Appendix C
Road Network Performance Principles & Guidelines

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Road Classification

There are two main systems for the classification of roads in New South Wales, the functional classification system and the funding classification system. A third system that defines the environmental capacity of residential streets is also a form of classification.

Funding Classification

The RTA has also adopted a "funding related" classification system that is primarily for administrative purposes. The key road classifications under the funding classification system are defined as:

- State Roads – roads performing an important state function and for which the RTA fully funds the maintenance cost. State roads are essentially arterial roads;
- Regional Roads – roads performing a significant regional function and for which the RTA and Council share the costs of maintenance. Regional roads are essentially sub-arterial roads; and
- Local Roads – roads performing a local or collector function and for which the Councils fully fund the maintenance cost. Additional funding is available from the RTA in certain circumstances on grounds of urban amenity and road safety.

The funding road classification of roads in the project site area is as follows:

- State Roads:
  - M2 Motorway;
  - Lane Cove Road; and
  - Epping Road.
- Regional Roads:
  - Balaclava Road, south of Epping Road;
- The RTA are presently carrying out a review, with the following roads under consideration for regional road status:
  - Herring Road, between Epping Road and Talavera Road;
  - Waterloo Road, between Herring Road and Lane Cove Road;
  - Talavera Road, between Christie Road and Lane Cove Road; and
  - Christie Road.
- All other roads are local roads.

Functional Classification

The functional role or performance of individual roads can be appraised according to the classification of that road within an overall road hierarchy. Changes to traffic flows on the road can then be assessed within the context of the road hierarchy.

Both the NSW Roads and Traffic Authority and Growth Centres Commission have developed guidelines for classification of roads. The RTA published guidelines for the classifications of roads in a functional system in their document "Functional Classification of Roads".

The objectives of these guidelines can be summarised as:

- In planning terms – the classification of streets and development of an operational hierarchy is seen as "an essential component of structural planning at the neighbourhood level; and
- In operational terms – the concept of functional classification is seen as "an endeavour to match the class of road to its use and to the environmental needs of the community".

The RTA document classifies roads according to the role they fulfil and the appropriate volume of traffic that they should convey:

- **Arterial Road** - is typically a main road carry in excess of 15,000 vehicles per day and over 1,500 vehicles per hour in the peak period. They predominantly carry traffic from one region to another, forming principal avenues of communication for metropolitan traffic movements.
- **Sub-Arterial Road** – is typically a secondary road carrying between 5,000 and 20,000 vehicles per day and over 500 and 2,000 vehicles per hour in the peak period. They predominantly carry traffic from one sub-region to another forming secondary inter-regional transport links.
- **Collector Road** – is typically a minor road carrying between 2,000 and 10,000 vehicles per day and over 250 and 1,000 vehicles per hour in the peak period. They provide a link between local areas and regional road carrying low traffic volumes. At volumes greater than 5,000 vehicles per day, residential amenity begins to decline noticeably.
- **Local Road** – is typically a local street carrying less than 2,000 vehicles per day and 250 vehicles per hour in the peak period. They provide immediate access to individual houses and carry low traffic volumes.

Table C1 provides details of the characteristics of different functional classifications of roads. The table shows that there is considerable overlap between the functions of the various classes of roads.

Table C1: Functional Classification of Roads - Parameters

Factor/ Measure of Effectiveness	Arterial/ Freeway	Sub-Arterial	Collector	Local
Vehicle Speed / Operating Speed	70-110km/h	60-80km/h	40-60km/h	40km/h (or less)
Traffic Volume (AADT)				
- Residential Area	No Limit	< 20,000	< 5,000	< 2,000
- Other Area	No Limit	< 20,000	< 10,000	< 4,000
Through Traffic	yes	some	little	no
Intersection Spacing	Approx. 1km	Approx. 0.5km	-	-
Road Geometry				
- Number of Lanes	4 or more	2 or more	2 or more	1 or more
- Medians	✔	As needed	no	no
- Minimum Carriageway Width	13m	7m	7m	4m
Pedestrian Crossings	Grade Separated or Signals	Signals or Refuge	Marked Crossing, Children's Crossing or Refuge	Marked Crossing, Children's Crossing or Refuge

