main roads

DECEMBER 1983

main roads

JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

DECEMBER 1983, VOLUME 48, No. 4
ISSN 0025-0597

CONTENTS

Front Cover: A grader at work on the Tumblong Deviation, Hume Highway.

Back Cover: The original Lansdowne Bridge over Prospect Creek, designed by David Lennox and completed in 1836. A more recent structure can be glimpsed through the arch.

Issued by the Commissioner for Main Roads, B. N. Loder.

Price one dollar.

Annual subscription four dollars post free.

Additional copies of this Journal may be obtained from the Public Relations Section, Department of Main Roads, 309 Castlereagh Street, Sydney, New South Wales, Australia.

Typeset by Adtype Photocomposition

Printed by Seaborn Printing

THE IMPORTANCE OF BEING EQUAL

If you think of any sealed road that you have travelled on in the past, you will remember it as looking pretty much like all the others: bitumen surface, centreline, and so on. It won't surprise you to know that closer scrutiny would reveal all roads are not created equal. But it might surprise you to know that those little inequalities can make a lot of difference in terms of money and comfort.

The Australian Road Research Board (ARRB) has just completed a major study of quality control in road construction and of statistical approaches to road specifications. Data was collected from all States, concentrating on pavement thickness and surface finish for freeways, arterial and local roads constructed between 1975 and 1980 in both urban and rural areas.

The study shows that 35% of these roads had a pavement thickness up to 20% less than the target thickness. The designed life expectancy of these roads is twenty years or more and a 10% shortfall in total pavement thickness has been estimated to reduce the effective life of a road by about half.

Improvement of target thickness control to better than 10% would result in direct savings of about $2 million per year. The cost associated with such control would only amount to about 1% of the total construction cost of the road.

Furthermore, greater uniformity would mean improved comfort for drivers and passengers and reduced vehicle operating costs.

The report also emphasised that close conformity with design requirements and better uniformity of construction can be ensured if specifications are based on statistical techniques using simple electronic control equipment rather than on older methods.

The cost and service implications of these findings go to show that, at least as far as roads are concerned, it is important to be equal.

THE F3 TAKING SHAPE

Sydney-Newcastle Freeway

Planning and construction of the Sydney-Newcastle Freeway commenced over 20 years ago. The first 10 km section, between the Hawkesbury River and Mt. White, was opened in 1965, and was extended a further 5 km north to Calga the following year. In 1968 a new 11 km section further south was opened from Berowra to the Hawkesbury River and in 1973 a new six lane bridge linked the two existing sections.

These initial sections pass through very rugged terrain for most of their 26 km length. Considerable engineering problems arose from the narrowness and broken nature of the natural spurs and ridges along which the Freeway is built.

A major part of the work was the excavation of sandstone rock and earth. Over 8.2 million cubic metres of material was excavated, 95 per cent of which was sandstone. The deepest cutting was 44 m and the highest fill was 65 m.

Following the adoption of the Pacific Highway between Sydney and Hexham as part of the Sydney-Brisbane National Highway, the Department and the Commonwealth Bureau of Roads undertook studies to determine the best route for the highway north of Wyong.

The review recommended that earlier plans to locate the route east of Lake Macquarie be abandoned in favour of a route west of Lake Macquarie passing near Morisset and Barnsley.

The Freeway route north of Calga was determined by the need to service, but if possible not intrude into, developing areas such as Woy Woy, Gosford, The Entrance, Swansea, Blacksmiths and the developed areas of Newcastle.

Special consideration was given to the effect of local coal mining on the northern sections. Where possible the Freeway passes through areas where mining has been completed. Otherwise the route follows ridges to reduce the effect of subsidence.

Current and future work on the Freeway is planned in four sections:

1. Wahroonga to Berowra
2. Calga to Ourimbah Creek
3. Ourimbah Creek to near Wyee
4. North of Wyee

Section 1 – Wahroonga to Berowra
Final design is taking place on this 15 km section through Sydney's northern outskirts, and construction is expected to commence in the near future. This section will join the existing Freeway at Berowra.

Section 2 – Calga to Ourimbah Creek
When completed, this 21 km section of the Freeway will be 14 km shorter than the existing route. The major features of construction are the twin bridges over Mooney Mooney Creek, and a 4 km deviation of the existing highway. Work has commenced on the first stage of this section.

Section 3 – Ourimbah Creek to near Wyee
This 15 km section which is nearing completion forms a bypass of Wyong. At the northern end a 7 km Motorway link will carry traffic from the Freeway back to the Pacific Highway at Doyalson.

The route crosses several swampy areas but passes largely through rural land. A significant exception is the large cutting at Kangy Angy at the southern end of this section.

Section 4 – North of Wyee
Preliminary work has commenced on this 37 km section which will pass to the west of Newcastle connecting with access roads at Wallsend. Final design will take place after the assessment of submissions and comments on the Environmental Impact Statement for the route, which was placed on public display in May 1983.

Design

The design standards for the Freeway:

Design speed	– 130 km/h (110 minimum)
Number of lanes	– four (divided carriageways)
Lane width	– 3.7 m
Shoulder width (outer)	– 3.0 m
Shoulder width (inner)	– 1.2 m (2.4 m where 3 lanes)
Shoulder seals	– full width
Climbing lanes	– 3.7 m wide flanked by 1.2 m shoulder
Median width	– 15 m plus provision for future additional lanes if needed
Grade	– Generally maximum of 5% but increased to 7% over short lengths
Horizontal curve radius	– 1000 m desirable but sharpest curves 500 m
Access control	– full control with grade separated interchanges
Flood immunity	– 0.5 m clearance above highest recorded flood level

While these standards stipulate four lanes, with provision for future widening, the Department is designing for six lanes from Calga to Kariong and from Somersby to Cobbs Road at Tuggerah. This is due to high traffic volumes and to the fact that these sections are in rugged terrain and would normally warrant climbing lanes. However, rather than provide conventional climbing lanes with their tapered entries and exits, a normal six lane cross section has been adopted.

North of Tuggerah, the terrain is generally flat. Four lanes will be adequate except at some locations where steeper grades warrant extra lanes. Ultimately, by widening into the median, a total six lane width can be provided.

Throughout the length of the Freeway, detailed investigations and extensive drilling have been carried out to assess settlement behaviour in swampy areas, to provide information on which to base decisions on grading and batter slopes, and to check the suitability of cut material for use in fills.

Fill batters have been designed at 2:1 generally, except between Calga and Kariong where 1.5:1 batters are to be rock faced. Cut batters vary from 0.25:1 in hard sandstone to 5:1 in the very poor material encountered in one large cutting south of the Wyong River.

Departure from desirable standards has been necessary at some locations. The preferred grade of 5% has been exceeded on both approaches to the major bridge over Mooney Mooney Creek (7%), north from Kariong (6.5%) and between Somersby and Ourimbah (6.3%). Horizontal curves in the range 500 m to 1000 m radius are located in the heavy terrain between Calga and Kariong (850 m minimum) and on the spur descent from Somersby to Ourimbah (560 m minimum).

The requirement for erosion and sedimentation control has made it necessary to show on the plans the details for silt arrestors and water velocity reduction devices necessary to prevent scouring and silting of adjoining lands. Suitable treatments have been devised after consultation with the Soil Conservation Service.

Bridge structures

Apart from the very large twin bridges over Mooney Mooney Creek, the bridge over the Wyong River and substantial structures associated with the several interchanges, the bridges between Calga and Newcastle are not major structures. Generally they will provide 4 lanes. However, as with the roadway, they have been designed to suit the ultimate 6 lane width of freeway.

Some unusual features considered in the design are:

(i) Mining Subsidence

Coal seams under the Freeway at depths of 600 m to 1000 m have an average thickness of 2 m. In some locations where total extraction will occur, long term settlement of up to 1 m can be expected.

There has been no attempt to design for total resistance to such settlements but emphasis has been placed on flexible superstructures and flexible foundations where feasible. Thus most designs are of the simply supported individual span type with sub-structures founded on either spread footings or steel piles. Considerable use of flexible steel girders has been made and cast-in-place concrete piles have been avoided where possible.

(ii) Underpasses

Two superspan horizontal elliptical (oval-shaped) structures made of corrugated galvanised steel have been provided for lightly trafficked rural access roads at Kangy Angy on the section between Ourimbah Creek and South Wyong Interchange, and at Tooheys Road on the section between Wallarah Creek Interchange and Morisset Interchange.

The so-called horizontal ellipse is not truly elliptical in shape but consists of two large radius top and bottom arches joined by two smaller radius side arches. The elliptical shape offers a number of structural advantages, including more stability than the larger radius walls on a circular structure of the same horizontal span.

Use of the steel structures has been favoured because of their flexibility for mining subsidence and their economy in building a road suitable for light traffic. The main requirement before adopting a steel design is to check that the ground water is not too acidic.

(iii) Permanent Casings

Sites at Deep Creek on the Wyong River Flood Plain are not subject to mining settlements. Here the Department, using its own drilling crew, constructed cast-in-place concrete piles for a total of six carriageway structures.

The piles, founded on rock, had to be constructed through saturated sand, which required the use of permanent casings.

Considerable cost savings were made in the use of permanent casings by installing light sheet metal casings inside 10 mm thick steel temporary casings normally required for excavation. These casings were used instead of the 6 to 8 mm welded steel permanent pile casings which had been employed in similar circumstances in the past.

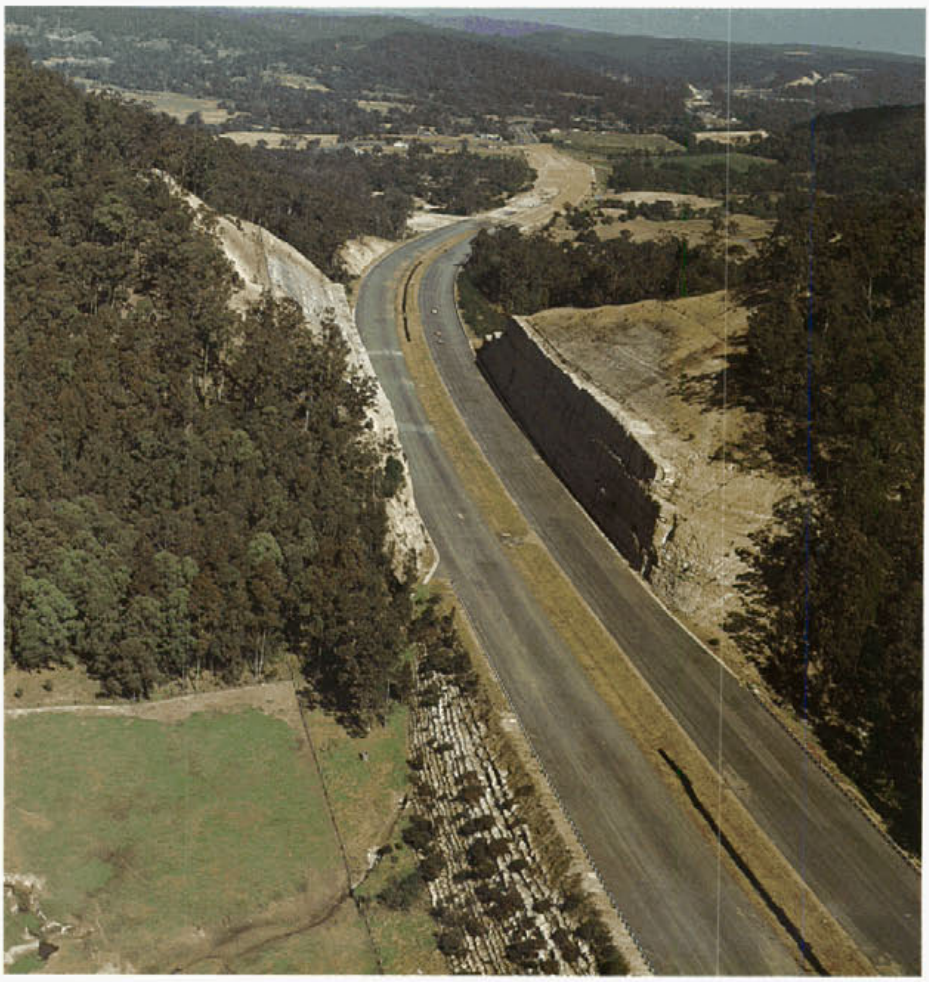
The tube lengths are joined by means of a coupler. A thermoplastic sealer is applied over the assembled joint prior to lowering into the temporary casing.

Construction

Current construction is being undertaken by a combination of direct labour and contract.

Construction of a second carriageway at Ourimbah is well in hand. (At right)

Work in progress on dual carriageways at Kangy Angy.



Some construction features of particular interest:

– Kangy Angy Cut

Approximately 60 m deep, with a yield of 784000 cubic metres, this is the deepest cut ever undertaken by the Department.

- The hard lithic sandstone in the lower 24 metres of the cutting required double the NAASRA (National Association of Australian State Road Authorities) recommended loading of explosive for loosening.
- The material has an unconfined compressive strength of between 65 and 75 MPa.
- Excess material from this cut was crushed on site and is being used as sub-base material on the work south of the Wyong River.

– Swampy Conditions

In swampy conditions a working platform was constructed over the embankment area by removing saturated material using a Hymac 580 Excavator and, with sound material, backfilling a channel wide enough to support a tractor-dozer and scraper. This channel was then widened and backfilled progressively using the tractor-dozer and scraper until the working platform was completed.

– Pavement Drains

A nominal 75 mm macadam type subbase is being used on fills and the pavement is boxed to conserve materials. Pavement drains consist of 100 mm diameter slotted asbestos cement pipes which are laid on top of the stabilised select layer under each edge of the pavement.

These drains collect water which has filtered through the pavement. They are easier and cheaper to construct than conventional subsoil drains.

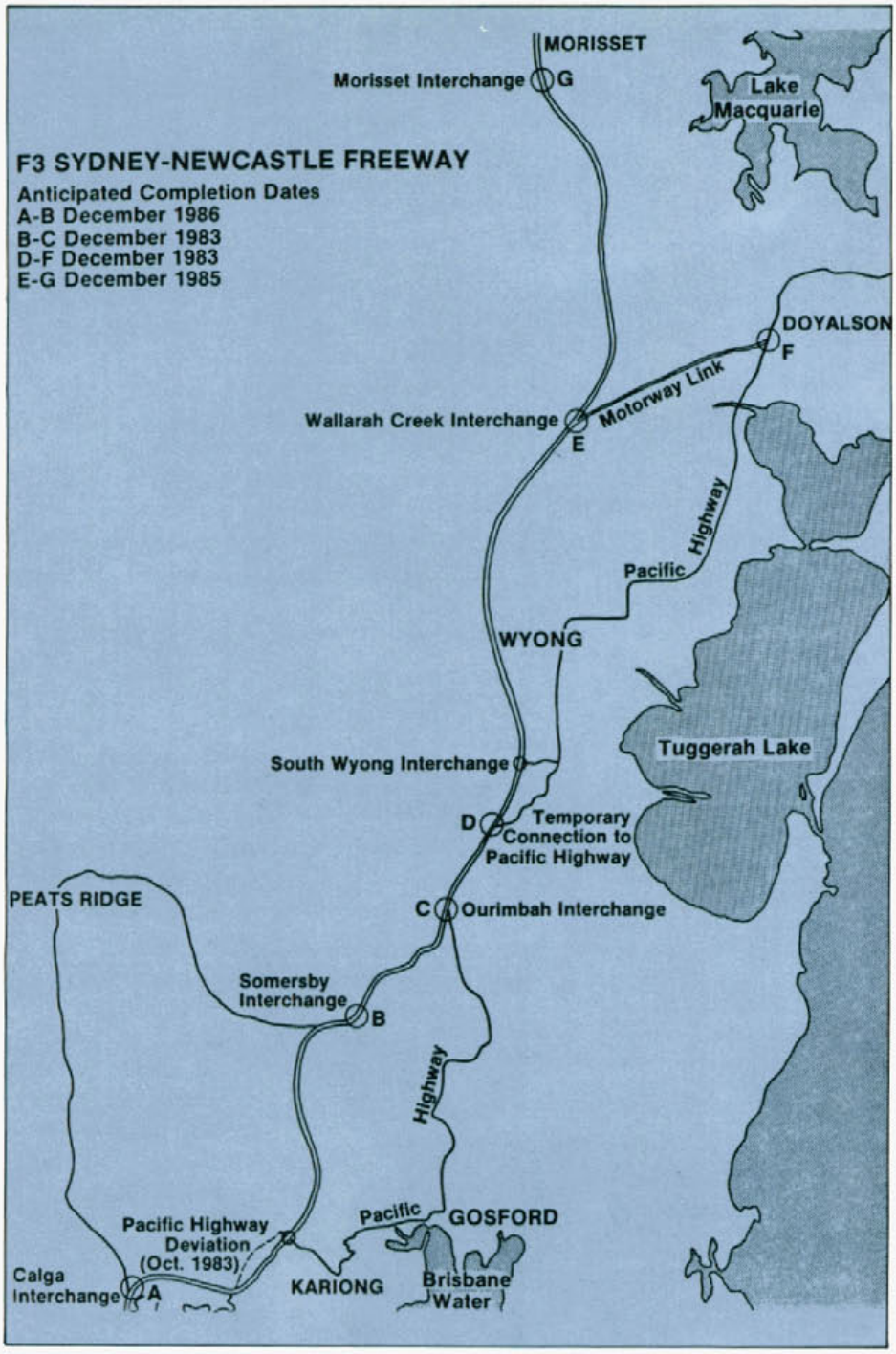
– Bottom Ash

Included in the investigations for pavement materials was a waste product from vertically fired boilers at Munmorah Power Station known as "bottom ash".

