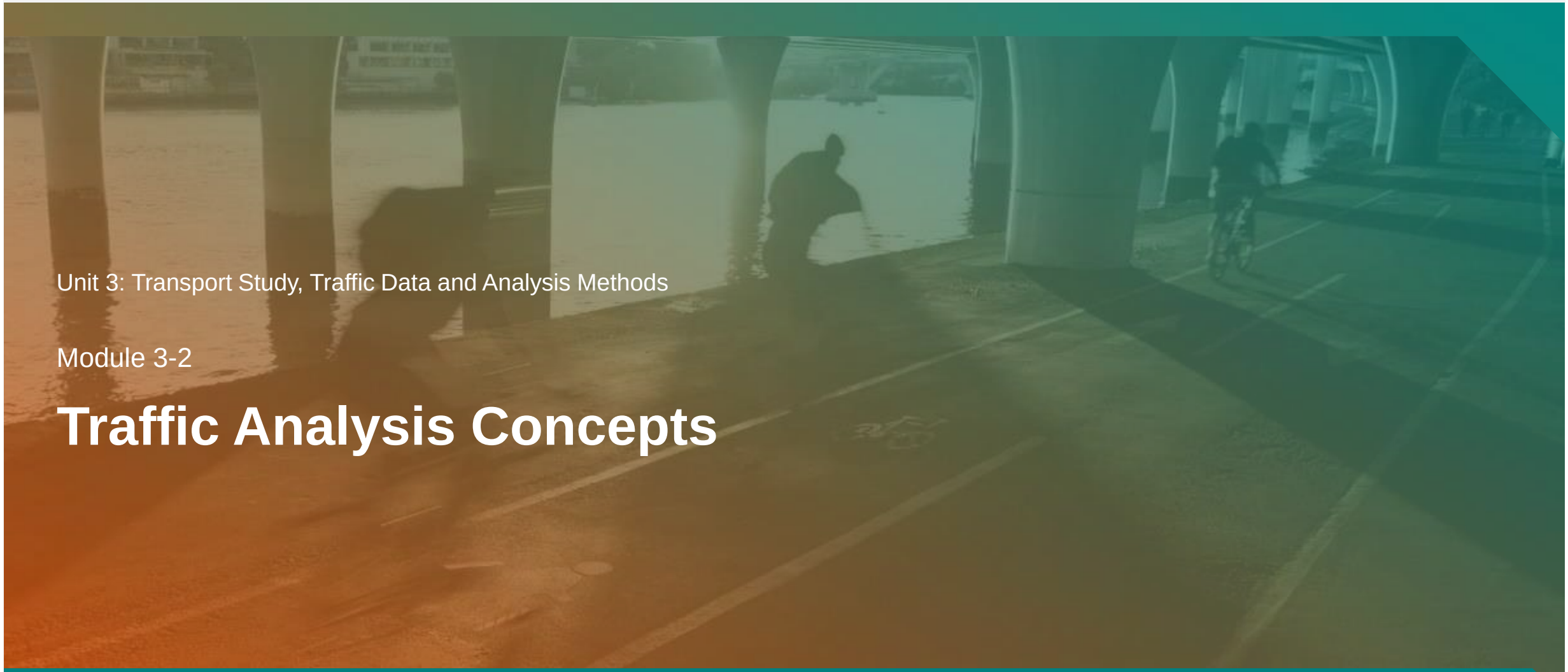

Unit 3: Transport Study, Traffic Data and Analysis Methods

Module 3-2

Traffic Analysis Concepts

Traffic Management Training Module

Austroads

Today’s presenter

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Outline of this Module

- Capacity
- Level of Service
- Degree of Saturation

Capacity

Austroads

Capacity

See Section 3.2.1, Austroads (2020a)

The maximum sustainable hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under the prevailing roadway, environmental, traffic and control conditions (Austroads, 2020a).

