Application of Amcord Principles to Rural Residential Street Design

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INTRODUCTION

AMCORD PRINCIPLES

The introduction of AMCORD (Australian Model Code for Residential Development) in 1989-90 can be credited with having completely revolutionised the established principles of residential street design, while the publication of "Queensland Streets" (Q.S.) by the Institute of Municipal Engineering Australia (Queensland Division) in 1993 provided guidelines for the application of these principles to practical design.

The design principles of AMCORD and "Queensland Streets" may be summarised as follows:
- Residential Street v Traffic Route
  A clear distinction between the Residential Street, whose major function is to provide access to the allotments which front it, and the Traffic Route, whose function is to provide for the movement of traffic.
- Limitation of Traffic Speed and Traffic Volume
  Specific geometric design criteria and subdivision layout to restrict traffic speeds and traffic volumes in Residential Streets to maximum limits which are compatible with acceptable residential safety and amenity criteria.
- Prohibition of Frontage Access
  When the acceptable traffic speed and traffic volume limits cannot be complied with, frontage access of allotments is denied - i.e., the thoroughfare becomes by definition a Traffic Route rather than an Access Street.

APPLICATION TO RESIDENTIAL SUBDIVISION

From seminars and private discussion on the application in practice of "Queensland Streets", it is apparent that in the minds of a number of designers and Council officers the street design principles of AMCORD and Q.S. are applicable only to small-lot subdivisions, a mis-conception probably arising from AMCORD's emphasis on development with allotments smaller than previously regarded as conventional (eg, 400m² rather than 600m²).

In fact the street design criteria recommended in both publications are applicable to subdivisions with allotment sizes through the full range of Urban Residential development, say from approximately 300m² to 1200m², with frontages from about 12m to 24m. The larger lot sizes within this range (600m² area and 17m frontage upward) provide greater parking capacity per lot, both within the allotment and at the kerbside, and hence the design of narrow carriageways is actually less critical for development of this lot-size range than for smaller lots (see Q.S. Section 2.4).

However for lot frontages towards the top of the range the total travel time within a low-speed environment may become the limiting design factor (see Q.S. Section 3.4).

PURPOSE OF THE PAPER

The purpose of this Paper is:
- To consider the application of AMCORD and "Queensland Streets" design principles to development, commonly referred to as "Residential" development;
- To determine variations and requirements appropriate to the larger-lot environment;
- To recommend specific guidelines for the design of streets in such developments.

METHOD OF THE PAPER

The Paper follows the method of Q.S.; first the factors which affect the design...
Residential Streets, and then suggesting appropriate guideline criteria for design.

The keywords are "Suggested Guidelines". The recommendations herein do not presume to be prescriptive standards, and although they may if desired be interpreted as "Deemed-to-Comply" criteria it should always be borne in mind that there will probably be other, and possibly better, ways of achieving the desired results.

**RURAL RESIDENTIAL DEVELOPMENT**

**DEFINITION**

Rural Residential development may be defined as the provision of sites for separate dwelling-houses on allotments larger than are found in urban areas, to provide for low-density residential living without all normal urban facilities, but still providing a reasonable standard of accessibility and services.

**HISTORY**

The earliest form of "Rural Residential" development was unplanned, and originated as larger lots subdivided on the outer fringes of cities and towns, with low standard access streets and few if any services. Because land prices were relatively cheap these areas tended to develop as semi-slums, the disaffected caravan on blocks, with lean-to annex, being the trademark. Most of these early examples have now been upgraded, generally at considerable cost to the Local Authority.

Perhaps the first planned and consciously high-standard Rural Residential developments originated in the Albert Shire hinterland fringe areas of the Gold Coast in the early 1970's. Here a plentiful supply of affluent purchasers provided a market for relative up-market allotments developed to high standards.

Since that time, there have been a number of similar developments on the fringes of this and other urban areas, the marketing success dependent on location, services provided and local market demand.

Experience has indicated a fairly limited market for this form of development, and a tendency for relatively high turnover, as the virtues of rural living tend in many cases to be soured after a while, by the reality of incessantly chauffeuring children to school and to a variety of extra-curricular activities.

**LOCAL AUTHORITY STANDARDS**

Most Local Authorities in or bordering substantial urban areas recognise and make provision for Rural Residential development in one form or another. However there is a wide variety in the applicable development standards, and even in nomenclature.

**Nomenclature**

The terms: -
- Rural Residential
- Park Residential
- Low-Density Residential

are commonly used, either as alternatives for similar development in different Local Authorities, or within the same Local Authority for variations in development density.

**Allotment Dimensions**

Eliminating what are essentially larger conventional residential lots, Local Authority requirements for Rural Residential lots are generally within the following range:-

- Minimum area - 4000m² to 2.0ha
- Minimum frontage - 40m² to 70m

However the majority are within the range:-

- Minimum area - 4000m² to 8000m²
- Minimum frontage - 40m² to 50m²

**Construction Standards**

Construction standards also vary considerably between Local Authorities, but the following summarises the usual range of requirements.

- Roads may have kerb and channel or be unkerbed, and pavement surfacing may be asphaltic concrete or bitumen seal.
- Stormwater Drainage may vary from virtually urban standard (full underground drainage other than defined natural watercourses), to rural type cross-road drainage only.
- Water Reticulation is generally required, but may be either normal Council reticulation, or a combination system, eg. constant flow / roof water.
- Sewerage Reticulation is generally not required, except perhaps in special cases where disposal of septic system effluent may be a problem.
- Electricity Reticulation is always required, with overhead distribution allowed in some cases, but others requiring underground distribution.

**PLANNING PHILOSOPHY**

A Local Authority's standards for Rural Residential roads and streets, and for subdivisional layout, will reflect the Authority's planning philosophy in regard to this form of development, whether such philosophy is formally expressed or not.