This ash is chemically inert and similar to fly-ash, but has no commercial market. It is in the form of highly angular grains ranging in size from about 10 mm to a very fine sand. The ash is light in weight, its compacted weight being about half that of common pavement materials.

Interchange construction and pavement work on the section between Wyong River and Wallarah Creek. (Top)

The section between Somersby and Ourimbah is almost complete.



Based on the information available from various trials, bottom ash stabilised with 6% lime was adopted as a sub-base material on the Motorway link to the Freeway.

The cost of the bottom ash in place, and stabilised on site, is approximately one-third the cost of equivalent sub-base composed of quarry products. Stabilisation was carried out by a pugmill established at the stockpile site at Munmorah Power Station. This yielded a 36% saving over the usual method of on-site stabilisation with a pulvimixer.

– Flexible Pavement

A flexible pavement approximately 0.9 m thick was used between Ourimbah Creek and the Wyong River and on the Motorway. The availability of crushed sandstone from the Kangy Angy Cut and bottom ash from the Munmorah Power Station made this a more economical proposition than a rigid pavement.

Based on experience gained from the South Western Freeway (F5), it was imperative to use a free draining sub-base.

– Rigid Pavement

On the section between Wyong River and Wallarah Creek Interchange (CBR less than 2%) a rigid pavement was adopted consisting of:

- 150 mm thick lean mix (5 MPa-7 MPa) concrete sub-base.
- 230 mm thick plain (unreinforced) 30 MPa concrete base.

The contractor will construct the pavement using an on-site batch plant. A slipform paver and a curing and texturing machine will also be used.

The slipform paver will automatically insert tie bars in longitudinal joints, and will insert a crack inducer ribbon in the longitudinal joint when paving is more than one slab wide.

Emergency telephone system

Emergency telephones will be installed every 1.6 km on the Freeway and every 2.6 km on the Motorway.

When a user lifts the receiver and presses a button, the call will automatically go through to the Department of Main Roads' Emergency Centre in Sydney, pinpointing the location of the telephone. The phones are designed so that the call can remain connected only while the handpiece is held in the hand. ●

THE ROUNDABOUT SOLUTION TO TRAFFIC PROBLEMS

There are times when a roundabout solution can make a great deal of sense. In New South Wales, the Department of Main Roads is gradually introducing roundabouts in all suitable locations to decrease delays at intersections and improve traffic safety.

To understand the recent upsurge in the use of roundabouts, it is fitting to look at the history of the Australian road system. At the beginning of this century, Australia had an extensive road system linking small outlying country areas and the low density urban population centres. While traffic volumes remained low the offside priority, or "Give Way" to the right, rule could adequately handle traffic with safety and minimal delays. However, as demand grew, delays at congested intersections increased and a marked deterioration in safety was noted. To counteract a potentially unsafe situation the States began moving towards a priority controlled road system. Although this system effectively stemmed the increase in intersection accidents, it had the detrimental effect of increasing delay on minor roads.

At this time, three major methods of control of intersections were available to the traffic engineer. These were:
– no control (give way to the right)
– priority signing
– traffic signals

In New South Wales, where innovation in area traffic control and computerised traffic signals was far advanced, the usual solution to control problems was either priority signed control or the introduction of signals. This led to a situation where there are currently about 1650 traffic signals of which about 90% are in the main metropolitan areas of Sydney, Newcastle and Wollongong. Road Authorities in other States, notably Victoria, South Australia and Queensland, decided to follow the British example and introduced the use of roundabouts. It was thought that roundabouts would satisfactorily handle those intersections where priority control was inadequate but signals were not warranted. At the present time there are over 700 roundabouts operating in Victoria, 150 in South Australia and over 100 in Queensland, mainly in the Brisbane Metropolitan area.

With the experiences of the other States to follow, the Department of Main Roads in New South Wales is now supervising and controlling the introduction of roundabouts subsequent to new legislation that has been introduced by State Parliament. A detailed manual has been made available to all Councils on the design and construction features necessary for safe roundabout design. This strict control will ensure proper installation at appropriate locations.

History of roundabouts

The idea of gyratory, or roundabout, operation dates from at least 1903 when M. Henard, a noted French civil designer, recommended the use of 'rotary control systems' at intersections. Probably the earliest practical application of this system was the Columbus Circle constructed in New York in 1905, while other systems were introduced successively in Paris in 1907, at the Place de L'Etoile (where 12 radial roads meet) and the Place de La Nation (where 10 roads meet).

British designers, seeing these innovations in France, decided to include them in the first generation of garden cities around London. The first roundabout in Britain, introduced at Letchworth in 1909, consisted of a 55 foot diameter central island with an overall diameter of about 104 feet.

Due to the intervention of the First World War the introduction of roundabouts was delayed until the 1920s. By the end of that decade major roundabouts were operating all over London, some at points of major traffic conflict such as the Aldwich, Parliament Square, Hyde Park Corner, Marble Arch and Trafalgar Square. Comments at the time indicated that roundabouts were a positive contribution to traffic control and although there was some public resistance their use was generally accepted.

With the introduction of vehicle responsive traffic lights in the early 1930s, roundabouts again went into a slight decline, but were still considered an indispensable form of control where major roads intersected.

With the rapid increase of vehicle ownership in the United Kingdom in the 1950s and 1960s, certain drawbacks with the then operating system of roundabouts became evident. Due to the nearside priority rule there was a tendency for roundabouts to lock. This led to the general acceptance of the offside priority rule. Under this system traffic approaching the roundabout had to "give way" to traffic circulating on the roundabout, effectively preventing locking. In 1966 this rule was implemented nationally.

With this change in operation, progress was rapid to the point where, in the United Kingdom, a number of traffic signal installations are being replaced by roundabouts. British experience has indicated that the old form of large roundabouts is inappropriate, so smaller roundabouts are being introduced. The latest generation has extremely small islands, less than four metres in diameter. In some experimental locations there is no central island whatsoever, with rotation being achieved by direction arrows.

By the 1960s Australia found itself in the same situation that Europe and North America had experienced since the late 1920s. The intrinsic solution, of course, was the introduction of priority roads. This effectively maintained main road capacity and, in a number of cases, improved it. However, in certain cases this system led to high delays on minor roads which in turn led to increased accidents as drivers took more risks to enter the priority road.

The solution to this problem took different forms in each State. In Victoria, South Australia and Queensland a combination of channelisation, traffic signals and roundabouts was used in problem areas. In New South Wales traffic signal systems were highly advanced and so became the major form of treatment. In addition, New South Wales delayed the full introduction of priority roads and was faced with the ensuing problems five years later than some other States. It was therefore possible to learn from their experience as well as benefit from advances made in the United Kingdom. The New South Wales Government has now amended the Road Traffic Act to make roundabouts a major traffic control device in this State.

Safety

Research indicates that roundabouts

Negotiating the roundabout at the intersection of Lady Game Drive and Fiddens Wharf Road at West Lindfield. (Top)

A "poached egg" roundabout at the intersection of Railway Parade, East Parade and Rowe Street, Eastwood.

have significant safety advantages. In the United Kingdom a study of 50 roundabouts indicated generally an overall halving of vehicular and personal injury accidents. The same study indicated substantially greater reduction in fatal and serious injury accidents.

A similar study of roundabouts in Victoria also showed that accidents were reduced by half. It indicated that the provision of roundabouts on local streets produced the best results. Roundabouts were introduced at six high accident locations on local roads and no accidents were recorded in the following two years. The introduction of roundabouts at 36 intersections on secondary roads reduced accidents to less than a quarter of their previous rate. Finally, at 21 major road intersections, accident rates were reduced by half.

The results of these surveys are also confirmed by limited research in both South Australia and Queensland which has led to a significant increase in roundabouts in all three States.

As the use of roundabouts in New South Wales is relatively new, it is too early to draw conclusions on any overall improvement to safety. However, there are no reasons to believe that roundabouts should not contribute to an improvement in safety at intersections and, in several cases, this already appears to be significant.

Pedestrians

There is no information to suggest that roundabouts are less safe for pedestrians than other intersection types. In most cases the provision of a roundabout will decrease pedestrian delay. The installation of well-designed splitter islands of sufficient size to stage pedestrians, whereby they are required to cross only a uni-directional traffic stream, will result in pedestrians being able to move more safely and freely around the intersection than before. First, pedestrians will cross the entry road close to the holding line and would only conflict with slow or stationary traffic. Then they will have to cross the exit lane. Although traffic will be moving at a greater speed it should still be below free running speed and, if drivers use their indicators correctly on the roundabout, pedestrians will be aware of potential conflicts.

Where pedestrian volumes are high or there is a high proportion of young, elderly or infirm pedestrians wanting to cross the road, or where pedestrians are experiencing particular difficulty in crossing and are being delayed excessively, consideration should be given to providing marked pedestrian crossings. It is desirable that these crossings be placed at least 20 m "downstream" from the roundabout exit. Also, fencing could be installed to ensure that pedestrians use the crossing facility provided.

Direction signing

Advance direction signs will normally be provided at all approaches to roundabouts in rural areas and, where practicable, on all major urban arterial roads. Where applicable, they will contain additional information such as route numbers.

ROUNDABOUTS

A SIMPLE GUIDE TO THEIR OPERATION AND SAFE USE

A roundabout is a traffic control device used at intersections to improve safety and reduce traffic delays. It consists of a central circular traffic island around which all vehicles must travel in a clockwise direction and includes painted or raised median islands and signs on the entrances.

This is a Roundabout Warning Sign. These signs are placed on all approaches to the Roundabout. They warn that you are approaching a Roundabout.

This is a Roundabout "Give Way" Sign. These signs together with "Give Way" line markings are placed at the intersection of each approach road with the Roundabout. This sign requires all drivers to "Give Way" to any traffic already on the roundabout if there is any risk of collision.

PROCEDURE AT ROUNDABOUTS WITH TWO OR MORE ENTRANCE LANES

1. When entering a roundabout Give Way to any traffic already on the roundabout if there is any risk of collision but keep moving if the way is clear.

Red cars must slow down and give way to green cars.

Green cars to keep moving if the way is clear.

If green cars have crossed giveway line, red cars must slow down to avoid collision with green cars.

2. Unless local conditions or road markings indicate otherwise, you should:

When turning left

- Approach in the left-hand lane; keep to that lane in the roundabout and leave by that lane.
- Use the left turn indicator on approach and through the roundabout.

When turning right

- Approach in the right-hand lane;
- Use the right-turn indicator before entering the roundabout and maintain this signal while keeping to the right-hand lane in the roundabout; change to the left-turn indicator at the exit before the one to be taken;
- Leave the roundabout in the left-hand lane of the exit road unless conditions dictate the use of right-hand lane.

When going straight ahead

- Approach in the middle lane; keep to that lane in the roundabout.
- Use the left-turn indicator at the exit before the one to be taken.

The recommended course in this situation is shown by the green path; where conditions dictate, drivers may follow the courses indicated by the yellow paths.

When a roundabout has a single lane entrance, drive in the centre of the lane both at the entrance and within the roundabout. Use the turn indicator in the manner described for two or more entrance lanes.

SOME BASIC RULES FOR SAFE DRIVING THROUGH ROUNDABOUTS

- Decide as early as possible whether you wish to turn left or right or continue straight ahead.
- Move into appropriate lane well before the intersection.
- Maintain adequate braking distance between your own and the vehicle ahead.
- Slow down and be ready to stop at the "Give Way" line (broken line across the road) only if necessary.
- Watch for vehicles on the roundabout approaching from your right and enter the roundabout if there is adequate and safe gap in the traffic flow.
- When on a roundabout look out for and show consideration to other vehicles crossing in front of you, especially those intending to leave by the next exit.
- When ready to leave the roundabout, signal your intention to turn left in sufficient time and move into your correct exit lane.
- Watch out for pedal cyclists and for long vehicles which may have to take a different course both on the approach to and on a roundabout.
- If pedestrian volumes are significant special crossing facilities would usually be provided. However, watch out for pedestrians at all times, particularly at crossings located on the approach and exit roads.

For roundabouts to work well it is necessary for every vehicle to keep moving and at the same time to grant the courtesy of equal movement to all other vehicles sharing the roundabout.

(Reproduced with permission of the Traffic Authority of New South Wales.)

Generally, these signs will be supplemented by direction signs placed on the left hand side of the circular roadway at each exit from the roundabout. Where an appropriate location cannot be found in this area, signs might be placed on the approach islands.

This is a marked improvement on normal intersection signing. Not only does it give drivers a second chance to determine their direction but, by circumnavigating the roundabout, they can pick their exit regardless of the lane entered.

Lighting and marking

Most roundabouts will be provided with some form of lighting so as to increase visibility on the approach points and at conflict areas, where traffic enters the circulating stream and where it separates at the exit points. The exact location of lighting poles will be dependent on the size and operation of the roundabout.

In most cases, there are likely to be limitations on space, so lighting poles will normally be situated adjacent to but clear of the edge of the carriageway. For aesthetic and environmental reasons, it is not intended to use high mounted or high voltage lights in local street areas.

In addition to the provision of lighting, roundabouts will be clearly outlined by such means as painting and reflectorising kerbs, to provide low level hazard markers and raised reflective pavement markers.

Construction and landscaping

In the design of roundabouts, consideration will be given to the need for achieving the highest degree of road safety practicable whilst maintaining aesthetic and environmental standards.

To this end, structures associated with roundabouts such as kerbs, signs and utility poles will be located clear of areas most likely to be traversed by out of control vehicles.

In all cases kerbs will be of the mountable type and all signs will be of light gauge steel, or wood, so that minimum damage will result if a collision occurs.

Roundabouts offer significant advantages over other forms of channelisation with respect to landscaping. Pleasing arrangements can be obtained by using low level bushes, shrubs and flowers. This form of treatment works just as well with local urban roads and large rural roundabouts.