Measured in passenger car units (PCU) per unit time

Equivalent factors to convert other vehicles types into PCU

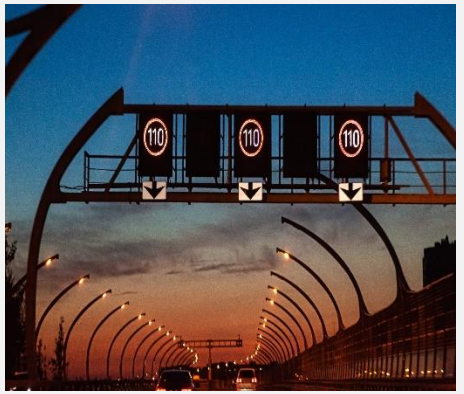
Default peak analysis period in Australia
And New Zealand is 30 minutes.

Factors Affecting Capacity

See Section 3.3, Austroads (2020a)

Austroads

1. **Roadway conditions**
   - Road functionality
   - Lane width
   - Design speed
   - Road geometry
     - Horizontal alignment
     - Vertical alignment



Relevant adjustment factors available in HCM (2016)

Factors Affecting Capacity

See Section 3.3, Austroads (2020a)

Austroads

2. Terrain conditions

- Level – Trucks operate at the same speed as cars
- Rolling – Trucks operate at reduced speed
- Mountainous – Trucks operate at crawl speed

Relevant adjustment factors available in HCM (2016)

Factors Affecting Capacity

See Section 3.3, Austroads (2020a)

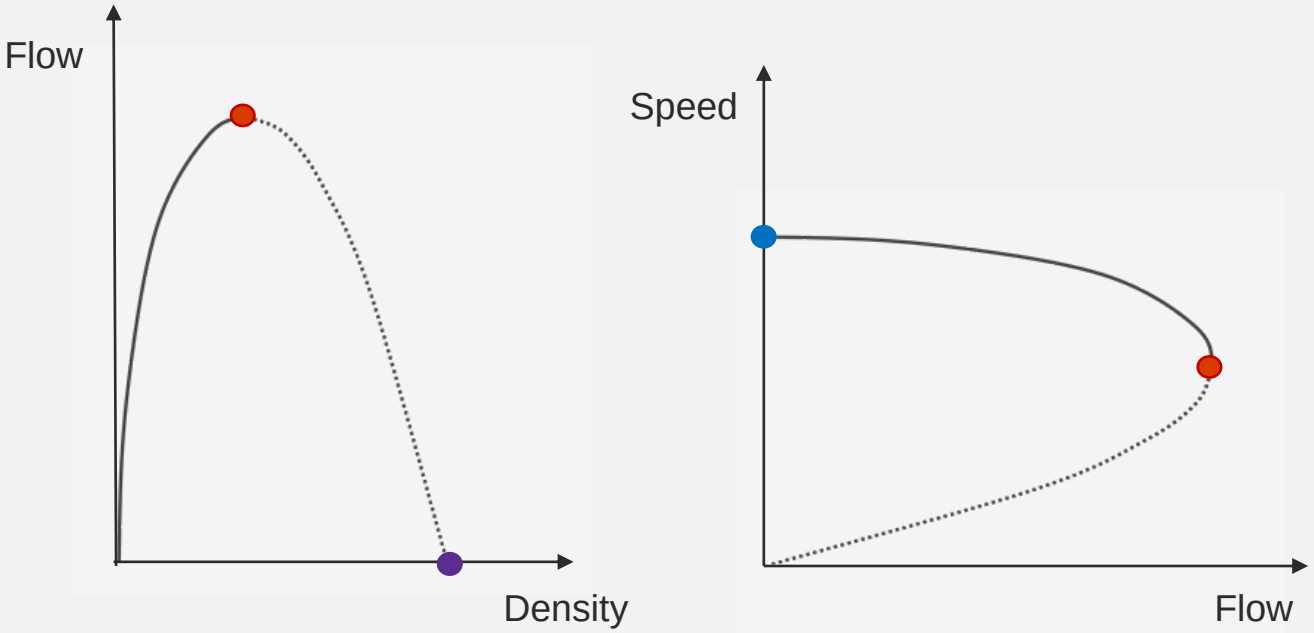
Austroads

3. **Traffic composition**
   - Proportion of heavy vehicles in traffic
   - Pedestrians and cyclists
4. **Driver behaviour**
   - Commute vs weekend travel
5. **Traffic control devices**
   - Different control devices have different affects

