M. ...	9 & 12	Supply and delivery of screenings	R. Holder	766 5 0
,, ...	9 & 12	Heating and spraying of binder, etc.	Chesterfield & Jenkins	782 15 9
Gwydir S. ...	12	Supply of 2,400 cub. yds. gravel between 14 m. and 25 m.	Mabbitt Bros.	309 0 0
,, ...	63	Construction of reinforced concrete culvert 2·25 m. from Bingara.	Model Homes Ltd. ...	333 19 6
Macintyre S. ...	12	Supply of 3,000 cub. yds gravel between 14 m. and 19½ m.	Wilson & Johnson ...	525 0 0
Severn S.... ...	9	Reconstruction between 416 m. 973 feet and 421 m. 1,000 feet.	R. L. Smith	2,384 1 3
,, ...	9	Construction of deviation between 401 m. 2,865 feet and 402 m. 1,700 feet.	A. Sharman	3,619 3 0
,, ...	9	Construction of reinforced concrete culvert at Yoongan Creek.	J. Dwyer	797 2 0
Tenterfield S. ...	64	Construction of reinforced concrete box culvert at 21 m. 4,200 feet.	,, ...	912 13 0
Yallaroi S. ...	63	Construction of culverts, etc., at 12·3 m. and 12·7 m. ...	F. Bakon	622 6 4
		CENTRAL WESTERN DIVISION.		
Canobolas S. ...	7	Construction of bridge over Gosling Creek	A. M. Smith	2,885 16 2
Jemalong S. ...	224	Gravelling, etc., between 319 m. 65 chns. and 321 m. 20 chns.	Griffiths & Campey ...	361 11 6
Warren M. ...	202	Supply and spreading gravel...	E. Edwards	495 12 6
Wingadee S. ...	1083	Clearing, etc., between 51 m. and Shire boundary ...	N. Andriske & A. Beasley.	467 19 6