There are other advantages in providing landscaping. Flower beds on the periphery of the circular roadway and on the central island can prevent pedestrians from crossing them. This is also seen as a deterrent for larger vehicles from taking short-cuts across the islands.

Roundabouts and the residential street

Part of the operational aspect of a roundabout is that traffic has to decelerate in order to negotiate it. This feature is very useful in residential areas where reduction in speed is desirable. In some areas, sets of roundabouts at intersections on long straight residential streets have been used to create speed reduction. Monitoring of other facilities to obtain the same results, e.g., speed humps and road constriction, indicates that roundabouts produce greater and more constant reductions in speed, thereby reducing noise and danger in residential areas.

The future

As at June 1983, New South Wales had more than 50 roundabouts, of which about a dozen are on classified roads. Most of these roundabouts are designed to presently recommended Departmental standards.

Growth in Roundabouts in N.S.W.

Built Before	30 June '81	30 June '82	30 June '83
Total roundabouts constructed	13 (7)	20 (8)	55 (13)

(. .) number of roundabouts on Main Roads

Roundabouts are likely to become a common feature on New South Wales roads, with their inherent operational and safety advantages over traditional uncontrolled and priority controlled intersections, and their ability to handle

Preliminary layout in temporary materials at the intersection of Hampden Road and Brand Street, Artarmon.

complex traffic movements without the large delays and maintenance costs experienced by traffic signals.

Likely locations for future provision are:

- new sub-divisions where traffic growth is expected to be high and where the redistribution and differential rates of growth are likely to produce varying demands from year to year;
- locations where traffic delays are high enough to make sign priority control unsatisfactory and where traffic signals are less suitable;
- areas with heavy right-turning traffic;
- at multi-leg intersections (intersections with more than four approach roads);
- at T-intersections where the major route turns through the intersection;
- where major roads intersect at oblique or acute angles;
- at residential locations, especially on long straight residential streets, where speed reduction is desirable.

As motorists become more familiar with the operating procedure, it is possible that roundabouts will also become a feature on freeway ramp terminals where they can greatly reduce confusion while decreasing delays.

Roundabouts are unlikely to be found at the following locations:

- where satisfactory geometrical design cannot be provided due to insufficient space;
- where traffic flows are unbalanced and large delays would result on one or more of the approaches to the intersection;
- within linked traffic signal systems, where their presence would disrupt the pattern of flows and where signals can provide better levels of service;
- at locations where exit roads can suffer large delays producing tail-backs and causing locking of the roundabout (i.e. near level crossings or signals on minor approaches to arterial roads);
- where high pedestrian traffic volumes would make it difficult for them to cross the roads in safety;
- at locations where lane switching operates at peak periods.

Advantages of roundabouts

(Compared to sign priority or traffic signal control.)

1. The capital cost of installing roundabouts and traffic signals can be similar, but in some cases roundabouts can be much cheaper, depending on their location and size. However, roundabouts are virtually maintenance free and are therefore definitely cheaper in the long run.
2. A roundabout is more efficient in controlling traffic than the provision of signs alone as it has more visual impact and removes the uncertainty of priority.
3. They simplify driver decision-making at the entry point, as all the driver has to do is determine if a gap is available in the circular roadway.
4. The necessary reduction in speed means that, if conflicts do occur, the relative difference in speed between vehicles is small.
5. Roundabouts can produce large reductions in total delay when compared with other forms of control, especially traffic signals. (It should be remembered that there are 168 hours in a week and of these only 10 to 20 are normally peak hours. Thus roundabouts are providing more efficient control for at least 148 hours a week and in many cases for the whole week.)
6. Space permitting, an intersection and its immediate approaches and exits can be enlarged to handle more traffic without the need to widen the streets along their entire lengths.
7. Right turn prohibition is not necessary and no turning slots need to be constructed to accommodate right turners.
8. Roundabouts are more aesthetically pleasing and have lower noise levels than signalised intersections.
9. There is less incentive for commuters to seek alternative routes, as all movements can be made at roundabouts.
10. Roundabouts increase safety and improve the environment.
11. They can be used to restrict the movement of heavy vehicles without the necessary enforcement required for "Light Traffic Thoroughfares".
12. They reduce fuel consumption and air pollution emissions from idling engines.

Roundabouts are a safe, efficient and pleasing form of traffic control. Although drivers may experience some problems in adjusting, they will soon come to appreciate the efficient control of traffic roundabouts provide. ●

TRAFFIC OPERATION DURING TRAIN STRIKE

Between 22 June 1983 and 15 July 1983 all trains in New South Wales were stopped on all routes, placing an increased burden on the arterial road system. Special measures had to be taken to facilitate the movement of people and goods throughout the metropolitan area.

Traffic control

The centrally monitored computerised SCAT system controls nearly 1,000 signalised intersections in the Sydney Metropolitan Area (see article in September 1983 issue).

From experience gained in earlier transport strikes, a set of special signal timing adjustments has been formulated to cater for the extreme traffic demands encountered during strikes. These can be activated in a matter of seconds by a simple computer instruction.

A major factor in the preparation of these special timing plans has been surveillance of the metropolitan area during strikes from the Department's helicopter. This is fitted with a computer terminal connected by radio link to the central SCATS computer in Oxford Street.

The helicopter was airborne each day during the recent train strike, allowing the signal timing to be adjusted while it was actually hovering over congested intersections. The need for adjustments was usually due to accidents and broken-down vehicles. The helicopter is equipped with both DMR and Police radios which were used to obtain the necessary action to quickly clear such incidents. Traffic reports were also relayed to the commercial radio stations to advise motorists of problem areas and advise alternative routes.

Emergency measures

A number of other traffic management measures were implemented to improve the capacity of the road system:

- Extension of clearway hours – initially, clearway conditions were extended to 6.00-10.00 a.m. and 3.00-7.00 p.m. Because of the severity of the strike, a further extension was made during the last week of 5.30-10.30 a.m. and 2.00-7.00 p.m.
- Prohibition of some right-hand turns – the most notable improvement was associated with the intersection of Broadway, City Road and Bay Street. Movement from Bay Street into Broadway was prohibited and this traffic entered Broadway via Mountain Street, reducing congestion dramatically in both City Road and Parramatta Road.
- Additional tow trucks placed on standby at critical locations.
- Restriction of opening times of bridges for the passage of water craft, particularly in the mornings.
- Abolition of bridge toll – during the last week of the strike, the State Government abolished the payment of toll on the Sydney Harbour Bridge. Not having to stop to pay toll is psychologically pleasing to motorists in the same way as not having to stop at traffic signals.

Traffic volumes

Data from seven permanent counting stations were used to study traffic volumes during the strike. The stations are located on routes considered to be representative of major corridors directly affected by the transport stoppage: Canterbury Road, Burns Bay Road, Princes Highway at Tempe, Kings Cross Tunnel, Sydney Harbour Bridge, South Western Freeway at Leumeah and Western Freeway at Regentville.

The three hour peak periods showed an increase of only 3.4% in the morning and 1.3% in the afternoon. These slight variations indicated that much of the arterial road system operates at or near capacity in the peak periods under normal circumstances. Daily volumes, however, increased by about 5.2%, showing that many persons who used cars during the train strike tended to travel outside the usual peak period. High traffic volumes were observed as early as 6.00 a.m. on some routes.

This pattern was generally repeated on the Sydney Harbour Bridge, where there was little change in the three hour peak periods and an overall increase of 4.2% in the daily traffic volume.

Travel times

Looking back to the transport strikes of ten years ago, traffic congestion was then so severe that the journey from Parramatta or Sutherland to the City took up to three hours in the morning peak period. Traffic signals were switched off at all major intersections and police directed the traffic.

During recent strikes all traffic signals were operational. Journey times on many routes were only marginally worse than normal days (depending on accidents and breakdowns) and compared to ten years ago, have been reduced by about half.

Observation indicated that Sydney motorists coped well with the strike in terms of their journey to work, adjusting their routine to the best advantage.

Every effort was made by Departmental staff and other authorities to cater for the increased traffic and the changes in demand. The special traffic signal timing adjustments and aerial surveillance greatly assisted in this task.

These combined factors resulted in an increase in travel times on long commuter trips of between 10% and 50%; this is a significant improvement on the travel times experienced in earlier strikes. ●

TIDAL FLOW OPERATION ON THE SYDNEY HARBOUR BRIDGE

On 6 September 1982, the operation of 5/3 tidal flow (five lanes northbound and three lanes southbound) was introduced on the Sydney Harbour Bridge to cover the evening weekday peak period from 3.45 p.m. to 6.45 p.m. This replaced the previous 6/2 configuration which was causing severe delays to southbound traffic during the evening peak.

Originally, the new arrangements were introduced on a trial basis, but they have been adopted permanently as a result of their success in virtually eliminating southbound delays.

Monitoring results

After the introduction of 5/3 tidal flow, the Department closely monitored the effects on traffic crossing the Bridge:

• Volumes

The total four hour volumes (3.00 p.m. to 7.00 p.m.) of northbound traffic during the last full week with fine weather in August 1982 (prior to the change from 6/2 operation) was measured as 33,480 vehicles. The same four hour period during the week ending 29 October 1982 (after the change to 5/3 operation) was measured as 33,910 vehicles.

The total four hour volume (3.00 p.m. to 7.00 p.m.) of southbound traffic before the change was measured as 19,270 vehicles whereas after the change, for the same period, southbound volume was measured as 18,980 vehicles.

• Delay

On calculated data, total delay to northbound traffic increased from 174 to 610 vehicle hours. Total delay to southbound traffic of 840 vehicle hours was eliminated. Thus there has been an overall reduction of some 400 vehicle hours' delay.

An overall benefit still exists when allowance is made for total person delay owing to the greater number of people transported north by buses during the evening peak. A saving of 267 person hours has been estimated.

• Travel times

With regard to southbound traffic during the evening peak period, the exercise has been an unqualified success. The previous mean travel time from North Sydney to the City of about 13 minutes has been reduced to about 5 minutes. This means that regular commuters to and from North Sydney no longer face severe delays in their evening trip.

For northbound traffic, the previous mean travel time from the City to North Sydney has been increased from about 5 minutes to about 8 minutes. The longest delays occur on Grosvenor and Clarence Streets, as it is desirable to provide traffic management to maintain a high flow on the Western Distributor. Travel time on the Cahill Expressway has also increased as a result of less diversion into the City streets.

• Adaptability

If exceptional circumstances arise affecting northbound traffic, the 6/2 condition is introduced for an appropriate time period to relieve severe congestion. Such exceptional circumstances may result from blockage of the northbound lanes due to breakdowns or accidents at critical locations. Unusually high demands of traffic leaving the City can also be a factor, because of transport strikes or adverse weather conditions. It has been necessary to introduce 6/2 operation on fourteen occasions since September 1982.

Overview

Despite the net benefit in overall vehicle delay, the significant change in the distribution of delay indicates that only a 6/3 operation will greatly relieve both northbound and southbound delays. The provision of an additional lane on the bridge would better balance capacity with demand and, to this end, the construction of a ninth lane is desirable. In the meantime, the Department will continue to monitor the operations of the Sydney Harbour Bridge with the object of keeping overall delays to a minimum. ●

TOLL COLLECTING ON THE SYDNEY HARBOUR BRIDGE

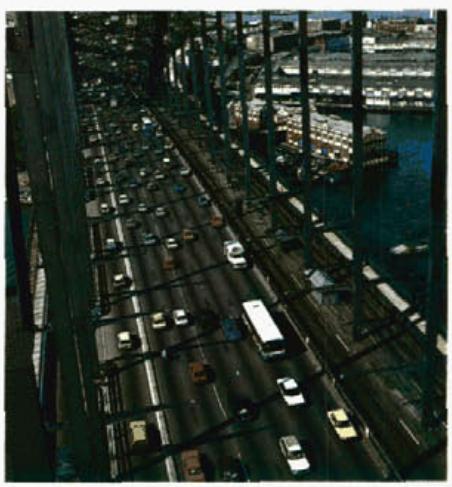
The traffic flow effects of toll collecting on the Sydney Harbour Bridge have been investigated by the Department a number of times in recent years. The combined evidence of delay analysis and various test cases have led to the conclusion that removing the toll would not improve traffic flow on the bridge.

Delay analysis

Delays experienced by a motorist on the bridge result from several factors:

- queuing delay due to the bridge itself;
- queuing delay due to the toll gates;
- queuing delay due to the merging areas downstream from the toll gates;
- service delay incurred as a result of reducing speed to pay tolls.

(a) Queuing delay due to the bridge itself. This is the major component of traffic delay, the extent of which can be several minutes in morning peak on the southbound approaches. The

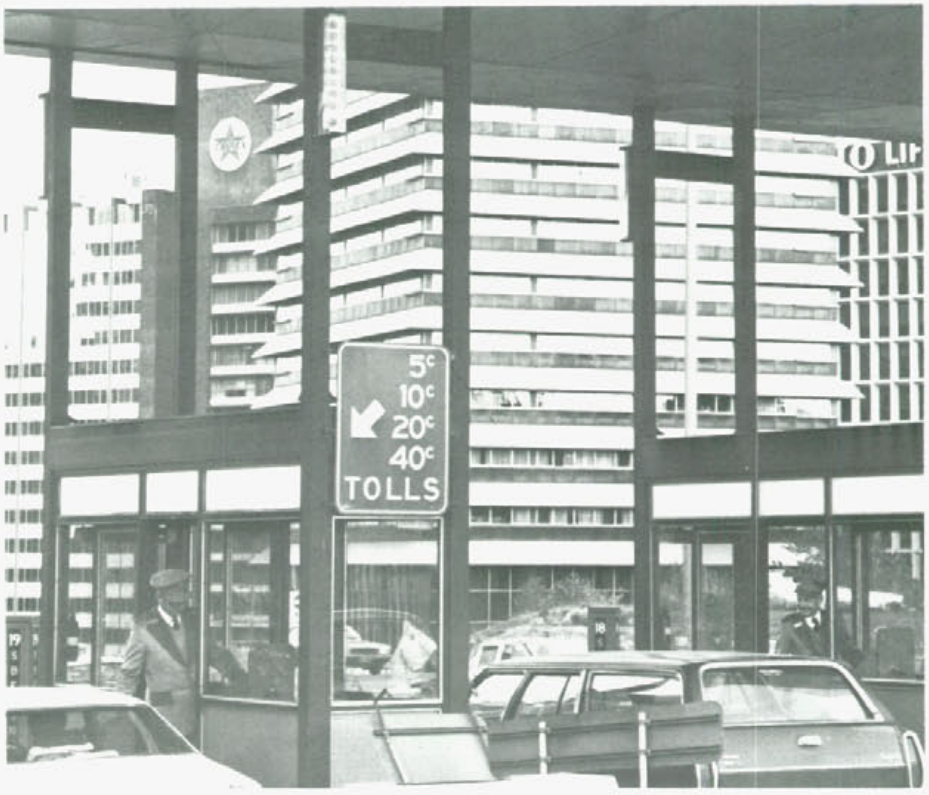


bridge itself rather than the toll gates provides the capacity restraint, when there is a greater traffic demand in peak times than capacity to satisfy this demand. However, the capacity of the toll gates is greater than the capacity of the mid-section of the bridge deck, so the gates pass volumes of traffic which are proportional to the known capacities of the bridge lanes.

(b) Queuing delay due to the toll gates. The fact of having toll gates does subject vehicles to delay. The point is that this delay is small compared to the total system delay and removing the toll would not increase the number of vehicles per hour moving across the bridge. Queuing theory models support this. The probability of a vehicle being delayed at a toll barrier is 0.567 in the morning peak and the average queue per barrier is 1.7 vehicles. The average queuing delay per vehicle due to the toll gates is minor, of the order of 10 seconds. Because of approach conditions, some booths have longer queues.