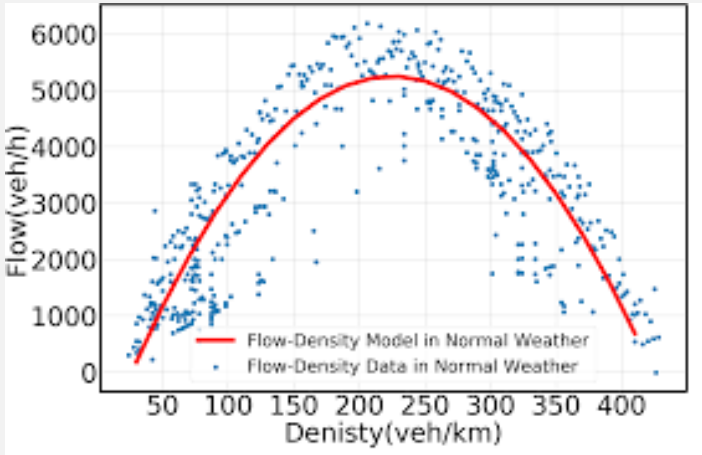
Relevant adjustment factors available in HCM (2016)

Peak Flow Capacity

Maximum serviceable flow when operating under *ideal* traffic conditions



Using Empirical data



Source: Chen et al. (2019)

Uncongested regime

Congested regime

Capacity

Jam density (k_j)

Free flow speed (v_f)

Peak Flow Capacity

Limitations:

- Typically unsustainable at higher congestion due to unstable traffic flow
- A slight turbulence at peak capacity can cause flow breakdown
- Corresponds to theoretical capacity which can only be achieved momentarily

Example:

Peak flow capacity of a freeway with a speed limit of 100 km/h is *2300 pc/h/ln*

However, lower capacity values prevail over sustained time period

Operational Capacity

See Vicroads (2019a)

Austroads

- **Maximum Sustainable Flow Rates (MSFR)** over extended periods of high demand under conditions when:
  - Traffic density is regulated to maintain stability, *e.g. managed motorways*
  - No significant restriction to driver's freedom to maneuver
- Lower (and more sustainable) than peak flow capacity

Measurement:

- *Empirical:* Operational capacity ~ 90% peak flow capacity (RMS, 2017)
- *Stochastic:* Computed for a given flow breakdown probability