Factor/ Measure of Effectiveness	Arterial/ Freeway	Sub-Arterial	Collector	Local
Heavy Vehicle Load Restrictions	None	Preferably none	Yes, if residential	Yes, if residential
Traffic Management				
- Intersection Control	---------- Refer to Table C2 ----------			
- Lane and Separation Lines	✔	✔	✔	✔
- Property Access	Minimised	Minimised	✔	✔
- Control of Turning Vehicles mid-block access	Median controlled	Maybe control	no	no
- Right Turn Bays	✔	Preferred	no	no
- Road Closures	none	none	possible	
- LATM devices	-	-	✔	✔
- SATM devices	-	✔	-	-
Interconnections	sub-arterial	arterial/collector	sub-arterial/local	collector
Parking				
- Peak Period	no	no	✔	✔
- Off Peak	no	✔	✔	✔
- Period Parking	no	maybe	✔	✔
- Unrestricted	no	no	maybe	✔
- Parallel Parking	no	no	maybe	✔
Bus and Transit Lanes	✔	✔	✔	-

Sources:
"Updated Guidelines for Functional Classification of Roads", Roads and Traffic Authority of New South Wales, 1993
"Road Design Guide", Roads and Traffic Authority of New South Wales

Table C2: Suitability for Provision of Right Turn Movements

Right Turn From	Right Turn To			
	Arterial/ Freeway	Sub-Arterial	Collector	Local
Arterial/Freeway	Yes	Yes	Possible	No
Sub-Arterial	Yes	Yes	Yes	Possible
Collector	Possible	Yes	Yes	Yes
Local	No	Possible	Yes	Yes

Source: "Road Design Guide", Roads and Traffic Authority of New South Wales

The Growth Centres Development Code classifications, shown in Table C3, are consistent with the RTA classifications.

Table C3: Functional Classification of Roads (Growth Centres Commission)

Road Type	AADT	Functions and Connections	Speed Limit
Arterial/Freeway	35,000+	Connects large urban areas	Up to 80km/h
Sub-Arterial	10,000 – 35,000	Arterial roads to town centres Carries major bus routes	Up to 70km/h
Collector	3,000 – 10,000	Connects neighbourhoods Can accommodate public transport	Up to 60km/h
Local	1,000 – 3,000	Priority to pedestrians and cyclists Designed to slow residential traffic	Up to 50km/h

Source: Growth Centres Development Code, Growth Centres Commission, October 2006

The functional road hierarchy surrounding the project site is as follows:

- Arterial Roads:
  - Epping Road.
- Sub-arterial roads:
  - Herring Road, between Epping Road and Talavera Road;
  - Talavera Road, between Christie Road and Lane Cove Road
- Collector Roads:
  - Talavera Road, between Culloden Road and Christie Road;
  - Culloden Road, between Waterloo Road and Talavera Road;
- All other roads are local roads.

Road Capacity

Level of Service (LoS) is an index of the operational efficiency of a roadway or intersection. The analysis is essential in planning and design of the transport network and can influence the number of lanes provided or the arrangement of a traffic control system under study.

LoS can be measured mid-block or at intersections. As a mid block measure, LoS is a qualitative measure describing the operational conditions on a road and their perception by a driver. At intersection, LoS is considered in terms of average delay experienced by drivers. Intersection LoS is discussed later in this Appendix.

The capacity of urban lanes with interrupted flow is provided in Table C4 for each LoS. These capacities may increase when priority is given to the major traffic flow at intersections or if there is flaring at intersections to accommodate more traffic. The spacing of intersections will differ with the hierarchy and function of the road.

The capacity of major streets within an urban area can be based on an assessment of their operating Level of Service. Level of service is defined by AUSTROADS (1988) as a qualitative measure of the effects of a number of features, which include speed and travel time, traffic interruptions, freedom to manoeuvre, safety, driving comfort and convenience, and operating costs. Levels of service are designated from A to F from best (free flow conditions) to worst (forced flow with stop start operation, long queues and delays) as defined in Table C4.

Table C4: Mid-block Level of Service and Capacity

LoS	Description	Hourly flow (vehicles)	
		1 Lane	2 Lanes
A	Free flow - A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.	200	900
B	Stable flow (slight delays) - In the zone of stable flow and drivers still have the reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with LOS A.	380	1400
C	Stable flow (acceptable delays) - Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	600	1800
D	Approaching unstable flow (tolerable delays) - Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.	900	2200
E	Unstable flow (congestion; intolerable delays) - Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause break-down.	1400	2800
F	Forced flow (jammed)	>1400	>2800

Source: RTA Guide to Traffic Generating Developments

The typical capacity of urban lanes with interrupted flow is provided in Table C5 for each LoS, as defined in the RTA Guide to Traffic Generating Developments. These capacities may increase when priority is given to the major traffic flow at intersections or if there is widening at intersections to accommodate more traffic. The spacing of intersections will differ with the hierarchy and function of the road.