The South East Queensland Regional Planning Advisory Group (RPAG), in its recently issued "Regional Framework for Growth Management for South East Queensland", has included policies on Rural Residential development. As it is probable that these policies will ultimately be applied to the majority of Rural Residential development in Queensland, the relevant provisions are quoted below:-

**Policy 1:** Rural residential development should be provided as a component of housing and lifestyle choice in South East Queensland.

**Policy 2:** The use of land for urban development should take priority over the use of land for rural residential development.

**Policy 3:** Outside proposed urban and future urban areas, desirable and suitable areas for rural residential should be identified and a managed supply of rural residential land provided.
Policy 5: The level of physical and human services infrastructure provided in rural residential areas should be adequate but more limited than for urban residential areas, and the full development and maintenance costs should be recovered.

Action 5.2: Local Government should review their policies on development contributions and rates, and ensure that full "private benefit" costs are being recovered for the initial development and for the longer-term maintenance.

Action 5.4: Local Government should identify urban or service centres for the delivery of community services.

Action 5.5: Rural residential areas should be located in close proximity to existing or proposed settlements or community facilities.

Policy 6: Rural residential development should not contribute to environmental degradation of land or water, and should not be located in hazardous areas.

Action 6.2: Local Government should also identify hazardous and unsuitable areas (bushfire, flooding, unstable and steep land).

Policy 7: Rural Residential development should not occur in areas of good agricultural land, major extractive or mineral resources, or land of significant environmental value, and conflict with these land uses should be minimised.

With some subjective interpretation, the implications of these Policies in regard to Rural Residential road requirements may be summarised as follows:-

- **General Philosophy**
  While Rural Residential is a valid housing and lifestyle alternative, it is extravagant of land and inefficient in provision of services, and hence is regarded as a "luxury" form of development.

- **Design and Construction Standards**
  Roads and streets should provide for all present and future needs, to reasonable public expectations, with no foreseeable requirement for future capital works, and with minimum future maintenance costs.

- **Traffic Generation**
  No likelihood of future re-subdivision into smaller lots need be anticipated.
  Identification of future facility and service locations will enable prediction of future traffic requirements.

- **Topography**
  Exclusion of land suitable for urban uses, viable agricultural land, and land of environmental value means that Rural Residential development will often be on land of marginal topographic suitability. Road grading, allotment access, slope stability and drainage may therefore be significant design constraints.

- **Environment**
  Road location and design, and future house sites and allotment accesses, should minimise earthworks and tree clearing, to reduce visual impact.
  Preferred road location (eg., ridgetops) may be environmentally unacceptable.
  Possible environmental hazards (eg., flooding, bushfires, slope stability) require consideration in road location.

- **Financial Contributions**
  Appropriate contributions to upgrade existing roadworks, to which the development will contribute traffic, are likely requirements.

### STREET DESIGN PHILOSOPHY

#### GOAL AND OBJECTIVES

The recommendations for Rural Residential street design are based on the same philosophy as set out in Q.S., viz:  

**Goal** - Streetworks design and construction practice which provides an Optimum Combination of:

- **Safety**
- **Amenity**
- **Convenience**
- **Economy**

for subdivision residents, street users, and the community generally.

The **Optimum Solution** for each design and construction element is that which provides the most appropriate balance between the often conflicting ideals of these four Primary Objectives.

While the basic philosophy remains the same, the physical variations between conventional Residential and Rural Residential development mean that the optimum solution will in many (perhaps most) cases be different.

#### SIGNIFICANT DIFFERENCES

The physical variations between Residential and Rural Residential development which have most significance in the application of AMCORD and Q.S. principles to Rural Residential street design are:

- **Allotment Frontage** The wider frontages (eg., 50m compared to 18m) result in much greater travel distances for a given number of allotments, and hence the acceptable travel time in a speed-restrictive environment becomes a much more significant limitation.

  The greater distances also result in more reliance on motor vehicles, and less pedestrian and cycle traffic on the street.

- **Allotment Area** the larger allotment areas (eg., 5000m² compared to 600m²) generally result in greater setback of dwellings from the street boundary.
Clive R. Jenkins

This reduces the impact of traffic noise on amenity, provides much greater capacity for on-site parking, and encourages parking within the site, rather than on the street. There is also less likelihood of children playing on the street.

- **Street Reserve Width**
  - Street reserve widths tend to be greater (typically 20m or more compared to 15m or less) resulting in increased verge width. This again reduces traffic noise impact, provides increased safety visibility distance, and where on-street parking does occur, tends to encourage parking on the verge rather than on the carriageway.

**TRAFFIC SPEED**

**RESIDENTIAL STREETS**

As detailed in Q.S. (2.3) high traffic speeds in residential streets are detrimental most significantly to the safety of residents and street users, and also to the amenity of residents from increased noise.

Lower traffic speed results in a reduction both in the number of accidents and in the severity of injuries, particularly where pedestrians or cyclists are involved.

The only effective means of providing a consistently lower traffic speed is by restrictive geometric design based on a selected "Design Maximum Speed".

In the case of conventional residential streets the recommendations of Q.S. are:

- **Access Street**
  - Design maximum speed 30km/h

- **Collector Street**
  - Design maximum speed 40km/h

**SPEED AND SAFETY**

In Rural Residential streets some increase in Design Speed, compared to Residential standards, may be acceptable without significantly compromising safety, as:

- **Pedestrians and cyclists** are few, due to the generally long travel distances to facilities, resulting in use of the car rather than foot or cycle travel.
- **Children playing** on the street are rare, due to the larger allotment areas.
- **Safety Visibility** of a driver to a child running from a house onto the street, or a car exiting from an allotment is generally greater than in a residential street, due to (typically):
  - greater setback of houses from the street
  - greater verge width
  - fewer parked vehicles either on the carriageway or the verge
  - few high fences

While recognising that lower Design Speeds are preferable, it is considered that in the circumstances, 60 km/h is reasonable as the highest "Design Maximum Speed" for streets with allotment access.

**TRAVEL TIME**

From considerations of safety and amenity "slowest is best". However this ideal must be tempered by the practical limitation of the resultant increased travel times within the speed-restrictive environment and the element of convenience.