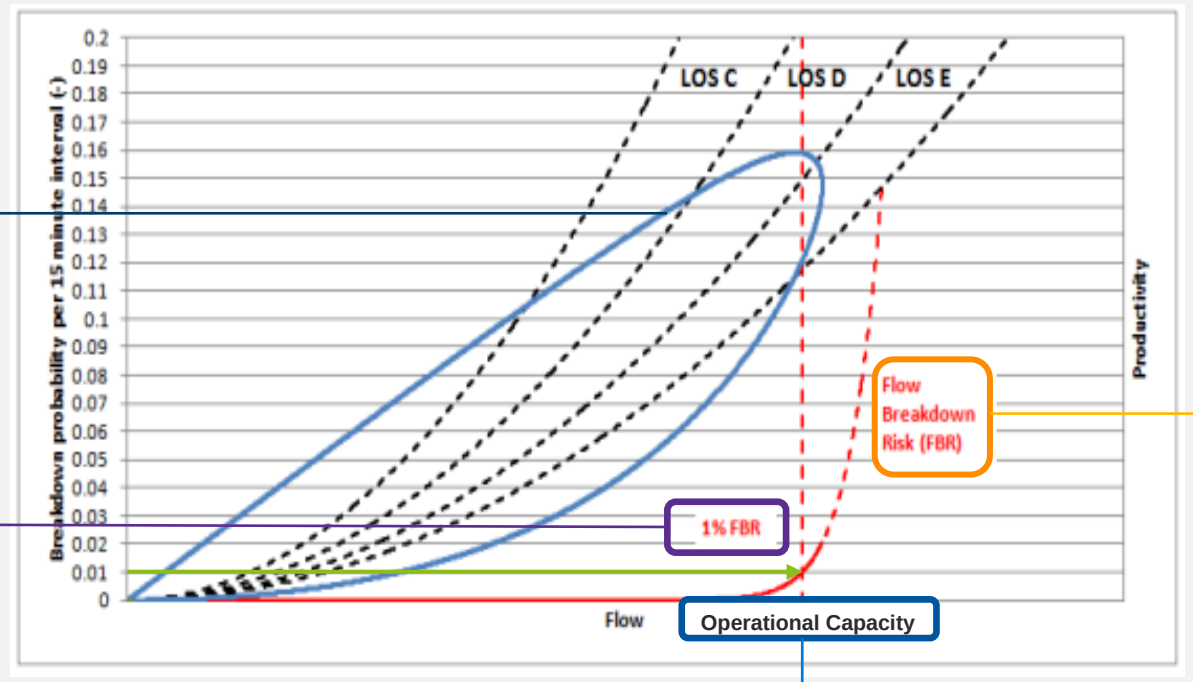
Operational Capacity

Stochastic Approach:

Models the probability of flow breakdown at incremental flow ranges

$$Productivity = Flow \times Speed$$

1% chance of flow breaking down per 15-minute interval



A probability curve which forecasts the likelihood of a breakdown at a given flow

Source: Vicroads (2019)

Predicted flow rate which will sustain in 99% scenarios

Spare Capacity

The amount of increase possible in the demand flow rate to obtain a degree of saturation equal to the practical (target) degree of saturation (SIDRA Intersection, 2020).

$$Spare\ Capacity = \frac{X_m - X_p}{X_p} . 100\ \%$$

$$X_p = \frac{Y}{1 - {}^{L}/_{120}}$$

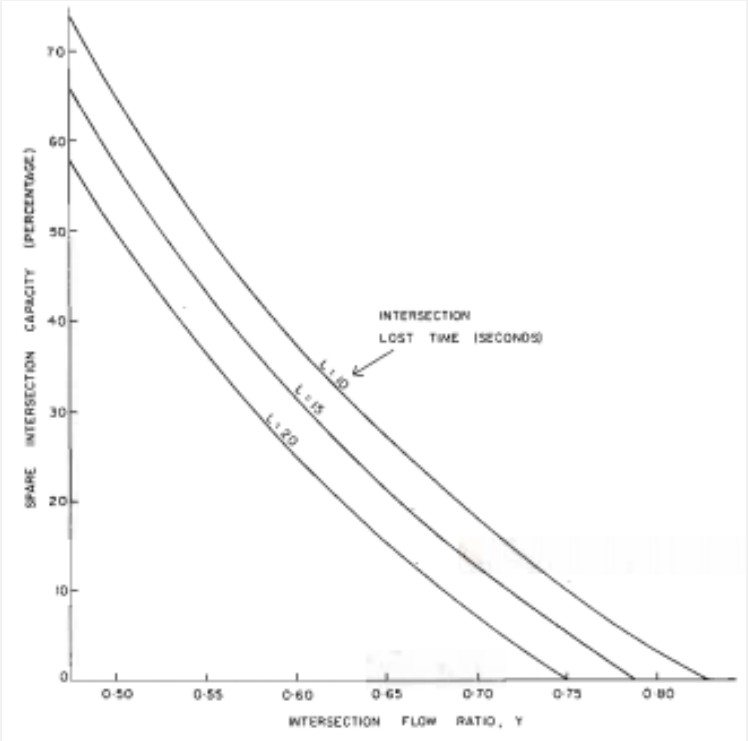
X_m = maximum acceptable degree of saturation, recommended value is 0.9

X_p = practical minimum degree of saturation for an intersection

c_{max} = maximum cycle time, recommended value is 120 seconds

Y = intersection flow ratio

L = total intersection lost time per cycle



Source: Akçelik (1978)

Time to Reflect

1. Which of the following is not a factor affecting capacity? Select all that apply.

A. Using car navigation system

B. Work zones

C. Presence of heavy vehicles

D. None of these

Answer:

Option A is correct!