A service volume, as defined by AUSTROADS (1988), is the maximum number of vehicles that can pass over a given section of roadway in one direction during one hour while operating conditions are maintained at a specified level of service. It is suggested that ideally arterial and sub-arterial roads should not exceed service volumes at level of service C. At this level, whilst most drivers are restricted in their freedom to manoeuvre, operating speeds are still reasonable and acceptable delays experienced.

However, in urban situations, arterial and sub-arterial roads operating at Level of Service 'D' are still considered adequate. It is acceptable to provide road capacity at Level of Service 'D' in the peak hour since overprovision of road capacity is not conducive to promoting alternative transport modes to the car. The LoS for uninterrupted flow conditions along urban roads is identified in Table C5.

Table C5: Level of Service Uninterrupted Flow Conditions Along Urban Roads (One Way Hourly Volumes)

Description	LEVEL OF SERVICE					
	A	B	C	D	E	F
2 Lane Undivided (2U)	760	880	1000	1130	1260	Flows Forced
2 Lane with Clearways and limited access (2CL)	1010	1170	1330	1500	1680	
4 Lane Undivided (13m) (4U)	1260	1470	1680	1890	2100	
4 Lane Undivided with Clearways (4UC)	1510	1760	2010	2270	2520	
4 Lane Divided with Clearways (4DC)	1600	1860	2130	2400	2660	
4 Lane Divided with Clearways, limited access and intersections(4DCI)	2250	2620	3000	3380	3740	
6 Lane Undivided (6U)	2020	2350	2690	3020	3360	
6 Lane Divided with Clearway (6DC)	2440	2840	3250	3660	4060	
6 Lane Divided with Clearways, limited access and intersections (6DCL)	3375	3930	4500	5070	5610	

Intersection Performance

The capacity of an urban road network is controlled by the capacity of the intersections within that network. Average delay is commonly used to assess the actual performance of intersections, with Level of Service used as an index.

The key indicator of intersection performance is Level of Service, where results are placed on a continuum from 'A' to 'F'. The level of service for a sign controlled intersection is determined based on the average vehicle delay on the worst approach movement. The level of service criteria is described in Table C6.

Table C6: Level of Service Criteria

LoS	Traffic Signal/Roundabout	Give Way/Stop Sign/ T-Junction control	Average Delay per Vehicle (secs/veh)
A	Good operation	Good operation	Less than 14
B	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity	15 to 28
C	Satisfactory	Satisfactory, but accident study required	29 to 42
D	Operating near capacity	Near capacity & accident study required	43 to 56
E	At capacity, at signals incidents will cause excessive delays.	At capacity, requires other control mode	57 to 70
F	Unsatisfactory and requires additional capacity, Roundabouts require other control mode	At capacity, requires other control mode	>70

Source: RTA Guide to Traffic Generating Developments

Level of Service 'D' is generally accepted by the NSW Roads and Traffic Authority as the design constraint, that is, intersections should be designed to operate at LoS 'D' or better. It should also be noted that capacity constraint can be used as a demand management technique and that over-provision of capacity can encourage more car use.

The Average Vehicle Delay (AVD) provides a measure of the operational performance of an intersection as indicated below, which relates AVD to LOS. The AVD's should be taken as a guide only as longer delays could be tolerated in some locations (i.e. inner city conditions) and on some roads (i.e. minor side street intersecting with a major arterial route). For traffic signals, the average delay over all movements should be taken. For roundabouts and priority control intersections (sign control) the critical movement for level of service assessment should be that movement with the highest average delay. The average delay ranges for each level of service band is also shown in Table C6.

The Degree of Saturation (DS), or the ratio of flow to capacity, is another measure of the operational performance of individual intersections. For intersections controlled by traffic signals both queue length and delay increase rapidly as DS approaches 1. And it is usual to attempt to keep DS to less than 0.9. Degrees of Saturation in the order of 0.7 generally represent satisfactory intersection operation. When DS exceed 0.9 queues can be anticipated.

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