For Residential streets Q.S. recommends a maximum low-speed travel time of 60 to 90 seconds, but for Rural Residential development the travel distance per lot is much greater in proportion to the allotment frontages (eg. 50m compared to 16m - 18m, or about 3:1). Hence except in a very small development the travel times in the speed-restrictive environment would become unreasonably long at design speeds of 30 and 40 km/h, and the resultant average travel speeds of about 25 and 30 km/h, assuming 20 km/h "slow points".

On the other hand it is reasonable to assume that the higher the average speed the longer the travel time acceptable at that speed without driver frustration, up to perhaps 60 km/h, which should be an acceptable speed for a reasonably extended time, as being the usual statutory speed limit expected within a frontage access environment.

The relationship between Travel Distance and approximate Number of Lots in the street length, for various Average Speeds and Travel Times is shown in Figure 1.

From this Table it is apparent that some increase in Design Speeds and/or Travel Time is necessary for practical design of most Rural Residential development.

<table>
<thead>
<tr>
<th>Average Travel Speed (km/h)</th>
<th>Total Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 or less</td>
<td>60 seconds</td>
</tr>
<tr>
<td>30 to 40</td>
<td>120 seconds</td>
</tr>
<tr>
<td>40 to 50</td>
<td>180 seconds</td>
</tr>
<tr>
<td>60 or more</td>
<td>No limit</td>
</tr>
</tbody>
</table>

However it is emphasised that there is no experimental data to verify these assumptions.
### Speed / Time / Distance Relationship

<table>
<thead>
<tr>
<th>AVERAGE TRAVEL</th>
<th>TRAVEL TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEED km/h</td>
<td>60 Secs</td>
</tr>
<tr>
<td></td>
<td>Distance m</td>
</tr>
<tr>
<td>30</td>
<td>500</td>
</tr>
<tr>
<td>40</td>
<td>667</td>
</tr>
<tr>
<td>50</td>
<td>833</td>
</tr>
<tr>
<td>60</td>
<td>1000</td>
</tr>
</tbody>
</table>

Note: “Number of lots” assumes average frontage of 50m as shown and 4 lots at head of cul-de-sac.

**FIGURE 1**

### Traffic Volume

**Amenity**

The most significant effect of traffic volume in both Residential and Rural Residential streets is loss of amenity due to noise, as the acceptable limit for noise amenity is well below the physical capacity from traffic engineering considerations.

For Residential streets, the recommendations of both AMCORD and Q.S. are 3000 vpd maximum, 2000 vpd desirable, as the “Environmental Capacity” traffic volume criteria.

While traffic volume is the major factor in the severity of the noise problem, traffic speed, proportion of heavy vehicles, and the street grade are other factors affecting noise generation.

The severity of the noise impact on residents is a function of the distance from the carriageway to the house, as well as the design of the house, type of fencing, and intervening landscaping. A diagram compiled by Pak Poy - Kneebone as background data for AMCORD, relates these factors, and is attached as Appendix A.

The following Figure 2 simplifies this diagram, to show the required distance from the kerb to the front of house, for various Design Speeds and Traffic Volumes, for an acceptable noise level at the house.

### Distance Kerb to House for Acceptable Noise Level

<table>
<thead>
<tr>
<th>Design Speed (km/h)</th>
<th>Traffic Volume (vpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3000</td>
</tr>
<tr>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>50</td>
<td>11</td>
</tr>
<tr>
<td>60</td>
<td>13</td>
</tr>
</tbody>
</table>

**FIGURE 2**

Assumes:
- Noise level at house 58dB(A)
- Street grade 5%
- Heavy vehicles 5%
In Rural Residential development the typical carriageway to house distances are greater than in conventional residential development, as:
- verge widths are generally greater, and
- set-backs of houses from the road boundary are generally greater.

Verge widths in Rural Residential development will typically be 7m to 9m, assuming a reserve width of 20 - 25m, and a carriageway width of 6 or 7m.

House set-backs vary greatly, from a minimum of 6m where topographic constraints apply (eg. a street along a ridgetop), to 100m or more in open country. However a setback of less than 10m is unusual except where there is a severe topographic constraint.

Hence, a combination of increased Design Speed and/or Traffic Volume, compared to Residential recommendations, would be acceptable from amenity considerations.

TRAFFIC GENERATION

There is little information available on traffic generation from Rural Residential development at the present time.

Generation rates quoted from similar development in Victoria indicate 7 to 9 trips/lot/day, and some available counts in Pine Rivers and Albert Shires indicate generation figures of 8 to 10 trips/lot/day. Further traffic count information is presently being obtained from existing subdivisions in Albert and Pine Rivers Shires. Available figures do show wide variation in both peak hour volumes and the timing of the peak hour.

Compared to conventional residential development, a higher generation rate could be expected as:
- Schools, shops and services are generally at a considerable distance, requiring use of a car to access;
- Public transport is generally non-existent or at a considerable distance; and
- Two-car households would usually be the norm, due both to necessity and the generally higher economic bracket of residents.

On the other hand, because of the longer distances involved, trips are more likely to be planned to minimise their number - eg, combining school pick-up and shopping, sharing school drop-off and pick-up between families.

It is strongly recommended that locally recorded generation data be used where available, but in default of such availability, figures for Residential development are probably conservative, viz:-

| AADT | 10 trips/lot/day |
| Peak Hour | 1 trip/lot/hour |

The saving grace is that for internal street design, traffic volume is unlikely to be the limiting factor.

ASSESSMENT OF TRAFFIC VOLUME

Assessment of the traffic volume at any point in the street system may be readily made using the method set out in Q.S. (Section 2.2). In general Rural Residential street layouts are simple branching layouts with few loop streets, and all traffic generators are usually in the same direction, thus making the assessment process even simpler.