(c) Queuing delay due to the merging areas downstream from the toll gates. This factor is negligible, although a few seconds' delay per vehicle could be attributed to it in Lane 8 because of the short taper length and the physical limitations on lane changing immediately downstream from the toll barriers.

(d) Service delay incurred as a result of reducing speed to pay tolls. Service delay at each toll booth is of the order of ten seconds. This represents the time taken for the vehicle to decelerate from operating speed to stop, for the driver to pay the toll and for the vehicles to accelerate back to operating speed. In peak traffic conditions when vehicle speeds in the system are low, this component of delay also becomes negligible.



Test cases

Observation of no-toll situations was made in three instances. In each case, the sample was too small and the duration too short to permit firm conclusions being drawn, but general trends were apparent:

- During the morning peaks of 1 October 1976 and 4 October 1977, Radio 2SM paid the Sydney Harbour Bridge toll for motorists, who were waved through the toll gates. It was concluded that, on both occasions, the sponsorship did not benefit traffic, and there is some evidence that it adversely affected flow although the effect was only marginal.
- The five day toll collectors' strike from Monday, 14 January 1980 to Friday, 18 January 1980. Signs were displayed instructing motorists to proceed through the toll gates. The overall statistics did not support the contention that no payment of toll improved traffic flow as a whole.
- Temporary abolition of toll to ease travel arrangements during the last week of the recent train strike, that is, from Monday, 11 July 1983 to Friday, 15 July 1983. Because of changing travel arrangements by motorists, it is not satisfactory to compare one hour of a toll week with the same hour of the toll-free week in order to check the effect of no toll. Consequently a comparison was made of the maximum one hourly total southbound flow for a toll week with that for a toll-free week. The figures show that the slight increase in traffic flow was insignificant, having regard to the travel delays in getting to the Harbour Bridge and subsequently in travelling through the city at peak time.

Area of need

In considering the peak hour traffic flow on the Sydney Harbour Bridge, it must be appreciated that the system is potentially unstable. A small change in the demand/capacity ratio can dramatically increase or decrease delay, queue length and vehicle speeds.

Therefore, the greatest benefit to traffic on the bridge in terms of queue reduction, increased operating speed and smoothness of flow will be obtained by improving incident detection of vehicle breakdowns and the like rather than by removing tolls. If a vehicle breaks down during the period when traffic is entering and leaving the system at an average rate of around 1,800 v.p.h./lane, i.e., when the queue lengths are stable, then for each minute during which a lane is out of service, the queue lengthens by some 30 vehicles. In other words, traffic can bank up the equivalent of one kilometre in a lane in just over four minutes.

The Department is currently researching and developing a driver aid scheme for the Sydney Harbour Bridge. This will not only improve accident and breakdown detection but will also improve lane reversal procedures to reduce 'dead time' during peak periods. ●

MAJOR HUME HIGHWAY DEVIATION SOUTH OF GUNDAGAI

Early work

The present route of the Hume Highway near Tumblong, south of Gundagai, was opened to traffic on 23 December 1938. This section shortened the then existing highway by 13.7 km and eliminated a circuitous, narrow and poorly aligned section across the rugged Tarcutta Range.

The deviation was 16.9 km long with a single carriageway 8.5 m wide. Work was commenced as an unemployment relief project using an unskilled labour force of 240 people.

Later mechanical equipment was supplied, primarily to excavate the formidable 22 m cutting at Sylvias Gap. This included 30 lorries (1.5 cu. m capacity), six tractors (30-45 kw), two heavy duty rippers, a revolving bowl pneumatic tyred scoop (1.5 cu. m), a cable-operated pneumatic tyred 'carry all' scoop (4.5 cu. m), a steam shovel (0.75 cu. m), a 2-bag concrete mixer, six compressors and the 'trailbuilder' – a 45 kw tractor fitted with a 3.3 m wide hydraulically operated blade.

An article entitled "Study of Plant Operations on Tumblong-Tarcutta Deviation" – giving details of this work – appeared in the May 1940 issue of "Main Roads" Vol. II, No. 3, pp. 85-89.

Design standards of 1936 were adequate for the traffic of the day but by 1966 the volume of traffic had increased to some 2000 vehicles per day. It is now three times that figure and about half of this is heavy vehicles.

There has also been an increase in vehicle accidents. Since 1966, over 700 accidents have occurred on the deviation, with more than 400 injuries and 58 fatalities.

On the present route there are 18 curves which are below current standards, as well as appreciable lengths of roadway with restricted sight distance, no overtaking opportunities and narrow bridges.

New deviation

Work commenced on the new deviation in August 1980. It will have dual carriageways each 11.6 m wide and superior surface conditions designed for a minimum of 110 km/h vehicle speeds. The new route is 2 km shorter than the old one and its 17.3 km length is being undertaken in two sections:

- Section 1, 11.0 km – between 11.3 and 22.3 km south of Gundagai, which was opened on 21 November this year; and
- Section 2, 6.3 km – between 22.3 and 28.6 km south of Gundagai, which is expected to be opened by mid-1985.

The whole deviation should therefore be fully in use within 18 months, and the final cost is expected to be $27 million. Construction is being funded by the Commonwealth Government as a National Highway Project, with funds for Section 2 being provided under the Australian Bicentennial Road Development (ABRD) Program.

Earthworks and drainage

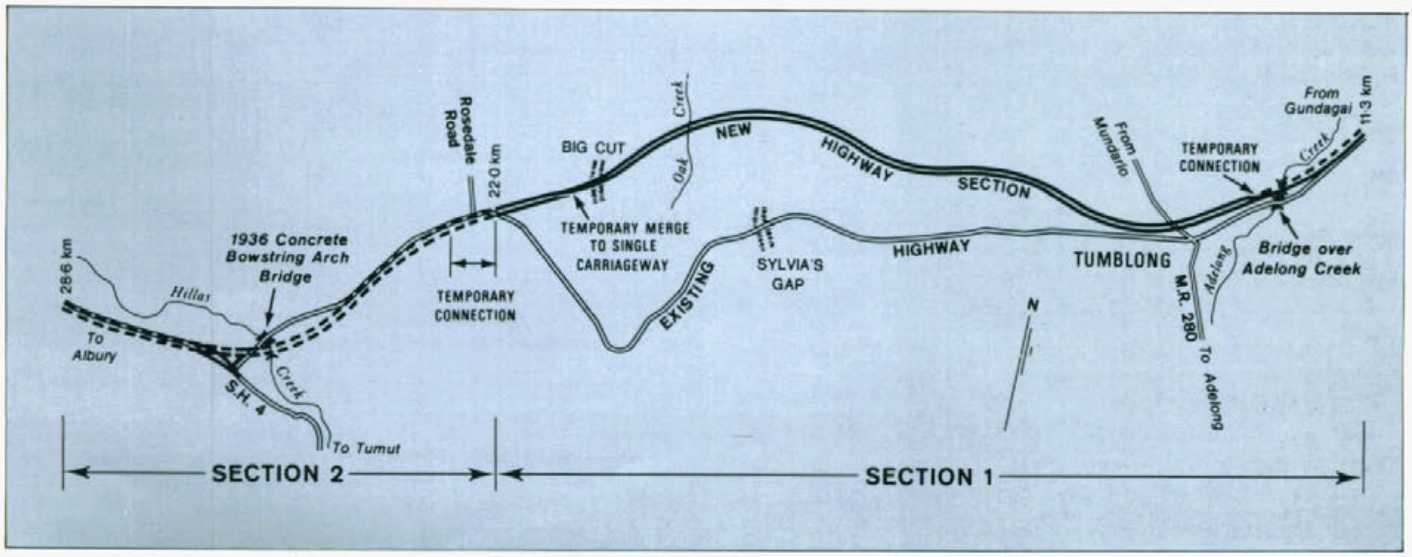
The deviation passes through some of the most difficult and rugged terrain on the Hume Highway.

In the early stages of fencing and clearing operations, access through the work was by four-wheel drive vehicles only and the construction of "zig-zag" access tracks over the hills was necessary to ensure safe passage, even in the driest conditions.

Cross drainage works presented many problems because of the difficulty in providing access for materials' supply. For example, at Oak Creek a large reinforced concrete box culvert, requiring in excess of 60 tonnes of steel reinforcement and 800 cubic metres of ready-mixed concrete, had to be built before earthworks could take place.

In total, the construction work has involved the excavation of nearly 3,000,000 cubic metres of earth and rock from cuttings and its subsequent breaking down and compaction in embankments. Almost 1,000,000 cubic metres of this material was too difficult to remove by loosening with conventional equipment and had to be drilled and blasted. More than half of this was blasted and removed to accommodate the dual carriageways through the Tarcutta Range. At one stage, daily blasting took place using up to 4 tonnes of explosive per shot.

Extensive use was made of lightweight helically corrugated galvanised steel pipes for drainage under high fills and



1. The old Hillas Creek Bridge and the twin bridges that will replace it.

2. The new twin bridges form part of an improved alignment over Hillas Creek.

3. Looking north along the 49 m deep cutting through which the deviation runs.

4. The new route vies for prominence with its predecessor.

bolted steel pipes up to 4 m in diameter for large waterways.

Large trench drains were used to extract water from a swamp and the provisions of a drainage blanket layer was made prior to constructing fills over the swamp to avoid the accumulation of water.

Rock-filled gabion baskets were used as an inlet structure for a large multi-cell pipe culvert in a swamp area. They also substituted as retaining walls in poor foundation conditions. The construction of dams and above ground "swimming pools" and the sinking of bores provided water for dust suppression and compaction during the earthworks phases of the project.

Benkelman beam deflection measurements were taken in the control of the earthworks compaction, to determine the stiffness of various layers of material and detect potential weak spots.

Then, prior to construction, seismic investigation work and extensive core drilling of all cuttings on the works were carried out to aid construction planners to assess the materials to be excavated.

Concrete pavement

Concrete for Section 1 was produced by an on-site semi-automatic batch plant, which regularly supplied 1 500 cubic metres per day. A 6 km long 100 mm diameter PVC underground pipeline was connected from the Murrumbidgee River to the batching plant to provide an adequate water supply.

For the deviation, the Department adopted a "jointed unreinforced undowelled (plain) concrete pavement", which consists of two layers of concrete – a 150 mm sub-base of 5 MPa concrete and a 200 mm base of 30 MPa concrete. Both are constructed from specially designed mixes (e.g., fly-ash has been used extensively in the sub-base) that have low shrinkage characteristics to minimise the effects of cracking.

Thermal blankets were used on the pavement works to prevent premature cracking of the fresh concrete during the very cold winter months. For economy and speed, haulage of the concrete was by conventional highway tip trucks, in lieu of the normal concrete transit mixers.

The concrete contains no reinforcement except in bridge approach sections and in irregular or tapered sections. Tie bars are used in the induced or constructed longitudinal joints. Transverse sawn contraction joints, 60 mm deep, are provided at variable spacing between 3.7 m and 4.6 m and skewed at a 10 degree angle. Theoretically, these will induce any contraction cracks to occur at controlled locations.

The two concrete layers have been laid using a slip form paver – at a rate of up to 680 m a day. There are two longitudinal joints in the pavement, formed by plastic crack inducer ribbon and tied together with transverse steel tie bars, all automatically inserted by the paver. The insertion of the tie bars has been done in such a way that they are not located at the sawn transverse joints.

The joints are sealed with a 6 mm preformed neoprene compression seal. Load transfer between sections relies on aggregate interlock, and the angle of the joints ensures that there is no simultaneous impact by the wheels of a vehicle on one section alone. To make sure that the induced cracks do not reflect into the sub-base, the bond between the two layers is broken by a second application of wax curing compound on the sub-base concrete. This is applied 24 hours prior to casting the overlying base.

The finished concrete is transversely textured with randomly placed grooves, of average 1-2 mm depth, spaced between 10 and 25 mm. This is followed by the application of a chlorinated rubber-based curing compound. The texturing increases skid resistance and reduces the likelihood of aquaplaning, by allowing water to quickly dissipate from the road surface. With none of the major joints which used to be an integral part of concrete roadworks, this continuous pavement will eliminate the regular thudding and "click-clack" noise usually experienced when travelling on older concrete roads, and will give a smoother, quieter ride.

Contractors in action

The 8.7 km length from the junction of Main Road No. 280 and the existing Hume Highway at Tumblong to near Rosedale Road required 1.6 million cubic metres of earthworks and associated drainage. The successful tenderer was White Industries. The work was completed in seventy weeks at a cost of approximately $6.2 million.

At a final cost of about $6.5 million, Leighton Contractors Pty. Ltd. undertook the task of placing the two layers of 11.6 m wide concrete pavement on these 8.7 km of dual carriageways using a Guntert and Zimmerman slip form paver. The work was completed in fifty weeks and illustrated that a new era in road construction had commenced.

Earthworks in progress on the rugged Tumblong terrain. (Top)

Select fill separated by conveyor from the oversized rock material.

The Department was the successful tenderer to carry out earthworks and drainage on the 2.3 km length from Adelong Creek to Tumblong. In a forty-week period the Department undertook 450,000 cubic metres of earthworks at a cost of $2.4 million.

Concrete paving (similar to that on the adjoining length) was carried out by Leighton Contractors Pty. Ltd. The work took seven weeks to complete at a final cost of $1.2 million.

Section 2 of the deviation extends for 6.3 km from Rosedale Road to south of the junction with the Snowy Mountains Highway. A tender of over $3.2 million was let to Citra Constructions Ltd. for 750,000 cubic metres of earthworks and associated drainage on this southern end of the deviation. This contract work is expected to be completed before the end of 1983.

As work on this section partially encroaches on the existing highway, it has become necessary for the construction to be undertaken in stages so that there is a minimum of disruption to traffic. Further contracts are to be let for the construction of the pavement, a new bridge at the junction with the Snowy Mountains Highway, and then the completion of earthworks and pavement which encroach on the existing highway.

Bridgeworks

Three new bridge structures have already been constructed and a fourth is yet to be built as the deviation nears completion.

New twin bridges over Hillas Creek were completed in March 1983 at a cost of $1 million. Designed by the Department, they are of the composite steel girder concrete deck type with three spans each, 76 m in length and 9.2 m between kerbs. They were built by Nelmac Pty. Ltd. at a cost of $1 million.

The twin bridges replace an unusual 40 m span bowstring arch concrete bridge which was constructed in 1938 as part of the original deviation. The structure is being retained for its historic interest but will not be open to traffic. (An earlier similar structure carries the Pacific Highway over Shark Creek near Maclean – see photograph and brief details in the March 1979 issue of "Main Roads", Vol. 44, No. 3, p. 89 and article in May 1936 issue, Vol. 7, No. 3, pp. 89-91).

A bridge has been completed over Adelong Creek at a cost of $650,000. It is a five span precast T-beam concrete structure, 100 m long and 9.2 m between kerbs. This bridge was also designed by the Department and constructed by Nelmac Pty. Ltd., at a cost of $650,000.

When earthworks in the final stage of the deviation are completed, a bridge will be built to carry northbound traffic moving from the Hume Highway to the Snowy Mountains Highway over the southbound Hume Highway carriageway. It will be of the post-tensioned voided slab type consisting of three spans, 82 m in length and 7.3 m between kerbs.

The benefits of modern technology

One item of modern earthmoving equipment can remove in a mere 60 seconds the same volume of earth and rock that took a team of five men a full day to dig and load, when the first deviation was being constructed.

Compared with the small capacity 1930's equipment mentioned at the beginning of this article, the large earthmoving equipment in use on the current project includes 10 cu. m front-end loaders, 34 cu. m tractor scrapers and 42 cu. m off-highway dump trucks.