Tenders Accepted—*continued.*

Council.	Road No.	Work.	Name of Accepted Tenderer.	Amount of Accepted Tender.
		NORTH EASTERN DIVISION.		£ s. d.
Ballina M. ...	10	Surfacing between River-street and the Northern Municipal Boundary.	B.H.P. By-Products Pty Ltd.	376 14 5
Bellingen S. ...	119	Construction of deviation between Bellingen and Thora ...	J. Gam	9,542 16 8
Dorrigo S. ...	151	Bitumen surfacing between 0 m. and 1,660 feet and between 1 m. 2,400 feet and 2 m. 2,400 feet.	Chesterfield & Jenkins	636 7 0
Gundurimba S. ...	147	Construction of reinforced concrete culvert and deviation at 6¼ m.	Singh & Antoniolli ...	1,820 11 0
,, ...	64	Supply and delivery of 737 cub. yds. broken stone between 3 m. 2,171 feet and 3 m. 4,800 feet.	F. R. Smallwood ...	442 4 0
Harwood S. ...	10	Reconstruction of curve 3·1 m. north of Harwood ...	Model Homes Ltd. ...	764 1 11
Nambucca S. ...	10	Supply and delivery of 1,800 cub. yds. gravel	C. W. Kerans	382 10 0
Tintenbar S. ...	10	Supply, etc., of spalls between Burns Pt. Ferry and 12·29 m.	P. L. Cooke	441 13 4
,, ...	10	Reconstruction between 4 m. 35 chns. and 5 m. 69 chns.	T. W. Yeates	500 0 0
,, ...	146	Improvements, etc., between 4·4 m. and 5·6 m.	B. D. Cooper	1,382 9 2
Woodburn S. ...	10	Supply and delivery of 1,500 cub.yds. spalls	Model Homes Ltd. ...	318 15 0
		LOWER NORTHERN DIVISION.		
Cessnock M. ...	218 & 220.	Supplying and spraying 6,567 gallons bitumen	B.H.P. By-Products Pty. Ltd.	328 7 10
Erina S.	225	Surfacing between 0 m. and 3 m. 3,600 feet	D. S. Lawrence Pty Ltd.	1,328 6 8
Kempsey M. ...	198	Construction of section between 16 m. 3,536 feet and 17 ... m. 2,728 feet.	Keft & Gilbert... ...	1,951 14 9
Lake Macquarie S.	217, 220, 223 & 325.	Supply of crushed stone or slag screenings	B.H.P. By-Products Pty. Ltd.	504 14 0
Stroud S. ...	10	Reconstruction between Port Stephens boundary near Limeburner's Creek and Deep Creek.	G. E. Bryant Pty Ltd.	8,790 18 8
Tarro S.	104, 195, 218 & 352.	Surfacing with tar or bitumen	B.H.P. By-Products Pty. Ltd.	650 0 11
		SOUTH WESTERN DISTRICT.		
Albury M. ...	2	Reconstruction of realignment of Young-street	D. & G. McDonald ...	514 18 2
Bland S.	1017	Gravelling between Rankin's Springs and Hillston ...	F. Broad	969 13 9
Carrathool S. ...	6	Gravelling between 91 m. 200 feet and 95 m. 3,800 feet ...	W. Letheby	1,873 0 6
Coolamon S. ...	1097	Construction between 5 m. 1,200 feet and 6 m. 4,254 feet	C. H. Barber & J. Keefe	1,421 17 6
,, ...	243	218·18 chains of formation	A. J. Hill & Son Pty Ltd.	324 0 0
Coreen S.... ...	331	Realignment and reconstruction	R. Neuman	448 12 0
,, ...	314	Construction of approaches to Malwala Bridge	A. J. Hill & Son Pty. Ltd.	1,749 2 4
Hume S.	197	Construction of No. 4 approach bridge to Howlong Bridge over Murray River.	A. Stephens	1,586 0 0
,, ...	210 & 212.	Supply of 6,000 cub. yds. of metal screenings	McDonald Bros. ...	473 2 0
,, ...	1125	Forming, gravelling, etc.	W. Johnston	1,692 7 6
Kyeamba S. ...	211	Construction between 5½ m. and 7 m.	J. Alexander & Sons ...	564 18 6
Lockhart S. ...	59	Replacing 2 existing drainage structures	E. Jones	336 7 0
Mitchell S. ...	240	Construction of culvert at 17 m. post	J. A. Carson	367 4 5
,, ...	210	Supply and delivery of 3,433 cub. yds. gravel between 4 m. and 11 m.	E. J. Feaby	343 6 0
,, ...	57	Supply and delivery of 3,600 cub. yds. gravel	J. T. Clascott	405 0 0
Murrumbidgee S.	14	Loaming, etc., between 116 m. 150 feet and 120 m. 1068 feet.	W. E. Burgess ...	618 2 6
,, ,,	14	Loaming, etc., between 100 m. 3,772 feet and 106 m. 1,690 feet.	J. Deegan	411 0 0
,, ,,	14	Loaming between 94 m. 1,500 feet and 96 m. 368 feet ...	C. N. De Mamiel ...	300 6 0
Narraburra S. ...	1064	Construction of bridge over Narraburra Creek near 15 m.p.	Mrs. B. E. White ...	1,299 2 1
Tumbarumba S.	278	Improvement of alignment near Tumbarumba Railway Station.	R. Broad	917 11 9
Tumut S.... ...	280	Redecking and painting bridge at 6¼ m.	J. Henrick	379 17 0
,, ...	4	Widening, etc., between 45 m. 3,600 feet and 46 m. 1,100 feet.	,, ...	1,646 13 0
,, ...	4	Reconstruction and culverts	,, ...	1,934 17 6
Wade S.	254	Supply and delivery of 4,200 cub. yds. gravel between Yoogali and Yenda.	R. T. Alexander ...	997 10 0
,, ...	14	200 chains reforming, grading, etc., between 11 m. and 13½ m. from Wakool.	Arthur Bros.	1,028 1 3
Wakool S. ...	319	Construction of timber culvert and approaches	C. G. & F. Burdett ...	539 14 6

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