However, some Planning issues which can affect future traffic volumes must be emphasised:-

- **Future Resubdivision**
  Rural Residential development should not have to be considered as subject to future resubdivision to higher density (eg. Urban Residential), because as previously noted (2.4), Rural Residential should not be permitted on land identified as being suitable for future urban development.

- **Future Extension of Traffic Catchments**
  However, consideration must be given to likely future extension of streets which may result from subdivision of adjacent land, and include the estimated future traffic from such development in the design traffic volumes.

- **Future Traffic Generators**
  The probable location and nature of future traffic attractions, such as Schools, Shopping Centres, and Community Facilities, must be considered in traffic assessment, as well as existing such generators.
  Conversely, any future planning approvals for such traffic generators must consider the traffic implications on the existing street system, and provide for any necessary upgrading of traffic capacity.

PARKING

PARKING DEMAND

One of the major differences in the characteristics of Rural Residential streets compared to conventional Residential streets is the on-street parking demand - in Rural Residential streets, the demand is virtually nil.

PARKING SURVEY RESULTS

A recent survey of the occurrence of on-street parking in Rural Residential developments in Albert Shire (frontages 40 - 50m; allotment areas 4000m² - 8000m²) provided the following results:-

- On-carriageway parking - 1 vehicle per 113 lots
- On-verge parking - 1 vehicle per 24 lots.

Approximately 50% of on-carriageway parking was within cul-de-sac turning areas (circular heads), where narrow frontages or access strips to rear lots limited the availability of on-allotment parking.
When such cul-de-sac parking is discounted, the incidence of on-carriageway parking equates to about one vehicle per 5km of street length.

The very low incidence of total street parking can be attributed to the combination of high on-site parking capacity provided by larger allotment areas, and the generally greater walking distance from street to house due to greater verge widths and greater setback of dwellings.

The high ratio of verge parking to carriageway parking probably results from the combination of perceived narrow carriageway width (generally 6.0m), and the parking opportunity offered by relatively wide verge widths (6-7m), with little formal landscaping to inhibit parking.

**DESIGN CONCLUSIONS**

- The very low incidence of on-carriageway parking which might occur is quite insignificant from traffic considerations, and hence carriageways may be designed on the basis of the total width being available for moving traffic.
- The low incidence of verge parking which occurs is considered to be quite acceptable in principle in this type of development, as there tends to be little formal landscaping on the verges, and with the large frontages any parking is unlikely to occur on neighbours' verges.
- The provision of occasional indented parking bays as an alternative to verge parking is likely to be impractical due to the large lot frontages and consequent walking distances.
- However parking bays may be warranted at cul-de-sac heads, if narrow lot frontages and steep topography inhibit on-allotment parking.

**CARRIAGEWAY**

**CONSTRUCTION STANDARD**

As mentioned previously, present Local Authority requirements for Rural Residential streets vary considerably.

However, if the philosophy of "nil future capital cost and minimum future maintenance cost" is accepted (see Section 2.4), concrete kerb and channel (or concrete edge strip where appropriate), is virtually a mandatory requirement, to obviate the otherwise on-going cost of maintaining pavement edges, shoulders, and drainage swales.

The recommendations herein are therefore based upon the assumption of concrete kerb and channel being provided.

With reference to kerb and channel cross-section, it may be mentioned here that there is evident general opinion that "LGFA Standard Drawing No. R-01", as shown in Q.S. Figure 5.1.A, is too high and a lower, more easily mountable profile is preferable.

**NUMBER OF LANES**

From Section 6.3 no provision need be made for on-carriageway parking, and hence the carriageway width need be sufficient only for moving traffic.

The options are therefore:

- **One Lane** (plus occasional passing bays)
- **Two Lanes**

**ONE-LANE CARRIAGEWAY**

The single-lane carriageway has been identified in AMCORD and Q.S. as a valid option for low-volume residential streets, but has not been popular in practice, probably due to:

- Perceived market resistance
- Need to provide additional parking bays complicates design and construction, and negates any real cost saving from reduction in total paved area.

However, the single-lane configuration deserves further consideration for Rural Residential streets on the grounds of:

- **Safety** The concept provides an automatic reduction in traffic speed due to the expectation of the need to give way to opposing vehicles.
- **Convenience** Though obviously not as convenient for drivers as a continuous unobstructed two-lane carriageway, the much lower traffic volume per length of street means that the number of occasions of meeting opposing vehicles, and hence potential delay, is much less than for Residential streets.
- **Amenity**
  - Inbuilt speed reduction improves noise amenity
  - Narrower formation width reduces tree-clearing requirement, and also reduces earthworks and improves allotment access on side-slopes.
  - Reduced design speed allows a more curvilinear alignment, also enabling reduced cutting and earthworks.
- **Economy** the reduction in pavement construction (2.0 to 2.5m width) over virtually the whole street length can be quite significant, and although the "Rural Residential Philosophy" does not rate economy a high consideration, this saving can offset a higher construction standard elsewhere - eg. pavement thickness, drainage standards.

**DESIGN CRITERIA**

Limitations to the application of the "single-lane" concept are:-

- **Acceptable maximum travel time** in the low-speed environment, considered to be about 60 seconds (see Section 4.2).
- **Acceptable delay due to giving way to opposing traffic** (see Appendix 'B').
The analysis in Appendix 'B' indicates that the "Maximum Travel Time" is the limiting factor in the usual Rural Residential situation, limiting the total length of single-lane street to a maximum of about 450m. Rarely, the Acceptable Delay criterion may control, where the traffic catchment exceeds about 60 lots (see Appendix 'B').

However, in view of the lack of practical data on the performance of Single-Lane carriageways, the cautious approach would be to limit the catchment to 20 to 30 lots.

PASSING BAY SPACING
The spacing of passing bays should be:
- **Intervisible** so that a driver may see that the carriageway is clear to the next bay. This will vary with topography and vegetation.
- **Sufficiently close** that a driver can recognise the action of an opposing vehicle in the vicinity of the next bay - ie., waiting or continuing, say 100 metres.
- **Such that the delay in waiting** for an opposing vehicle is acceptable (from Appendix 'B' 100m is satisfactory from this consideration).