The following comparison of a comparable length of old and new sections of Highway work illustrates the differences in roadbuilding magnitude and the improvements in roaduser standards between the late 1930s and the early 1980s.

The big cutting on the Hume Highway near Tarcutta in 1938, and the way it looks today.

The construction of the Tumblong Deviation is being supervised by the Department's Southern Division, which has its headquarters at 211 Bourke Street, Goulburn. Since February 1983 the Divisional Engineer at Goulburn has been Mr. Arvo Tinni.

Although the work has been basically performed by contractors, a large number of local people and sub-contractors have been employed on the job and the local business community has benefited from the influx of workmen and their families into the district.

	Old Route	New Route
Total Length	12.5 km	11.0 km
No. of Carriageways	Single	Dual
Carriageway Width	8.5 m	Each 11.6 m
Excavation Volume	139,000 cu. m	2,050,000 cu. m
Largest Cutting	57,500 cu. m	550,000 cu. m
Deepest Cutting	22 m	49 m
Highest Fill	24 m	19 m
Steepest Grade	9.5%	6.7%
Minimum Curve Radius	213 m	1,600 m
Volume of Concrete	–	100,000 cu. m

The Department has recently produced a brochure on this important project and copies are available from the Public Relations Section. ●

XVII WORLD ROAD CONGRESS

The XVII World Road Congress of the Permanent International Association of Road Congresses (PIARC) was held at the Sydney Opera House from 8-15 October 1983. It was opened by the Governor-General of the Commonwealth of Australia, Sir Ninian Stephen, and was attended by almost 1400 delegates and over 400 accompanying persons from 82 countries.

Many important road construction and maintenance matters were discussed, as well as others including road safety, environment, energy conservation and finance. Delegates also inspected works in progress outside Sydney, and many took part in study tours to other parts of Australia after the Congress.

One of the highlights of the week was the International Trade Fair 'Road '83' and exhibition of road equipment at the Royal Agricultural Society's Showground in Sydney, which was opened by the Honourable Peter Morris, M.H.R., Commonwealth Minister for Transport and President of the Australian Organising Committee. Displays were provided by Australian and overseas companies and organisations which supply materials, machinery and skills for the construction of roads, bridges and tunnels and for traffic control.

General Conclusions

Towards the end of the proceedings, the following Congress General Conclusions were presented by Mr. Donald Aitken, Commissioner of Main Roads, Western Australia and General Reporter for the Congress:

"During the past week the Congress has discussed a wide range of topics within the subject of roads. These discussions centred on technical reports resulting from reports submitted by various countries under five nominated questions or else from the ongoing work of 11 technical committees. In addition there were two conference discussions and a workshop.

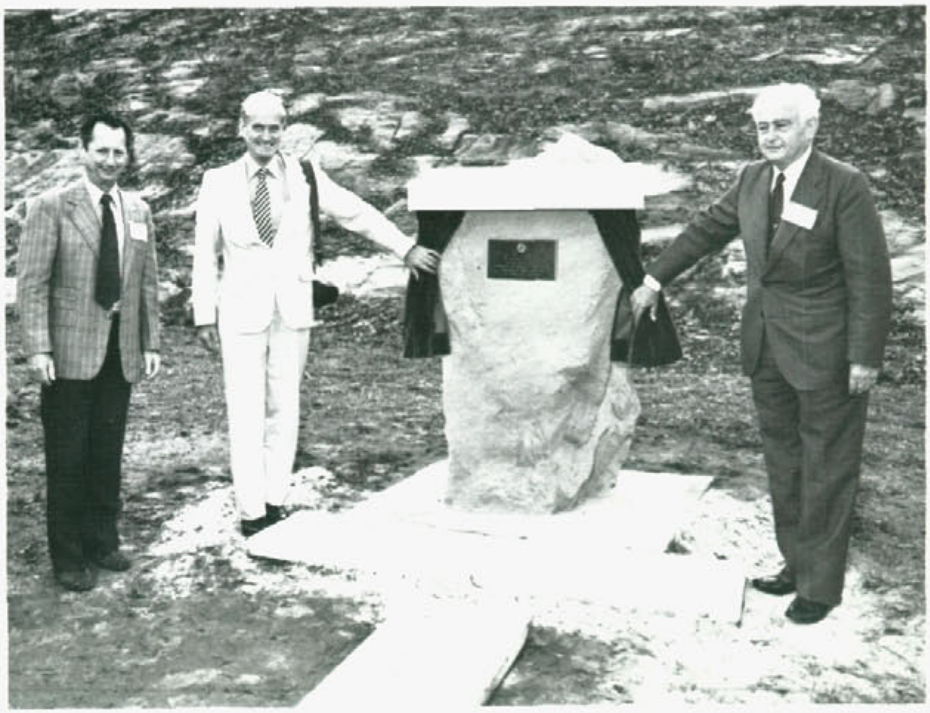
There is an increasing need in modern road engineering for the application of a high level of technology in the design, construction and maintenance of earthworks, drainage, subgrade and pavements.

In recent years there has been a greater use of computers, more particularly micro computers in the design and drafting of roads and bridges. For high speed inter-urban roads and motorways greater emphasis in design is being placed on the driver's perception of the road.

Ministers and Highway Administrators should encourage further development to take advantage of this higher level technology.

Studies should be continued into quantifying the effects of roads on the environment so as to be able to make a better environmental evaluation of alternative solutions.

Action is required on the development of a national strategy to facilitate the use of waste products as appropriate and standards for the use of geotextiles.



Delegates inspected roadworks in progress on the F3 Sydney-Newcastle Freeway. A plaque to commemorate the occasion was unveiled just north of the Kangy Angy cut. Pictured are Mr. B. N. Loder, Commissioner for Main Roads and Deputy Secretary-General of the Australian Organisation Committee, Mr. M. Milne, President of PIARC (Great Britain) and Mr. M. Huet, Secretary-General of PIARC (France).

The design and management of roads are important and have been the subject of several sessions and considerable discussion at the Congress. One concept deals with the optimisation of road management in terms of investment, maintenance, user costs and environment quality. Because of budgetary constraints there is a tendency in this concept to reduce the level of service in order to reduce infrastructure costs. Another approach which is of greater importance is to maximise the total benefits within the budget by adopting different levels of service according to the importance of the road.

Pavement design methods have been developed to a high degree but the validity depends upon the accuracy with which certain parameters can be measured. Further research on the validity of the methods must be pursued to assess the long term behaviour of pavements in service. Large scale model tests such as those carried out by accelerated loading facilities will assist this task.

It is important that adequate funds be provided by Governments to continue and pursue important basic research into road design, construction and maintenance.

The free interchange of technical information and transfer of technology between countries must be more strongly developed as a basis for increased skills and knowledge leading to improved and more efficient design, construction and maintenance practices.

In the urban scene the total demand for mobility is still rising but at a decreasing rate. Considerable emphasis is now being placed on promoting travel by public transport, in the use of cycles and by walking. In order to cope with this demand there is a need to increase vehicle occupancy and to effect a shift of passengers from private cars to public transport. This will require improvements to public transport facilities and possibly restrictions in the use of motor cars, but this change of emphasis will still require adequate investment in new road construction in urban areas.

New major road facilities can be justified in urban areas. They may result in significant advantages in improved traffic flow, reduce environmental nuisances, improve safety, produce economic benefits and conserve energy which can outweigh the adverse effects of new construction. It is usual to assess and weigh these and other factors so that politicians and other decision-makers have all the information available in making decisions. It is important that public participation and consultation occur, although the methods will vary between countries.

The first day of discussion at the XVII World Road Congress took place on Monday, 10 October 1983.

Traffic management techniques are increasing with advances in new technology. Area traffic control schemes embracing optimisation of systems and traffic signal co-ordination are being widely used. They and many other cost effective measures make a significant contribution to improving the environment and efficiency of cities.

Greatly improved road safety is still a challenge to the whole community. The implementation of good town planning principles in new suburbs and towns, the separation of cyclists and pedestrians from vehicular traffic and provision of special facilities, the removal of or restriction on through traffic from residential streets, improved road design based on better understanding of the behaviour of road users reinforced by driver education are all important in this task. A co-ordinated approach is necessary both in developed and developing countries.

Roads in developing regions were discussed as a specific question. The importance of adequate maintenance of roads and road making equipment was stressed and the need for adequate funds to provide satisfactory continuing serviceability was essential.

Although much has been done in the training of engineers and technologists, greatly accelerated programmes would be very beneficial and pay handsome dividends.

For greater effectiveness in overcoming problems in developing regions greater participation by developing countries in the work of PIARC both individually and through regional groupings of countries would be beneficial.

One subject which has been mentioned and discussed in many of the topics at the Congress has been that of effective maintenance. It is a problem of great importance in all countries embracing all classes and types of road. It is recognised that the temptation to base maintenance budgets on what has been provided in previous years should be resisted.

More factual information is required to make it possible to make longer term maintenance strategies more meaningful. There is evidence to suggest that funding and other resources in some countries are insufficient to fully preserve the investment made in the road system. Governments are urged to recognise these problems and to make strenuous efforts to overcome them.

Roads and road transport are essentially captive customers for oil products, and conservation should be pursued through more energy-efficient vehicles, higher occupancy rates, improvement of user behaviour, public transport, traffic management schemes, revised design standards, new road construction and reduction of the need for travel. Governments should be aware of the necessity of avoiding road construction and traffic management works which, while economical in themselves, may result in increased fuel consumption by road vehicles." ●

(A detailed account of the PIARC proceedings will appear in the March 1984 issue of "Main Roads" Journal.)

REPORT OF WARRINGAH TRANSPORT CORRIDOR INQUIRY

In 1977 the State Government formally abandoned a number of inner urban freeways, including the extension of the Warringah Freeway from Willoughby Road, Naremburn through Castlecrag and then to Seaforth, via a new bridge over Middle Harbour at Sugarloaf Point. The land reserved in planning schemes for road purposes was rezoned for residential purposes, open space, etc.

Following appeals from the Councils of five northern suburban areas (namely, Manly, Mosman, North Sydney and Willoughby Municipalities and Warringah Shire), the then Minister for Transport and Highways, Hon. P. F. Cox, announced in September 1978 that Mr. David S. Kirby, B.A., LL.B., Barrister-at-Law, had been commissioned to undertake an inquiry.

The terms of the Inquiry were:
"To inquire into, report upon and make recommendations relating to possible future and alternative uses of the Warringah Freeway Corridor reservation and with particular reference to the proposal made by the Northside Councils to the Minister for Transport and Highways on April 14th, 1978, to retain the reservation as a transport corridor."

The commencement of the Inquiry was delayed, awaiting completion of the Kyeemagh-Chullora Road Inquiry (of which Mr. Kirby was also Commissioner) and preparation of a Background Reference Document.

The Inquiry commenced in April 1981 and the public was invited, through advertisements, displays and pamphlet distribution, to make submissions. A total of 841 submissions were received including a detailed 2 volume, 208 page report by this Department, and others from the State Rail Authority, the Department of Environment and Planning and the Northside Councils.

Public hearings were conducted between March and November 1982. During the Inquiry, a number of discussions were held with consultants, namely, Emeritus Professor W. R. Blunden, Dr. J. P. Gerofi and Dr. P. Forsyth.

The Final Report of the Commissioner of the Inquiry was submitted to the Minister for Transport in April 1983 and tabled in Parliament on 17 August 1983. The main (357-page) body of the Report covers such aspects as "The Issues, Present Transport Problems, The Transport Problems of the Future, The Development of Warringah, The Economic Benefits of Development, The Road Options, The Public Transport Options,

Work in progress on the Burnt Bridge Creek Deviation between Sydney Road, Balgowlah and Condamine Street, Manly Vale.

Land Use Alternatives, The Environmental Objection, and The Corridor Issue".

The Report has been referred by the Minister to the Transport Strategy Advisory Committee (TRANSAC) for assessment and advice. This Committee comprises the permanent heads of a number of State Government Authorities and a representative from the Transport Workers' Union. It is responsible to the Minister for advice on strategic planning, implementation, evaluation and co-ordination of transport policy.

The final five pages of the Report, listing the Commissioner's Recommendations, are reproduced here for the information of interested readers. A copy of the full Report is available for perusal in the Department's Library, Fifth Floor, Head Office. Copies should be available shortly for purchase from the Government Printing Office and the Government Information and Sales Centre.

RECOMMENDATIONS

1. REINSTATEMENT AS A CORRIDOR

It was suggested that the former Warringah Freeway Corridor should be reinstated.

RECOMMENDATION: The Inquiry recommends against reinstatement of the corridor.

2. A LINK ROAD BETWEEN WILLOUGHBY ROAD AND EASTERN VALLEY WAY

It was suggested that there should be a link road connecting the Warringah Freeway with Eastern Valley Way.

RECOMMENDATION: The Inquiry recognises that such a proposal has merit. It recommends as follows:

- reinstatement of a corridor between Willoughby Road and Eastern Valley Way (opposite Mowbray Road);
- the corridor should be substantially more narrow than the previous freeway reservation. It should be no more wide than is necessary to accommodate an arterial road;
- that the boundaries of the corridor, as redefined, should be drawn after consultation between the Department of Main Roads, the Department of Environment and Planning and the Willoughby Municipal Council;
- that the massive interchange proposed at the confluence of the Warringah Freeway, the Gore Hill Freeway, and the former extension of Warringah Freeway to Seaforth, should be abandoned. A more modest intersection, preferably at ground level, and intruding as little as possible into Hallstrom Park, should be designed;
- that the corridor, as redrawn, should preserve access to The Incinerator of Walter Burley Griffin;
- that the property owned by the Government, and within the boundaries of the corridor, as redefined, should be retained;
- that property outside those boundaries should be referred to the Property Advisory Management Committee with a view to its disposal or acquisition by other Government agencies where appropriate;
- that upon construction of the link road compensation for the loss of part of Hallstrom Park should be effected by the closure of Flat Rock Drive. Open space on either side will be reunited, thereby ensuring continuity of important open space areas;
- that the Sydney Church of England Grammar School at Northbridge should be compensated for the loss of part of a playing field by being given the use of an equivalent area of vacant land to the north of the school boundary (being land within the former Warringah Freeway Reservation).

3. THE ESCARPMENT AT CASTLECRAG

The northern escarpment at Castlecrag is an area of immense charm. It has been neglected. What should be done with it?