PASSING BAY DESIGN
Desirably, passing bays should be designed to also act as "slow points", to ensure that a driver slows sufficiently to assess that the street section to the next passing bay is clear of traffic, before entering that section.

This requirement is less important in open country, where there may be ample visibility for two or more "sections" ahead.

The "Central Median" type device (Figure 4) is particularly appropriate for this situation, as it:-
- **Controls traffic speed**
- Provides passing facility (without encouraging parking, as a simple widening may)
- Lateral deflection of a vehicle is visible at a distance (indicating from the other end of a section that a vehicle is waiting)
- With substantial landscaping, is readily visible at a distance (both as a speed control, and indicating passing bay location). The "island" may be made quite large, to incorporate existing trees.

**DESIGN SPEED**
Adoption of a "standard" slow-point at passing bays (20 km/h speed), and a maximum length of 100m between bays, implies a "Design Maximum Speed" of 35 km/h (Q.S. Figure 2.3B), with an average travel speed of about 28 km/h.

This is probably an appropriate design combination in most situations, but in open country, with unrestricted visibility, it may be reasonable to increase the "Design Maximum Speed" to a maximum of 45 km/h by using a less restrictive slow point design and/or increasing passing bay spacing slightly.

The increased average speed would also allow an increased length of one-lane street within the 60 second acceptable time limitation. Given the higher speed, a longer time limitation may also be acceptable (see Section 4.2) which could further increase the length of one-way street. However, due to the lack of practical experience of such streets, extension beyond 60 seconds travel time is not recommended.

From the delay data calculated in Appendix 'B' it is apparent that the increase in traffic catchment resulting from the above increase in street length (ie, 4 additional lots for 550m) would not result in any significant increase in delay.

**CARRIAGEWAY WIDTH**
An appropriate carriageway width for the single-lane carriageway is considered to be 3.5m (see Q.S. Table 2.6,7) given the low incidence of cyclists in Rural Residential development. However, 4.0 may be preferable if the Design Speed is increased above 35 km/h.

<table>
<thead>
<tr>
<th>Slow Point Speed (km/h)</th>
<th>Bay Spacing (m)</th>
<th>Design Speed (km/h)</th>
<th>Max. Length (m) (Travel Time 60 sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>100</td>
<td>35</td>
<td>450</td>
</tr>
<tr>
<td>20</td>
<td>120</td>
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<td>550</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
<td>45</td>
<td>550</td>
</tr>
</tbody>
</table>

**FIGURE 3**
Virtually all single-lane carriageways will have one-way crossfall, with mountable kerb and channel on the low side, and mountable kerb-only on the high side. It is recommended that the carriageway width as specified be measured between the bases of the sloping kerb faces (i.e., invert of the channel on the low side).

Hence for a "3.5m carriageway" with one-way crossfall the width of bituminous surfacing will be approximately 3.2m.

On sharp curves, carriageway widening should be provided, such that a standard HRV tracks on the surfaced pavement. The required widening will be a function of both the curve radius and the deflection angle.

**EXAMPLES**

Figure 4 illustrates the principles of a typical single-lane Rural Residential Street, and a detail of a typical Central Median type passing bay / slow point.

Though the single-lane concept has been rarely used in practice to date, an example which has been constructed, and generally approved by residents, is shown in Figure 5. However in this case the passing bays were spaced at about 60m, closer than the maximum of about 100m recommended in this Paper.

On a much larger scale, anyone who has driven in the Western Highlands of Scotland will know that a single-lane road with much longer distances between passing bays is feasible, albeit with increasing inconvenience at higher traffic volumes.

![Figure 4](image-url)
TWO LANE CARRIAGEWAY

The practical traffic capacity of a two-lane carriageway, without parking, is well in excess of the traffic volume acceptable from noise amenity considerations (see Section 5.1).

Indicative traffic capacities could be:

- Level terrain - 7900 vpd (Level of Service C)
- Rolling terrain - 5200 vpd (Level of Service C)
- Mountainous terrain - 3700 vpd (Level of Service D)

(Ref: AUSTROADS - "Roadway Capacity" - 1988)

Hence a Two-Lane Carriageway is adequate for any Rural Residential street.

In the case of Residential streets (with on-carriageway parking) the traffic capacity limits of the "two-lane" and "three-lane" streets provide finite boundaries for "Street Hierarchy" classifications. However in the Rural Residential situation there are no such capacity limits, and hence the division into Hierarchical categories must be on the basis of a fairly arbitrary trade-off between Design Speed, Maximum Travel Time, and Amenity Volume. The appropriate Design Criteria for Two-Lane carriageways will vary with the Street Hierarchy classification.

STREET HIERARCHY

CLASSIFICATION

Using the same nomenclature as for Residential streets, a proposed street hierarchy is:

- Access Place
- Access Street
- Collector Street

The ideal is for the maximum possible number of lots to be in the lower classes of street, and thereby enjoy the greatest possible safety and amenity from lower traffic speeds and volume.

ACCESS PLACE

The Access Place will almost always be a single cul-de-sac, but occasionally an Access Place may have another branching from it (see Figure 9).

The One-Lane Carriageway (Section 7.3) is a possible Access Place configuration, and it is therefore reasonable to accept the same design limitations for the alternative Two-Lane configuration, viz:

- Design Maximum Speed 35 km/h
- Maximum Acceptable Travel Time 60 sec
- Maximum Length 450m

As for the single-lane street, the approximate number of lots in the "catchment" of a single cul-de-sac would be about 22, and the assumed traffic volume about 220 v.p.d.

Speed Restrictive Design should be in accordance with Q.S. Section 2.3, using any of the methods detailed therein - ie: alignment, slow points, or combinations thereof.

Carriageway width for a Two-Lane configuration would appropriately be either 5.5 or 6.0m (Q.S. Figure 2.6.F). Crossfall could be either one way or centre crown, with the width measured as for a single-lane carriageway (Section 7.3.).

ACCESS STREET

An Access Street will usually have one or more Access Places branching from it, but occasionally may be part of a single cul-de-sac, too long to be designed full length as an Access Place (ie, over 450m long - see Figure 9)

As the Design Maximum Speed will be intermediate between that of the Access Place (35 km/h) and the maximum recommended for frontage access (60 km/h - see Section 4.2), either 45 or 50 km/h might be appropriate, 45 km/h being preferred for safety and amenity.

Speed Restrictive Design should again be applied in accordance with Q.S. Sec. 2.3, but because of the higher Design Maximum Speed, restriction should be imposed as much as possible by curvilinear alignment rather than by slow points, to minimise the variation of travel speed (eg, desirable minimum speed 25-30 km/h rather than 20 km/h). Average travel speed would then be of the order of 37 km/h.

Total Acceptable Travel Time, from the head of the traffic catchment to the "downstream" end of the Access Street is about 120 seconds (see Section 4.3). With an average travel speed of 37 km/h, the maximum length of Access Street would be about 600m, if the Access Place travel time is the maximum of 60 secs, or appropriately longer if the Access Place travel time is less than 60 secs.

Carriageway Width from Q.S. Figure 2.6F would be appropriately 6.0 or 6.5m. It is recommended that both the Access Street and Access Place be 6.0m in width, for uniformity, both street classifications therefore having the same cross-section.

COLLECTOR STREET

The Collector Street will generally have a number of Access Streets branching from it, possibly Access Places, and may occasionally be the "downstream" end of a very long single cul-de-sac (see Figure 9).

The Collector Street is the highest category of Rural Residential street providing direct access to allotments. It will connect to a Connecting Road ("Road" as distinct from "Street") at its "downstream" end, which will provide the connection to the external road system.

The Design Maximum Speed will necessarily be the highest recommended on safety grounds (see Section 4.2) viz, 60 km/h.
Speed Restrictive Design should be applied by curvilinear street alignment only, desirably with a minimum speed of 40 km/h, both in the interests of safety and to minimise the driver inconvenience of the speed restrictive design. Average travel speed will therefore be of the order of 50 km/h.

Total Acceptable Travel Time, from the head of the traffic catchment to the downstream end of the Collector Street is tentatively recommended at 180 seconds (see Section 4.2). At an average travel speed of 50 km/h, the maximum length of Collector Street, if Access Place and Access Street travel times total their recommended maximum of 120 seconds, would be about 830m, or appropriately longer if minor street travel time is less than 120 seconds.

A possibility for “stretching” the Collector length could be the use of a relatively continuous alignment of 60 km/h curves (ie, about 160m radius), as the continuous speed, though restricted, should be more acceptable than variation between 60 km/h and a lower speed.

Carriageway Width for the Collector Street is recommended as 7.0m, this being consistent with extrapolation of Q.S. Figure 2.6.F, and with AUSTROADS standards (2 x 3.5m lanes). The appropriate cross-section is considered to be centre-crown, two way crossfall, with kerb and channel both sides.

While a width of 7.0m invert to invert is considered generally sufficient, where traffic volumes are higher and/or if a bus route is likely, 7.5m invert to invert (effectively 7.0m of bitumen) may be appropriate.

TYPICAL CROSS-SECTIONS

Typical Cross-Sections for the three street classifications described above are shown in Figure 6.
STREET RESERVES

Typically, 20m has been the minimum street reserve width for rural residential development to date, and it is considered to be a generally appropriate width.

Compared to Residential streets, the extra width is justified on the grounds of:
- Land is less valuable, and lot yield is generally based on gross area of the land, so there is no penalty in the wider reserve;
- Visual amenity is improved, the greater width between boundaries being appropriate to the more rural environment;
- Greater opportunity to retain existing vegetation within the street reserve (particularly if electricity and telecom is underground rather than overhead);
- Safety visibility distance is increased by the greater verge width, which is appropriate for the higher design speed; and
- Sound attenuation - distance, carriageway to house, is increased, appropriate also for the higher traffic speed.

The limitation of 20m as a satisfactory reserve width will be sound attenuation. From Figure 3, for 20m reserve and 6m building setback, the limitations on traffic volume would be:
- Access Street
  - (7m verges, 45 km/h) - 4500 vpd
- Collector Street
  - (6.5m verges, 60km/h) - 2800 vpd

Obviously, with the limitation of travel distance a traffic volume of 4500 vpd (450 lots catchment) cannot be attained on an Access Place or Street, and it will be rare that 2800 vpd (280 lots) will occur on a Collector Street.

However, if this is the case it is necessary to ensure that the minimum distance from carriageway to house is increased appropriately, most simply by widening the street reserve. From Figure 2 and Appendix A, the following reserve widths are required:

<table>
<thead>
<tr>
<th>Traffic (vpd)</th>
<th>Distance Req’d (m)</th>
<th>Reserve Width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2800</td>
<td>12.5</td>
<td>20</td>
</tr>
<tr>
<td>3000</td>
<td>13.0</td>
<td>21</td>
</tr>
<tr>
<td>4000</td>
<td>16.0</td>
<td>27</td>
</tr>
<tr>
<td>5000</td>
<td>19</td>
<td>33</td>
</tr>
</tbody>
</table>

An alternative means of ensuring the required setback could be by an easement, but this is unlikely to be attractive to a developer.

The above figures assume that the carriageway is central in the street reserve. Where this is not the case, and the traffic volume is near critical, the actual carriageway-building site distance should be checked.

The verge cross-section should provide a virtually level width of 2.0m minimum behind the kerb, to provide for verge parking (whether officially sanctioned or not), and breakdown parking. This strip need not be fully cleared of vegetation full length, as parking will occur very intermittently.

CONNECTING ROADS

Connecting "Roads" as distinct from the "Streets" having direct access to Rural Residential lots, link the rural residential development to the external road system. Two general types of connecting road may be identified:
- **Internal** - within the Rural Residential area, but having no frontage access due to design requirements (generally travel time limitations).
- **External** - generally an existing road forming a boundary of the Rural Residential development.