RECOMMENDATION: The Inquiry recommends the preservation of the escarpment as open space:

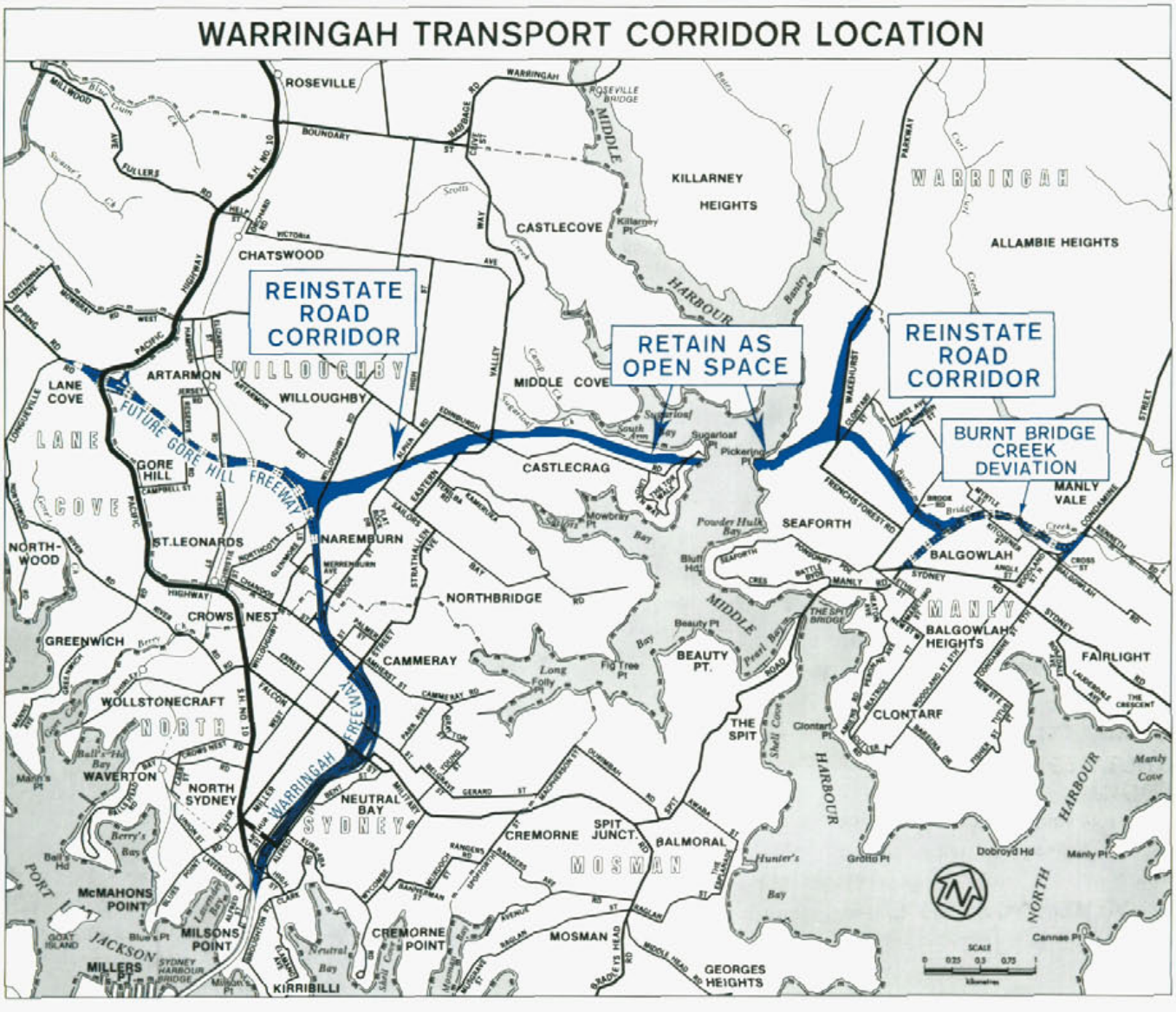
- the management of the escarpment should be entrusted to the Willoughby Municipal Council;
- the Council should be given a grant to assist in the administration of the area, being part of the money derived from the sale of properties no longer required;
- the boundary of the open space as delineated by IDO 27 should remain;
- the properties within the escarpment which are still privately owned should be progressively acquired to ensure continuity of the reserve;
- the open space within the escarpment owned by the Department of Main Roads should be transferred to either the Department of Environment and Planning, or the Willoughby Municipal Council, as the case may be.

4. A SUGGESTED LINK BETWEEN THE WAKEHURST PARKWAY AND THE BURNT BRIDGE CREEK DEVIATION

The Manly Council argued that the proposed Dalwood Homes Connection (at Seaforth) was unsatisfactory. A better road, accomplishing the same ends, and solving certain other problems, could be constructed within the former freeway reservation. The Council suggested that the Corridor should be reinstated in exchange for the deletion of the Dalwood Homes Connection.

RECOMMENDATION: The Inquiry accepts that such a proposal has merit. It recommends as follows:

- the Corridor for the Dalwood Homes Connection (between the Wakehurst Parkway and the Seaforth Shopping Centre) should be abandoned;
- that the property owned by the Government within the Dalwood Homes Corridor should be referred to the Property Advisory Management Committee;
- that the Property Advisory Management Committee, when determining what should be done with the property, should have regard to the suggestions by the Manly Municipal Council embodied in their letter of 8 December 1982. The suggested zonings appear to the Inquiry to be desirable;
- that a corridor between the Wakehurst Parkway and the Burnt Bridge Creek Deviation, and within the former Warringah Freeway Reservation, should be reinstated;
- that the boundaries of that Corridor should be drawn in order to accommodate an arterial road. That the example of the proposed Burnt Bridge Creek Deviation should emphatically not be followed when redrawing the boundaries of that Corridor. The Burnt Bridge Creek Deviation, in the Inquiry's judgement, is unnecessarily lavish in its width and design. It is, accordingly, more costly than it need be. It absorbs more open space than is desirable;
- that property owned by the Government within the boundaries of the Corridor as redefined should be retained;
- that property owned by the Government but outside those boundaries should be referred to the Property Advisory Management Committee with a view to its disposal or acquisition by other Government agencies where appropriate.



5. PROPERTIES WHERE THERE IS NO REINSTATEMENT

In two sections of the former Warringah Freeway Reservation the Inquiry has not made any recommendation for either reinstatement or the use of the land as open space. Those sections are:

- the section between Eastern Valley Way (opposite Mowbray Road) to the Castlecrag escarpment;
- the section from Pickering Point to the Wakehurst Parkway.

What should be done with the property within these sections?

RECOMMENDATION: The property owned by the Government should be referred to the Property Advisory Management Committee with a view to its disposal or acquisition by other Government agencies where appropriate. The Committee should, where possible, use the undeveloped areas (especially in the vicinity of Pickering Point at Seaforth) as open space.

6. WARRINGAH RAILWAY

A rail link to the North Shore line, using the corridor, was suggested.

RECOMMENDATION: If, contrary to our primary recommendation, the Government feels that a corridor should be reinstated, we recommend as follows:

- the corridor should be no more than 12 metres wide, being the width necessary to accommodate a double track railway;
- the corridor should not make provision for stations. It is impossible to say at this stage, with any degree of assurance, where stations can best be located;
- a corridor greater than 12 metres would be necessary on the Castlecrag escarpment if the cut and fill method of construction were employed. That method would be environmentally so damaging as to be unacceptable. Accordingly a 12 metre corridor (and the viaduct method of construction) is appropriate even in this area.

COMMUNITY AND SOCIAL BENEFITS OF MAJOR ROAD RESERVATIONS*

(M. E. Chapman, B.Sc.(Hons), M.T.C.P.
Investigations Officer, Planning Section, Department of Main Roads, N.S.W.)

ABSTRACT

Land held in major road reservations in the Sydney Metropolitan Area is coming under increasing pressure for development or redevelopment and there is a widely held belief that such reservations are uneconomical and socially undesirable. This paper discusses the planning process involved in reserving land for major roads, examines the question of whether there is a casual or incidental relationship between freeway corridors and urban blight in Sydney, gives examples of current land uses on freeway reservations in the Sydney Metropolitan Area and suggests certain short- and medium-term uses of reserved land prior to road construction thereon. The paper identifies some of the community and social benefits attending major road reservations and the disbenefits of not providing such reservations. While acknowledging that there are some adverse community and social effects attending freeway corridors, the paper suggests that opportunities for socially acceptable and desirable interim uses of reservations are available and may be implemented without jeopardising future road construction. (Aust. Rd. Res. 12(4) pp.247-54)

INTRODUCTION

The land held in major road reservations in Sydney is coming under mounting pressure for development and redevelopment. Increasing demand for land in Sydney, particularly land for residential purposes, has been evidenced by a significant escalation of prices in recent years. Although the price of an improved piece of land in Sydney is composed of many elements, shortage of space is a major contributor to the cost of land.

It is this excess of demand over supply, together with competing land uses, which is placing pressure on any vacant or underutilised land that might be available. Vacant land in Sydney is in most cases either unfit for building purposes or reserved for future uses such as housing, schools, public utilities, transmission and drainage lines, parkland and major roads. It is not surprising, therefore, to hear arguments from people wishing to develop remaining land to the effect that road reservations are an uneconomical use compared to the higher forms of land use in the surrounding developed areas.

Vacant land has often been ignored or forgotten, which in some cases has led to the area becoming unsafe. In addition, some inner city and selected areas, where reservations contain residential and other development, show signs of urban blight, causing concern from both economic and social points of view.

Reservations set aside for the construction of future roads will provide new and improved access for intra-city travel. Construction of these roads will increase the area of acceptable land available for development. It is the cost of access rather than the distance of travel which controls the accessibility of land for development. Travel time is a far better indicator of travel cost than distance. (Loder 1982)

Low density settlement in Sydney has led to a high degree of reliance on the motor car. It is not surprising that traffic congestion occurs in many parts of the Metropolitan Area in view of the large population, the high level of motor vehicle ownership and usage, the inadequacy of the urban road hierarchy, and the constraints on transport caused by the dissection of the urban area by large waterways. Today the sprawl continues, albeit in a more controlled manner, due to the Sydney Region Outline Plan (State Planning Authority of New South Wales 1968) and at a slower pace as land becomes available through Department of Environment and Planning, Land Commission and Housing Commission land releases. As development continues on Sydney's fringes, a more favourable attitude towards living in smaller units and a desire to live closer to the city has led to the gentrification of inner suburbs. Urban consolidation has been influenced by this trend.

The Department of Main Roads, New South Wales (DMR, N.S.W.) Report of 1945 noted that a new type of road, namely 'expressways and motorways' would be needed to cater for increased traffic. Nearly 40 years later Sydney's major roads are congested and local roads in residential areas are being traversed by through traffic. Traffic management schemes can only go so far towards relieving the situation. Only now are improvements beginning to be seen in the metropolitan area such as the Parramatta bypass and construction of freeway sections as a result of long-term plans.

This paper is not meant solely as an argument for the retention of land held in major road reservations; it is mainly concerned with the examination of economically and socially acceptable alternatives regarding the existing and future use of those reservations.

Major Road Reservations – The Need for Planning

Establishment of Reservations in Sydney.

In 1945, the Department prepared a report which brought together a great deal of data in order to prepare a Main Roads Plan. In that report Sydney's future traffic problems were envisaged and remedies suggested.

Roads of the existing type cannot themselves cater fully for anticipated future traffic requirements. At some points where important lines of traffic cross, it may be necessary to provide structures to enable the two lines to move at different levels, and a limited number of new roads of the expressway or motorway type may be required. (DMR N.S.W. 1945, p.13)

The Departmental Study was forwarded to the Cumberland County Council and, after modification, later became the County of Cumberland Planning Scheme. It was with the prescription of this Scheme in 1951 that many of Sydney's future major roads were reserved. Even then, the advantages of reservations outweighed the disadvantages of alternatives.

It is obvious that motorways within the urban area will involve completely new construction. To achieve this by street widening and by the destruction of built-up frontages is economically impracticable. This fact has the advantage of allowing the selection of many new

routes along district boundaries, where open space or rural land can provide permanent protection against impinging development, and access from the adjacent road system can be readily controlled. (Cumberland County Council, 1948, p.163)

Freeways were located along lines of minimum disturbance to existing development. Fig. 1 shows the freeway corridors in the County of Cumberland, from which examples are drawn in this paper.

Long-Term and Short-Term Planning–
A long-term framework is necessary as a reference for the preparation of short-term plans. The latter may be necessary in the development of a certain area due to unforeseen changes in population growth, travel desire lines, etc. Plans for individual roads can be varied according to this shorter time span, but a long-term plan must guide consideration of an efficient road network. To illustrate this point, a local road system within Sydney may be modified in some way in order to have a particular desired effect (e.g., reduction of through traffic in a residential area). Familiarisation with long-term regional plans and traffic patterns will give direction to the type of change needed. Well documented plans will also show whether the change can be implemented without having undesirable consequences for neighbouring areas.

The major justification for long-term planning came from the County of Cumberland Report.

The late Professor Denis Winston, in his comments on the County of Cumberland Scheme, continued to stress the advantages of long-term planning – this time in relation to road planning.

Where it is known, for example, that a new main road will be wanted in a certain location, it is commonsense to reserve the land now before further building development takes place, and the same applied to sites for important public buildings, school sites, or major sports areas. These sorts of costs would have to be met sooner or later by the constructing authorities concerned, and much higher prices paid as time went on if the County of Cumberland did not do the job now. (Winston, 1957, p.92)

An inter-relationship exists so that short term changes can, over time, indicate the need for variations in long-term plans.

Roads as an Integrated System–
As the above discussion indicates, planning for a particular road cannot be considered in isolation from other roads and surrounding land uses. The existing system of main arterials in Sydney is a product of historical factors and is far from ideal. Combining local movements of people and goods with long distance through traffic is a highly unsatisfactory situation. Lack of planning and lack of implementation of plans designed to adequately separate these traffic components has contributed to today's congestion.

In order to overcome this congestion a proper road hierarchy must be established in Sydney and an essential part of this hierarchy is the planned development of major roads and freeways. This would enable faster and safer long distance trips within the Metropolitan Area, and at the same time would relieve existing arterials.

Economic and Planning Benefits–
Roads form an integrated and dynamic system not only with each other but also with the land uses surrounding them. Planning of the road system in the manner outlined above enables government departments, agencies, councils and developers to establish appropriate land uses on roads designed to suit a particular type of traffic. Existing land use will in turn influence the road system plan.

Assuming that road reservations are part of such a plan, neighbourhoods can be planned (in design, economic and social terms) on either side of the reservation so that once the land is eventually required, surrounding areas will not be severed. Planning and economic benefits such as those outlined above are generally accepted by the broad community as legitimate reasons for adopting long-term reservations for major roads. While some disadvantages occur, particularly in regard to the opportunity costs of reserving land which could be put to other uses, the community's need to provide for its future transport requirements is generally seen as sufficient reason for retaining the reservations. It is in the area of social and community costs and benefits that arguments sometimes arise in relation to the retention of the reservations.

Community and Social Effects–
The essential problem of the planning process is that the benefits and costs of planning proposals are unevenly distributed throughout the community. Benefits frequently relate to the fields of economics or physical planning and primarily affect the broad urban community. The costs, however, are largely expressed in social or community terms and are felt mainly in the local area on which the reservation impinges.

While accepting this premise, in most critiques of the overall planning process little or no attention has been paid to the offsetting social and community advantages rising from the long-term reservation of land for major roads.

Major Road Reservations and Urban Blight

In order to determine whether reservations cause an obvious change in condition of dwellings, both existing and abandoned reservations were investigated. The inner city reservations, namely the Eastern Distributor, the Western and Southern Freeways, showed evidence of urban blight. However, the blight observed in these areas needs to be qualified.

Most cities in developed countries have experienced a population move from overcrowded living around the urban core to more spacious suburbs further out. The old areas were partly vacated, leaving older residents who were unable to move because of either financial or social reasons. Encroachment of industrial uses into these areas added to the blight. Dwelling stock was approaching the end of its useful life and the only residents prepared to live in such dwellings were those on low incomes who had no choice but to take low quality accommodation. As a consequence, building maintenance was not carried out. Many of Sydney's inner suburbs were affected in this way and have remained unchanged until recently.

Changes in attitudes toward inner city living have led to people on higher incomes moving back to the older suburbs and renovating or redeveloping large areas – this process is known as gentrification. Renovated dwellings (mostly terraces) have been observed on and surrounding each of the inner city reservations. However, differences in the severity of blight were noted between the present Eastern Distributor corridor and the abandoned sections of the Western and Southern Freeway corridors. The difference does not seem to rely on whether or not the reservation has been abandoned even though the worst case of blight was on the current Eastern Distributor Reservation. Most inner city areas, apart from those where extensive rehabilitation has been carried out, are in a run down state and generally dwellings

on the road reservation cannot be distinguished from those which are unaffected.