The "Internal Road" is analogous to the Residential "Trunk Collector" as described in AMCORD and Q.S. while the "External Road" identifies with the "Sub-Arterial or Arterial Road".

While the Connecting Roads cannot have Rural Residential lots directly fronting them, larger lots of "Rural" size, say 4ha or larger, may generally be allowed to have direct frontage, provided that the traffic volume is not unduly high and lot accesses are appropriately located.

Connecting Roads will generally be Rural Roads in character, and appropriately designed in accordance with AUSTROADS "Rural Road Design" - 1989. A typical standard could be a 7.0m wide bitumen sealed pavement on 11.0m wide formation, design speed 80 km/h (perhaps 60 km/h for an Internal Road, or in difficult terrain, or 100 km/h in open terrain).

OTHER DESIGN ASPECTS

STREET DESIGN

For Street Design aspects other than those dealt with previously, eg
- Geometric Design
- Intersections
- Turning Areas
- Speed Control Devices,
the relevant provisions of Q.S. may be applied with the following minor modifications:

- **Design Speed.** The slightly higher "Design Maximum Speeds" for Rural Residential streets enable some "freeing up" of the geometric speed control devices and intersections, Collector Streets for example intersection design including roundabouts, would not normally have a speed-limiting function and design would then appropriately be to normal AUSTROADS standards.
- **Turning Areas.** Given that land area will partly a constraint, use of the standard HRV for a TAC turning areas may be reasonable.
STORMWATER DRAINAGE

While detailed consideration of rural residential stormwater drainage design standards is beyond the scope of this paper, there are some aspects of drainage design which impact on the road design standards. These include:

- **Flow Width.** In general, one traffic lane (2.5m) should be clear of stormwater flow or pondage on all Rural Residential streets, at the adopted “Convenience Recurrence Interval” (2 years or 5 years). The resultant allowable flow widths are:
  - Access Street/Place (One-way crossfall) - 3.50m
  - Collector Street (Centre crown) - 2.25m

Given the relatively large stormwater catchments to Rural Residential streets, these requirements may involve quite substantial stormwater drainage works, but this is consistent with the “No Future Capital Cost, Minimum Maintenance Cost” philosophy.

- **Edge Strip.** In some situations, where there is no flow from upstream onto the street (eg, along a ridgeline) the use of a concrete edge strip rather than kerb and channel will avoid the collection and concentration of the stormwater runoff from the carrageway itself, which otherwise may be difficult to convey to an acceptable point of discharge.

- **Flood Access.** The accessibility of a Rural Residential development in time of flood may be a source of resident complaint, and may require future major capital expenditure by the Local Authority to upgrade, if not initially constructed to an acceptable standard.

The flood immunity of major cross-road drainage structures should therefore be carefully considered, from Safety, Convenience and Economy considerations.

DEVELOPMENT LAYOUT

PLANNING PHILOSOPHY

As previously mentioned (Section 2.4) the planning policy of excluding from Rural Residential development land suitable for urban use, viable agriculture, or of Environmental significance implies that future Rural Residential subdivision may be largely on land of marginal topographic useability.

Significant factors to be taken into account in the street and allotment layout of a development will include:

- **Environmental**
  - Visual Amenity: (Road location and house site location to minimise earthworks and clearing of vegetation)
  - Environmentally Significant Areas: (Preserve as open space)
  - Hazardous Areas: (Flooding, bushfires, slips, contaminated Land)
  - Adjacent Land Uses: (eg, quarries or industrial-buffering may be required)

- **Topography**
  - **Street Grading:** (Desirable maximum grade 16%, absolute maximum 20%)
  - **Side Slopes:** (Practical cross-section, retaining structures, slope stability)
  - **Allotment Access:** (Practical cross-section, retaining structures, slope stability)
  - **Drainage:** (Major waterways).

In general, the Environmental issues will identify land to be excluded from development, and perhaps the general form of development, while the Topographic issues will dictate the more detailed development form.

EXISTING DEVELOPMENTS

Existing Rural Residential layout tends to be of definite “branching” form, mainly cul-de-sacs off a Collector Street, with “looping” of streets tendency to occur only in relatively flat country. This layout form is often dictated by topography, the streets following ridge tops and/or gullies, but probably also results from avoidance of the additional “redundant” street length necessary to complete a loop, the extra length being more significant than in residential development due to the much larger lot dimensions.

Figures 7 and 8 show some typical existing Rural Residential subdivision developments in Albert Shire.

FUTURE LAYOUT

Environmental constraints may result in more future street location in gullies, rather than on ridge tops, from considerations of visual amenity, and in heavily vegetated areas possible bushfire hazard.

The “Branching” form of layout is consistent with the design principles of this Paper, having the advantages of:

- Excluding any risk of through traffic in Access Streets and Access Places.
- Enabling confident assessment of traffic volumes.

The ideals are to:

- **Maximise the number of short cul-de-sacs, so that the maximum possible number of lots have minimum passing traffic volume.**
- **Minimise the travel distances from the heads of catchments to the Connecting Roads.**

The Maximum Catchment Length of streets with frontage access, based on the recommended maximum travel times in Sections 8.2, 8.3 and 8.4 is:

<table>
<thead>
<tr>
<th>Average Speed</th>
<th>Time</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Place</td>
<td>28</td>
<td>60</td>
</tr>
<tr>
<td>Access Street</td>
<td>37</td>
<td>60</td>
</tr>
<tr>
<td>Collector Street</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>

Note: Distances rounded
Figure 8

TYPICAL RURAL RESIDENTIAL DEVELOPMENT
ORMEAU, ALBERT SHIRE
If the travel distances in the lower class streets are less than the recommended maxima, the total catchment distance can be increased. However this is contrary to the ideal of “maximum lots with minimum traffic. For example:

<table>
<thead>
<tr>
<th></th>
<th>Distance</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Place</td>
<td>300</td>
<td>38</td>
</tr>
<tr>
<td>Access street</td>
<td>450</td>
<td>44</td>
</tr>
<tr>
<td>Collector Street</td>
<td>1360</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>2110</td>
<td>180</td>
</tr>
</tbody>
</table>

Examination of existing development layouts (Figures 7 and 8) suggest that it will be only in the largest developments that the maximum total street length limits will be reached.

Interconnection between cul-de-sac heads is less important than in Residential subdivision due to the reduced emphasis on pedestrian and cyclist traffic. However, such connections in the form of pathways or park strips may be utilised as recreational walking, cycling or horse riding trails, particularly if connecting to Open Space areas, or forming part of an Open Space circuit.

If topography allows they may also be suitable for emergency vehicle routes, eg. for bushfire evacuation.

Bus Routes are unlikely to be a factor in street layout, as the low density of development will normally preclude economic provision of a bus route within a Rural Residential development. However, the possibility of future bus routes should be considered on Connecting Roads, and perhaps into larger developments, in which case a looped Collector Road system may be appropriate.

A schematic development layout, based on the principles discussed above, is shown in Figure 9.

**CONCLUSION**

This paper has endeavoured to show how the design principles and practices advocated in AMCORD and “Queensland Streets” can be adapted to the design of Rural Residential streets, with the benefits of improved Safety and Amenity for the residents of these developments.

However it is emphasised that some of the assumptions made herein (particularly the “Acceptable Maximum Travel Times”) require further verification in practice, and hence the recommendations should be regarded as a starting point for trial application rather than as “Standards” to be applied without full consideration of the particular circumstances.

**RURAL RESIDENTIAL DEVELOPMENT SCHEMATIC LAYOUT**

![Diagram](image)

Figure 9
Start by Entering Projected Traffic Volume. Here, Calculate Using 10 vpd/Dwelling

Projected Traffic Flow (vpd)

Speed Adjustment (km/h)

20-30 40 50 60 70

Distance required between facade of living area in the dwelling and edge of travel lane (i.e. edge of that part of the carriageway used for vehicle movement.

Verge Width Required + Dwelling Setback** of

5m 7m 10m 12m

15 10 5 0

% Longitudinal Gradient (assumes direction of travel evenly split over 24 hour period)

Check that Adequate Verge Width is Provided for Services, Pathways, Verge Parking and Sight Distance Requirements.

Characteristics for Conceptual Developments

Clive R. Jenkins

Sound Attenuation Distances

Appendix A
APPENDIX B

SINGLE LANE RURAL RESIDENTIAL STREET OPERATING CHARACTERISTICS

ASSUMPTIONS:
- Lot frontages 50m
- 4 lots at head of cul-de-sac
- 10 trips / lot / day
- 1 trip / lot / in peak hour
- 70:30 direction split in peak
- Vehicles reasonably evenly spaced
- Travel speed approximately 30 km/h
- Maximum acceptable travel time 60 seconds
- Maximum passing bay spacing of 100m
- Speed at passing bays 20 km/h

TRAVEL SPEED
If passing bays are designed as "Slow Points (20 km/h speed), and distance between bays is 100m (from consideration of visibility of an opposing vehicle), "Design Maximum speed" is 35 km/h (See Q.S. figure 2.3.B).

Average speed = $\frac{20 + 35}{2} = 27.5$ km/hr

STREET LENGTH
For Maximum Travel Time 60 seconds
Maximum street length = $60 \times 7.6 = 456$m

TRAFFIC
Maximum traffic catchment = $456 \times 2 + 4 = 22$ lots

Minimum traffic catchment = 4 lots

Opposing traffic (worst case, against peak flow)
Max (entrance to street) 0.7 x 22 = 15.4 vph
Min (head of cul-de-sac) 0.7 x 4 = 2.8 vph

Average time between meets
Maximum 3600
15.4 x 2 = 117 secs

Minimum 3600
2.8 x 2 = 643 secs

No. of meets per trip
(average, in "against peak")
$\frac{60/117+643}{2} = 0.158$

DELAYS
When a meet occurs, generally one vehicle will continue with no delay, the other will suffer a variable delay. The variable delay will consist of a constant "decel / accel" component (say 2 sec), plus the travel time of the other vehicle - average 50$m = 7$ secs

Hence, 
"average variable delay" = $7 + 2 = 9$ secs
and
"average delay per meet" = $\frac{2}{9} = 0.55$ secs
(50% no delay)

Average delay per trip $4.5 \times 0.158 = 0.711$ secs

Delay as % of travel time $\frac{0.711 \times 100}{60} = 1.25%$

This amount of delay is considered to be negligible, particularly since it applies to the worst case, viz "Against peak traffic".

BRANCHED LAYOUT

The above calculations are based on a single cul-de-sac. However it is possible that a branching layout, within the limit of 450m (60 second travel time) from the head of the catchment, may have a larger number of lots and hence greater opposing traffic volume.

The maximum number of lots within such a catchment will depend on the acceptable level of delay. On the basis of an arbitrary 10% increase in travel time, as suggested in Q.S., calculated on the "downstream" street section:

Travel time (100m @ 7.6 m/sec) = 13.16 secs
Max. acceptable delay (10%) = 1.32 secs
No. of meets @ 4.5 secs/meet = 0.29 meets
Time between meets + 13.16/0.29 = 45.2 secs
Opposing traffic volume = $3600/45.2 \times 2 = 40$ v.p.h.
Equivalent lots @ 0.7 v.p.h./lot = 57 lots

Based on the "worst case" street section, rather than the average over the whole street length, an assessment is considered to be conservative.

NON-UNIFORM FLOW

If the opposing traffic volume were substantially greater "platooning" of opposing traffic could occasionally create much longer delays, but the average gap between opposing traffic (45 sec) is so much greater than the transit time between (13 secs) that this is unlikely to be a significant occurrence.