The Eastern Distributor is very close to the central core of Sydney. It passes through Woolloomooloo and East Sydney, areas whose futures have been subject to a great deal of uncertainty. Many of the old terraces on the reservation have either been demolished or partly demolished by the Department because this was more economical than maintenance. Some others which are owned by the Department and still standing have had water and power disconnected prior to planned demolition. However, before demolition could be carried out squatters took up residence in the old terraces and the Government subsequently placed the corridor under review. No decision has been made to date even though the decision has been expected for several years. Any further action has been delayed. It is this kind of uncertainty rather than the reservation itself which has kept the dwellings in the reservation, and indeed the surrounding area, in a blighted state.

Spot renovation of dwellings has occurred both on and off the Eastern Distributor Reservation. With a programmed six to ten years before commencement of construction (pending the review decision), the Department has given approval to the renovation of several privately owned dwellings affected by the corridor. This will allow those residents a higher standard of living condition until their occupation ceases. Obviously residents and owners of commercial property would not carry out such work if there was a shorter term involved prior to construction; it would not be economically feasible.

Blight affecting whole areas, not only road reservations, was observed in Ultimo on and near the abandoned section of the Western Freeway. Since abandonment in 1977, both rehabilitation and redevelopment have occurred on the former freeway reservation, serving as a contrast to the poor quality dwellings in surrounding areas. New construction was also observed on the abandoned sections of the Southern and North Western Freeway reservations. Further investigation revealed that none of these blocks was owned by the Department at any stage, so that they have not been placed on the market by the Department and bought by developers. One property in particular, in Belmont Street, Alexandria, was destroyed by fire in 1972, rebuilt recently and is now for sale. Its sale does not necessarily rely on abandonment of the freeway.

The reservations are just as inconspicuous through suburbs such as Burwood, Concord, Ramsgate and others which developed after settlement of the inner areas. There are no obviously poor quality dwellings only on the reservation. These suburbs have not yet experienced the trend in renovation because the housing stock is relatively more recent, was built to more modern living standards and is in good condition. Abandonment of the North-Western Freeway has had varying effects on different sections. In Renwick Street, Drummoyne, one newly constructed house and three other houses were 'for sale' on the abandoned reservation. Belmont Street, Alexandria, also had a newly constructed dwelling 'for sale' on the abandoned section of the Southern Freeway reservation, while Kentville Avenue, Annandale, has dwellings in good condition and seems unaffected by either the former reservation or its recent abandonment. As shown above, any action taken on the real estate market is dependent on local factors including ownership of land whether or not owners are willing or able to sell.

The evidence presented here is not conclusive as to whether or not road reservations cause blight. A temporal study begun some years ago would have been valuable for this exercise. However, it seems that road reservations could have caused blight, have been placed in areas already blighted, or were placed in areas which would have declined anyway, depending upon the location and history of a given area.

Road reservations today, with better management on the part of the residents, the Department, Councils and other bodies, can take on a new look and be beneficial to a defined community before they are needed for construction.

CURRENT LAND USE ON ROAD RESERVATIONS

Sources of Information–

The Sydney Region Corridor Review, conducted by the Urban Transport Study Group (UTS) in 1977 obtained impact data for 128 of the 138 corridor sections under review. Appendix '1' of the UTS Review gives a detailed account of the numbers of properties and buildings affected within each corridor. Table 1 is a summary of that information.

De Leuw Cather reports on the Eastern Distributor (De Leuw Cather and Jackson, Teece, Chesterman and Willis 1977) and the South Western Freeway (De Leuw Cather 1978) are probably the most detailed sources of aggregate information for those reservations. The former study identifies the area under different forms of land use (Table II).

Sections of several reservations were selected to examine land use at first hand. General information on land use was gained during a helicopter reconnaissance of Sydney's major road reservations in January 1982. Sections were selected for further examination on the ground.

Open Areas within Reservations–

The examples sited in following sections will be used to illustrate land uses presently on road reservations within Sydney and will also provide 'food for thought' as to how other pieces of vacant or developed land might be utilised.

Road reservations have been observed under what might be termed as formal and informal uses. Formal uses include those sighted on the Western Freeway Reservation at Wentworthville. The reservation runs along the back of a caravan manufacturer's property and is

TABLE 1
IMPACT DATA FOR SYDNEY REGION CORRIDORS

Information Category	Total 128 Corridors	Four Corridors Recommended for Release
Buildings affected	3960	1259
Buildings to be acquired	3212 (i.e. 81% of buildings affected)	1139
Recreation (ha) (in reserve)	392.8	2
Total length (km) for which data were obtained	712.8	15.5 (approx.)

Source: UTS (1977)

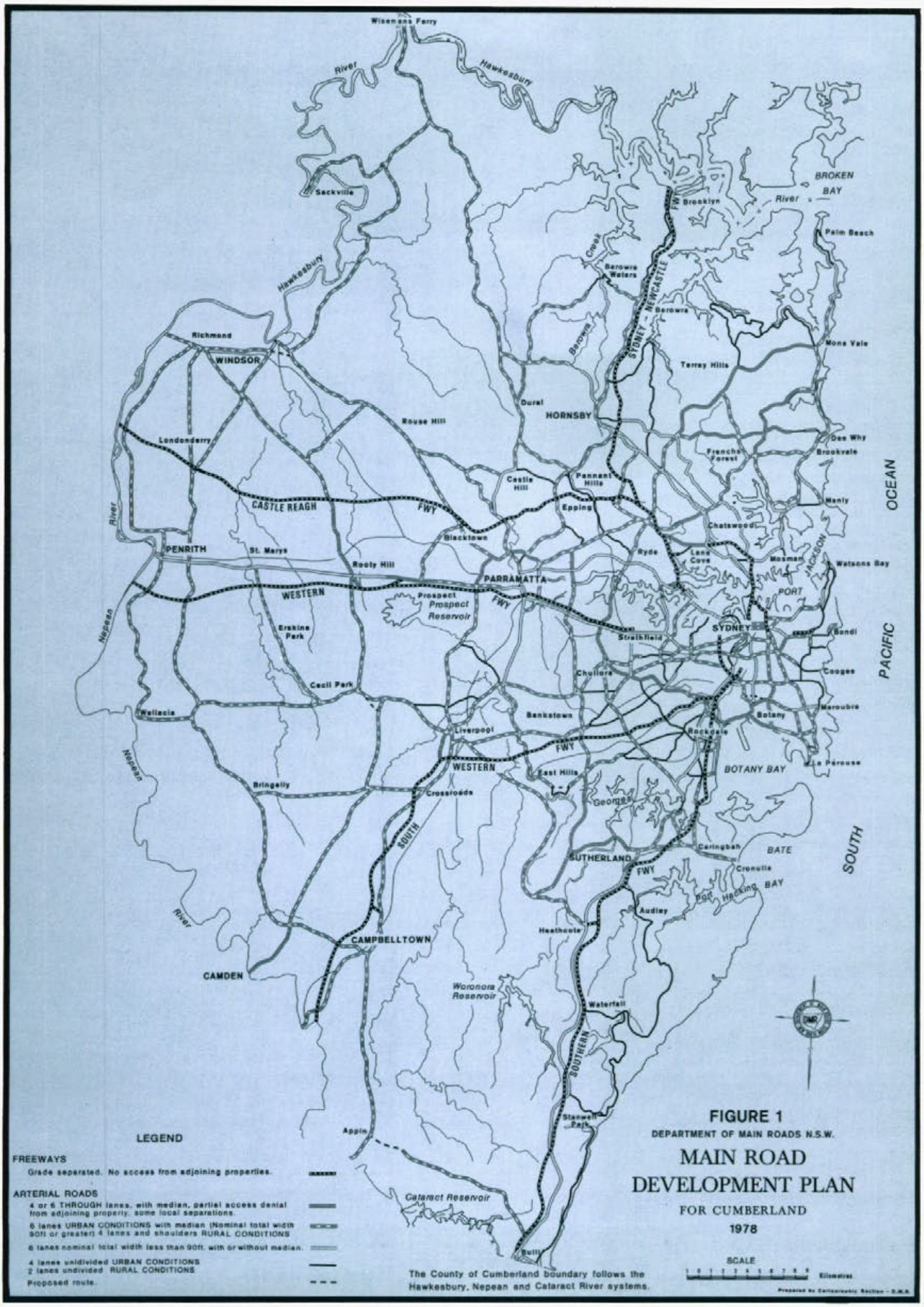

Wisemans Ferry
River
Hawkesbury
Sackville
Hawkesbury
Richmond
WINDSOR
Londonderry
Rouse Hill
River
CASTLE REAGH
FWY
PENRITH
St. Marys
Rooty Hill
WESTERN
FWY
Nepean
Erskine Park
Cecil Park
Wallacia
Nepean
Bringelly
Crossroads
SOUTH
River
CAMPBELLTOWN
CAMDEN
Appin
Cataract Reservoir
Woronora Reservoir
Prospect Reservoir
PARRAMATTA
Blacktown
Seven Hills
Castle Hill
Dural
HORNSBY
Berowra Waters
Berowra
Berowra Creek
SYDNEY - NEWCASTLE FWY
Brooklyn
BROKEN BAY
Palm Beach
Terrey Hills
Mona Vale
Frenchs Forest
Dee Why
Brookvale
Pennant Hills
Epping
Manly
Chatswood
Ryde
Lane Cove
Mosman
JACKSON
Watsons Bay
PORT
SYDNEY
Strathfield
Bondi
Coogee
Chullora
Maroubra
Bankstown
Botany
Liverpool
Rockdale
FWY
WESTERN
East Hills
BOTANY BAY
La Perouse
George's
Caringbah
BATE
SUTHERLAND
FWY
Cronulla
Port Hacking
BAY
Audley
Heathcote
Waterfall
SOUTHERN
Stanwell Park
Bulli
OCEAN
PACIFIC
SOUTH
LEGEND
FREEWAYS
Grade separated. No access from adjoining properties.
ARTERIAL ROADS
4 or 6 THROUGH lanes, with median, partial access denial from adjoining property, some local separations.
6 lanes URBAN CONDITIONS with median (Nominal total width 90ft or greater) 4 lanes and shoulders RURAL CONDITIONS
6 lanes nominal total width less than 90ft. with or without median.
4 lanes undivided URBAN CONDITIONS
2 lanes undivided RURAL CONDITIONS
Proposed route.
The County of Cumberland boundary follows the Hawkesbury, Nepean and Cataract River systems.
SCALE
Kilometres
FIGURE 1
DEPARTMENT OF MAIN ROADS N.S.W.
MAIN ROAD DEVELOPMENT PLAN
FOR CUMBERLAND
1978

TABLE II
LAND USE (M) IN THE EASTERN DISTRIBUTOR

Corridor	A		B	
	N*	S**	N	S
Residential	21 607	3117	3679	1747
Mixed business residential	892	446	1366	446
Commercial industrial	20 087	8366	4754	6642
Special uses	4306	3924	14 425	3924
Vacant land	5451	1477	3301	293
Total (ha)	5.24	1.73	2.75	1.30
	6.97		4.05	

* *'N' consists of sections A1-A3 and B1-B6 in respective corridors.*
** *'S' consists of the Flinders Street section which is wider for Corridor A.*
Note: The land areas shown exclude existing roads.
Source: De Leuw Cather et al. (1977).

being used for storage of caravans and employee parking. Although not a strictly legal use, as the land is not leased, it does show that otherwise vacant land can be used for storage or parking.

Land near Langdon Road, Winston Hills on the Castlereagh Freeway Reservation has been leased by the Department to store gravel for a shopping centre development. On the same freeway reserve near Junction Road, the Department leases a building to the Winston Hills Soccer and Sports Club for a nominal weekly fee. The building, originally part of a farm, is being used for community purposes. Another observed use, on private land on the Eastwood-North Ryde County Road Reservation, was that of market gardens. Even though this use may not be commercially viable and provided the use is not at the expense of another party's 'enjoyment' of the land, the land is at least being utilised and someone is gaining benefit from that use.

A great deal of land under road reservation in the outer suburbs is open and used to graze animals. An example is given on the Western Freeway reservation at Berith Road, Wentworthville, where a local resident has sought and received a letter of approval from the Department to graze a few goats. Anyone who wishes to use the reservation for grazing animals may write to the Department stating intended use of the land and make similar arrangements by approval, lease, or other, to bring the land into use.

Brush Farm Park is located across the proposed extension of Rutledge Street, Secondary Road No. 2081, Eastwood. Land south of the proposed alignment is under Departmental ownership, while land to the north is dedicated Public Reserve. The setting of this park, with its deep gully and prolific vegetation, lends itself to passive recreation. Some years ago residents lobbied to have noxious weeds, etc., removed from the park. At present it provides open space relief from the surrounding built-up area; it could also provide a bush setting for walks and children's exploration.

Land, however, does not need to be landscaped and furnished with park equipment to be attractive to children. Often, land which may seem derelict or waste, is being used by children for imaginative and creative play. Bushland, rocks, mounds, large derelict pipes, etc., can offer children the opportunity for hiding, climbing and games filled with adventure. Children enjoy such areas because they are free to use their imaginations.

Examination of these informal uses suggests there is a case for preserving and landscaping residues once a road is built. Holding the residues in their original state may allow these informal uses to continue.

The examples given above indicate that open areas within reserve land can be and are being utilised to the advantage of the community, neighbourhood and local area.

Built Areas within Reservations–
Probably the most common form of development found in the reserve is private residential dwelling; some are owned and leased by the Department. As mentioned at the outset, Sydney is facing a shortage of land for housing and this is being felt in the low income range of available houses. Those who cannot afford to buy are increasingly being forced to rent for longer periods and at high rents, particularly in the inner areas.

The squatters in corridor property in inner city areas are evidence of this severe shortage of cheap inner city accommodation. Although the areas may be regarded as degraded both in economic and social terms, they are providing shelter for a sector of Sydney's population which cannot afford high rents or high transport costs.

At December 1981, the Department owned 1162 residential tenanted properties, 172 commercial properties and 248 unimproved properties on land reserved for future road purposes within the County of Cumberland and the City of Blue Mountains. Present N.S.W. Government policy is that Departmental properties which are bought or become vacant must be offered to the Housing Commission of N.S.W. Emergency Housing Program. Houses owned by the Department therefore provide dwelling stock for those in need of emergency accommodation.

Other uses apart from residential are found in major road corridors. Propagation of seedlings is being carried out on land leased by the Department near Wingello Road on the Southern Freeway Reservation, Miranda.

Several timber yards and car yards were also observed on the Western Freeway Reservation but not all buildings need to be of such a permanent nature. Buildings may be temporary and used for anything from keeping garden tools under cover to temporary offices, schools or clubhouses for all ages. An organic garden centre with galvanised iron structures on the Castlereagh Freeway Reservation, West Pennant Hills, is on land owned and leased by the Department. A block on the corner of Bowden and Wigram Streets, Harris Park on the Western Freeway Reserve, is again owned by the Department but is temporarily being used to house a site office for the State Rail Authority of N.S.W.

Built areas within major road reservations may therefore vary considerably in character. As with open areas, the built-up areas provide a number of examples where land owned by the Department is being used to the advantage of one or more sections of the community, whether or not they are commercial ventures.

Benefits not Specific to Reservation–
The knowledge that the reserve is there

and will eventually be needed for a given purpose, gives the community and local/state planning bodies greater certainty, providing opportunities for complementary action.

People living on or near a reservation are generally aware of their situation in relation to future road proposals. Social and psychological adjustment to either dislocation, or being acclimatised to living near a major road, would be much less severe than in the case where a road is suddenly required and constructed without prior reservation of the land. The community needs to have ample warning of any development which has the potential to sever community ties, otherwise both social and economic systems will suffer.

A reservation also acts as a guide for physical planning. Local and State planning bodies can arrange their pattern of land use and network of roads to complement the future major road. Any use which is now being conducted on reserve land, e.g., children's recreation, or storage of goods, etc., should be identified by the responsible planning body and land may subsequently be set aside elsewhere in the area for transfer of that use once the reserve is required.

One inherent problem in using vacant reserved land for recreation purposes is that communities might tend to 'build up' round them. Social ties may be formed through children and parents meeting in such areas but upon construction of the road the opportunity for this social contact is lost. It is important to point out that the road reservation prior to construction can be used to benefit the community, in many cases providing much needed space for a variety of uses. People using the reservation would also realise that such a major development probably would not take place for some time and that they would be made aware of its need for construction purposes in time to find (and become used to) other venues for their activities.

Reservations have acted as a tool to set aside tracts of land for future use. If the reservation had not been made the large areas of natural bushland and open space we have today would be covered with urban development. In cases where it is unlikely that a major road will be constructed, that land may be used as a corridor for another form of transport or communications.

A decision to construct a new road through an unreserved area would cause major severance of the community and social dislocation costs would be high. As a result of such cost, sufficient pressure might be brought to bear on the constructing authority to postpone or abandon the ill-planned project.

Cities are systems of activities and the linkages between them. For any plan of a city such linkages are basic. If they are not provided for in the first instance, it could be difficult or impossible to provide them after land development has taken place.

Possibilities For Short and Medium Term Uses

A very useful paper for this exercise was presented to the Royal Australian Planning Institute Congress in Canberra 1980. Correy (1980) points out the often ignored and misused parcels of land suggesting they should be used as temporary landscapes for short- or medium-term use. Several of the examples cited from various countries have been shown to exist on reserve land in Sydney.

UNITED STATES – Mobile landscapes, where a piece of vacant land might become an ice rink, a circus ground, a movie theatre or a zoo just for the afternoon. (A mobile carnival was observed very close to the Cooks River reserve during the helicopter reconnaissance.)

EUROPE – Communal urban gardens are widespread. People are constantly reminded that the land will eventually be required for development and are given the time when this is likely to occur.

AUSTRALIA – During the 1930s and 1940s people grew vegetables on vacant land. Victory gardens were familiar. More outdoor markets, street festivals, etc., are now being seen and vacant land in appropriate locations would be ideal venues for such community activities.

A symposium on Trails in Washington D.C. 1971 pointed out that people in residential areas frequently feel uncomfortable, particularly in these days of concern over growing crime rates, if it is suggested that a portion of property next to their property is suddenly to be opened to the public. (Young 1971)

Residents' views would need to be sought prior to opening land to the public. Private use could be continued where this concern is apparent.

The public could be given limited access to road reservations which are largely bush for bushwalking tracks, cycleways and other passive recreation. The Department of Lands has used a tract of its own land for bushwalking. Their Benowie Track extends north from Thornleigh, through the Elouera Bushland to Cowan. Departmental reservations are more likely to be built upon in some sections but may still be preserved as natural bushland for passive recreation.

Further uses which could be tried on reservation land might include a BMX Track (a bicycle motorcross track designed for use by non-motorised bikes) as observed beneath transmission lines near the Castlereagh Freeway Reservation. Near Epping and Delhi Roads a Tennis Court Complex (formerly a golf driving range) has been established on the Lane Cove Valley Freeway Reservation. Another possible use is a skateboard track. Reservation land could also be used for the growing of turf, say, by Council, for beautification purposes in other areas of the Municipality or Shire.

Vacant land in built-up areas, not dedicated as Public Reserve or landscaped by Council, holds a fascination for children. Even though landscaping is not necessary, a little imagination and small expenditure on the part of Council or owner could provide children with more open space, not necessarily the traditional swings.

One of the dilemmas posed to planners in allowing provision for such places in a child sensitive environment is the responsibility for risk taking which often becomes inherent in such natural environments. The headlines are hit by accusations that the Council should have "done something" about a particular, apparently neglected natural area if a child is hurt. On the other hand, authorities may fail to be acclaimed for the use and pleasure any child may have experienced before any such accident. (De Monchaux, 1981, p.65)

This should not act as a deterrent to using vacant land as much needed recreation space in locations appropriate to such use. The last point cannot be stressed often enough. Any planned land uses for road reservations must be compatible with surrounding land uses so that harmony will prevail in the community. Only certain uses will be suited to residential areas, e.g., those devoid of air, noise or water pollution. Even uses which might be thought suitable may not be in practice. The keeping of horses for riding purposes in an area close to

houses could prove offensive in terms of odour – this was the case for a local area in Sydney some time ago but might not be the case in other areas. The storage of fuels or chemicals might also cause concern for residents. Industry is an obvious example of an offensive or hazardous use in a residential area but where industry has been established in proximity to or on a road reservation for some time, further temporary industrial uses (e.g., storage) might be allowed. The whole process of deciding what use should be located where, should therefore include the opinions of the community directly affected. Any use must be temporary in nature to allow its quick removal once the land is required for construction.

CONCLUSION

The presence of road reservations in long-term plans has been shown to be necessary and beneficial to the community. Long-term plans allow Councils and other bodies to plan land uses which are complementary to the road hierarchy, at the same time ensuring that the road system can support existing and future land use. Complementary plans may be in the form of short-term or incremental plans, which use the broader long-term as a guide.

Although some land reserved for freeways or other major roads in the Sydney Region appears to be underutilised or socially undesirable (in blighted areas) it does not mean that the reservation is the cause of blight and must be abandoned. The land, or buildings on it, may be providing a much needed service which is not readily apparent from superficial observation. If the use does prove to be undesirable for a particular location, it may be possible to modify the conditions in such a way as to allow a temporary use which is of benefit to a nearby neighbourhood or larger community. Sydney's road reservations should be examined, together with their surrounding land uses. A study of this kind could offer suggestions as to a range of temporary land uses suited to a particular area or allow the continuance of an existing use.

This paper has demonstrated that there are many different types of land use on road reservations which can exist in harmony with the land uses of surrounding areas and remain acceptable, even though some uses might not be economical. The point to stress is that a piece of reserved land should not be pressured into commercial use if that use is going to be incompatible in the area. It is far better to have the land under a use agreed upon by the local community or persons affected by the reservation and have it used advantageously in regard to those people than to have the land lying idle. Of course in order to relieve Sydney's traffic problems, it would be more beneficial to the community to have the planned freeways and major roads. ●

This paper was published in "Australian Road Research", Vol. 12, No. 4, December 1982.

REFERENCES:
CORREY, A. (1980). Ephemeral Landscapes: A case for temporary landscape design in a changing society. Royal Australian Planning Institute Congress, 19 May.
CUMBERLAND COUNTY COUNCIL (1948). Report on the planning scheme for the County of Cumberland, New South Wales, p.163.
DE LEUW CATHER (1978). South-Western Freeway Study for the Department of Main Roads, New South Wales Stage Construction Liverpool-Bankstown, September.
– and JACKSON TEECE CHESTERMAN AND WILLIS (1977). Eastern Distributor Study for the Department of Main Roads, New South Wales, November.
DE MONCHAUX, S. (1981). Planning with children in mind. Prepared for the New South Wales International Year of the Child Secretariat and the Department of Environment and Planning, New South Wales, p.65.
DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES (1945). Main Road Development Plan for Sydney Metropolis and County of Cumberland (Part 1), pp.13-14.
LODER, B. N. (1982). Internal Department Submission, Department of Main Roads, New South Wales.
STATE PLANNING AUTHORITY OF NEW SOUTH WALES (1968). Sydney Region Outline Plan, 1970-2000 A.D., March.
URBAN TRANSPORT STUDY GROUP OF NEW SOUTH WALES (1977). The Sydney Region Corridor Review. August.
WINSTON, D. (1957). Sydney's Great Experiment (Angus and Robertson: Sydney), pp.74, 92.
YOUNG, H. J. (1971). Use of rights-of-way for trails. Proc. National Symposium on Trails, Washington, D.C, 2-6 June, pp.95-97.

Tenders Accepted by Councils

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 30 September 1983.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
				$
Auburn	Main Road No. 190	Construction of twin cell box culvert on Bede Street deviation.	John Cassidy Construction Pty. Ltd.	51,171.30
Gilgandra	Various	Bitumen sealing.	Boral Road Surfaces	68,112.67
Gilgandra	Trunk Road No. 77	Construction of bridge over Sallabalah Creek.	G. & E. M. Tincknell	166,257.00
Queanbeyan	Trunk Road No. 51	Construction of concrete crash barrier on alternate route between Queanbeyan and A.C.T. border.	Seovic Holdings	67,230.00
Severn	State Highway No. 12 and Main Road No. 136	Supply, heat & spray C170 bitumen on both roads.	Emoleum (Australia) Ltd.	59,852.80
Taree	Main Road No. 112	Construction of bridge over North Coast Railway line at Wingham.	Geoffrey Stewart Constructions	221,591.93
Taree	State Highway No. 10	Grouting and stabilisation of concrete road pavement between Pulteney Street and Manning Street, 0.1 km south of Taree to 0.1 km north of Taree.	Grouting and Construction Engineers (Australia) Pty. Ltd.	27,162.50
Walgett	Trunk Road No. 68	Construction of bridge over 13 m Warrnambool at 20.3 km west of Walgett.	Dallas Green and Co. Pty. Ltd.	213,400.00

Tenders Accepted by the Department

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 30 September 1983.

Road No.	Work or Service	Name of Successful Tenderer	Amount
			$
Freeway No. 3	Sydney-Newcastle Freeway. City of Gosford. Construction of dual carriageways including structures between Kariong and Somersby, 72.0 km to 78.0 km north of Sydney.	Abignano Ltd.	1,134,161.00 and Schedule of Rates
Freeway No. 4	Western Freeway. City of Parramatta and Municipality of Holroyd. Construction of reinforced concrete piles for viaduct between Wentworth Street, Granville and Church Street, Parramatta.	Frankipile Australia Pty. Ltd.	253,242.00
Freeway No. 4	Western Freeway and James Ruse Drive. City of Parramatta. Supply and delivery of units for three reinforced earth walls.	Reinforced Earth Pty. Ltd.	294,134.00
Freeway No. 5	South-Western Freeway. City of Liverpool. Construction of earthworks and drainage from the Hume Highway to the bridge over Georges River at Casula.	Walker Earthmoving Pty. Ltd.	248,328.00
Freeway No. 6	Southern Freeway. City of Wollongong. Construction of bridge on northbound carriageway over Byamee Street at Dapto, 94.0 km south of Sydney.	Adua Contracting Pty. Ltd.	208,891.00
State Highway No. 1	Princes Highway. City of Wollongong. Manufacture, supply, delivery to site, unloading and stacking of precast, pretensioned, concrete girders for bridge over South Coast Railway line at Flinders Street, north of Wollongong.	Humes Ltd.	84,252.00
State Highway No. 1	Princes Highway. Shire of Sutherland and Municipality of Kogarah. Construction of bridge over Georges River at Tom Uglys Point.	Citra Constructions Ltd.	8,229,359.00
State Highway No. 1	Princes Highway. Shire of Bega Valley. Winning, crushing and stockpiling of material.	W. K. Metals	57,600.00
State Highway No. 2	Hume Highway. Shire of Gundagai. Supply, deliver and lay asphaltic concrete on various sections.	Allen Bros.	153,092.50
State Highway No. 2	Hume Highway. City of Wagga Wagga. Win, crush, load and haul natural gravel from Kyeamba Gap pit to various locations on the highway.	Paul G. Lubke	202,500.00
State Highway No. 5	Great Western Highway. City of Penrith. Part construction of two culverts at Kingswood: A. Near Miller Street; B. Near Cosgrove Crescent.	Gallagher Civil Engineering	22,233.92
State Highway No. 9	New England Highway. Shire of Guyra. Reconstruction on section 59.8 km to 62.2 km north of Armidale.	Abignano Ltd.	Schedule of Rates
State Highway No. 9	New England Highway. Shire of Singleton. Construction of piles and pilecaps for Dunolly Bridge over Hunter River at Singleton.	Transbridge – Division of Transfield (NSW) Pty. Ltd.	365,000.00
State Highway No. 9	New England Highway. Shire of Tenterfield. Widening of bridge over Pyes Creek at 59.5 km north of Glen Innes.	Bricul Civil Constructions Pty. Ltd.	129,348.11
State Highway No. 9	New England Highway. Shire of Scone. Reconstruction from 25.2 km to 26.0 km north of Muswellbrook (Kelly Street, between Kingdon & Muppett Streets) – Earthworks, drainage and pavement works.	Civil Structures Division, Roberts Construction Ltd.	1,012,286.84
State Highway No. 9	New England Highway. Shires of Murrurundi and Parry. Supply and delivery of 10 mm and 20 mm asphaltic concrete between Willow Tree and Bendemeer.	Pioneer Asphalts	37,800.00
State Highway No. 10	Pacific Highway. City of Greater Taree. Construction of approaches to bridge over Stewarts River, 36.2 km to 39.3 km north of Taree.	P. Ward Civil Engineering Pty. Ltd.	1,666,539.00
State Highway Nos. 10 & 12	Pacific & Gwydir Highways. Supply, heat, haul and spray up to 482,000 l. of C170 bitumen on various lengths of both highways in the area controlled by South Grafton Works Office.	Spraypave Pty. Ltd.	204,934.00
State Highway Nos. 10 & 16	Pacific & Bruxner Highways. Supply, heat, haul and spray of up to 550,000 l. of C170 bitumen on various lengths of both highways in area controlled by Ballina Works Office.	Boral Road Surfaces (NSW)	283,005.00
State Highway No. 17	Newell Highway. Shire of Moree Plains. Supply & delivery of 880 cu. m of sealing aggregate to stockpile site on highway.	D. J. & S. Johnstone	20,400.00
State Highway No. 17	Newell Highway. Shire of Jerilderie. Construction of bridge over Billabong Creek at 2.0 km north of Jerilderie.	I. W. & K. M. Hunt	239,350.24
State Highway No. 19	Monaro Highway. Shire of Cooma-Monaro. Construction of bridge over Numeralla River, 98.0 km south of Canberra.	Hornibrook Group, Illawarra branch	1,121,000.00
State Highway No. 19	Monaro Highway. Shire of Cooma-Monaro. Winning, crushing and stockpiling of rock at 64.7 km south of Canberra.	W.B.K. Metals	21,600.00
Trunk Road No. 77	Shire of Gilgandra. Construction of bridge over Castlereagh River at Boyben.	Ermani Constructions Pty. Ltd.	522,797.00
Trunk Road No. 90	Shire of Great Lakes. Construction of bridge over North Coast Railway line at Stroud Road, 76.8 km north of Newcastle.	Civilbuild Constructions Pty. Ltd.	335,642.17
Main Road No. 279	Shire of Gundagai. Supply of bridge planks for construction of bridge over Morleys Creek at Homer Street, Gundagai.	Humes Ltd.	42,432.00
Main Road No. 509	Shire of Wyong. Construction of bridge over Tuggerah Lake at Wallarah Point, Toukley.	Transbridge – Division of Transfield (NSW) Pty. Ltd.	1,597,000.00
County Road No. 5015	Parramatta By-Pass. Abutment protection of Toongabbee Creek bridge, Old Toongabbie.	Fivedock Concrete Placing Pty. Ltd.	44,640.00
County Road No. 5016	Municipality of Bankstown. Construction of bridge over Salt Pan Creek.	Evalco Constructions Pty. Ltd.	187,780.30
County Road No. 5033	Cities of Blacktown and Parramatta. Reconstruction between Johnston bridge and Pyes Crossing at Seven Hills.	P. Ward Civil Engineering Pty. Ltd.	1,539,038.00
Kosciusko National Park Road No. 1	Shire of Snowy River. Winning and stockpiling of rock at 16.5 km west of Jindabyne.	W.K. Metals	30,000.00
Various	Bitumen sealing of various roads in South Coast Division.	Allen Bros.	198,933.00