Using navigation apps like Google, Tom Tom, etc. could make driving easier. However, it should not have a significant impact on the capacity of a road.

Level of Service

Austroads

Level of Service (LOS)

See Section 3.2.2, Austroads (2020a)

LOS is a qualitative stratification of the performance measure or measures representing quality of service (Austroads, 2020a).

- Stratification:
  - Alphabets from A to F
  - A represents free flow conditions, while F denotes traffic jam situation
- Services measures:
  - Speed
  - Travel time
  - Delay
  - Comfort

Level of Service (LOS)

See Section 3.2.2, Austroads (2020a)

Austroads

Recommended service measure for road facilities

Element	LOS measure[1]
Vehicular	
Interrupted flow	
• Urban street	Speed
• Signalised intersection	Delay
• Two-way-stop intersection	Delay
• Roundabout	Delay
• Interchange ramp terminal	Delay
Uninterrupted flow	
• Two-lane highway	Speed, per cent time spent following
• Multi-lane highway	Density
• Freeway	
- basic segment	Density
- ramp merge or diverge	Density
- weaving	Density
Other road users	
Public transport	[2]
Pedestrians	Speed, delay, space [3]
Cyclists	Speed, event, delay [3]

Source: Austroads (2020a)

LOS – Uninterrupted Flow Facilities

See Section 4, Austroads (2020a)

Austroads

For 2-lane Highways

LOS	Traffic Condition
A	• Motorists experience high operating speeds • Platoons of three or more vehicles are rare.
B	• Passing demand and passing capacity are balanced • Some speed reductions • Degree of platooning becomes noticeable.
C	• Most vehicles are travelling in platoons • Speeds are noticeably curtailed.
D	• Passing demand is high, but passing capacity approaches zero • High percentage of platooning vehicles.
E	• Demand is approaching capacity • Speeds are seriously curtailed.
F	• Arrival flow exceeds capacity • Heavy congestion • Operating conditions are unstable.

LOS – Uninterrupted Flow Facilities

See Section 4, Austroads (2020a)

Austroads

2-lane Highway

LOS	Class I highway		Class II highways PTSF (%)	Class III highways PFFS (%)
	Average travel speed ATS (km/h)	Per cent time-spent-following (PTSF) (%)		
A	> 90	≤ 35	< 40	> 91.7
B	> 80 – 90	> 35 – 50	> 40 – 55	> 83.3 – 91.7
C	> 70 – 80	> 50 – 65	> 55 – 70	> 75.0 – 83.3
D	> 60 – 70	> 65 – 80	> 70 – 85	> 66.7 – 75.0
E	≤ 60	> 80	> 85	≤ 66.7

Source: Austroads (2020a)

Multi-lane Highway

Free-flow speed	Criteria	A	B	C	D	E
100 km/h	Maximum density (pc/km/ln)	7	11	16	22	25
	Average speed (km/h)	100.0	100.0	98.4	91.5	88.0
	Maximum volume to capacity ratio (v/c)	0.32	0.50	0.72	0.92	1.00
	Maximum service flow rate (pc/h/ln)	660	1080	1550	1980	2200
90 km/h	Maximum density (pc/km/ln)	7	11	16	22	26
	Average speed (km/h)	90.0	90.0	89.8	84.7	80.8
	Maximum volume to capacity ratio (v/c)	0.30	0.47	0.68	0.89	1.00
	Maximum service flow rate (pc/h/ln)	600	990	1430	1850	2100
80 km/h	Maximum density (pc/km/ln)	7	11	16	22	27
	Average speed (km/h)	80.0	80.0	80.0	77.6	74.1
	Maximum volume to capacity ratio (v/c)	0.28	0.44	0.64	0.85	1.00
	Maximum service flow rate (pc/h/ln)	550	900	1300	1710	2000
70 km/h	Maximum density (pc/km/ln)	7	11	16	22	28
	Average speed (km/h)	70.0	70.0	70.0	69.6	67.9
	Maximum volume to capacity ratio (v/c)	0.26	0.41	0.59	0.81	1.00
	Maximum service flow rate (pc/h/ln)	290	810	1170	1550	1900

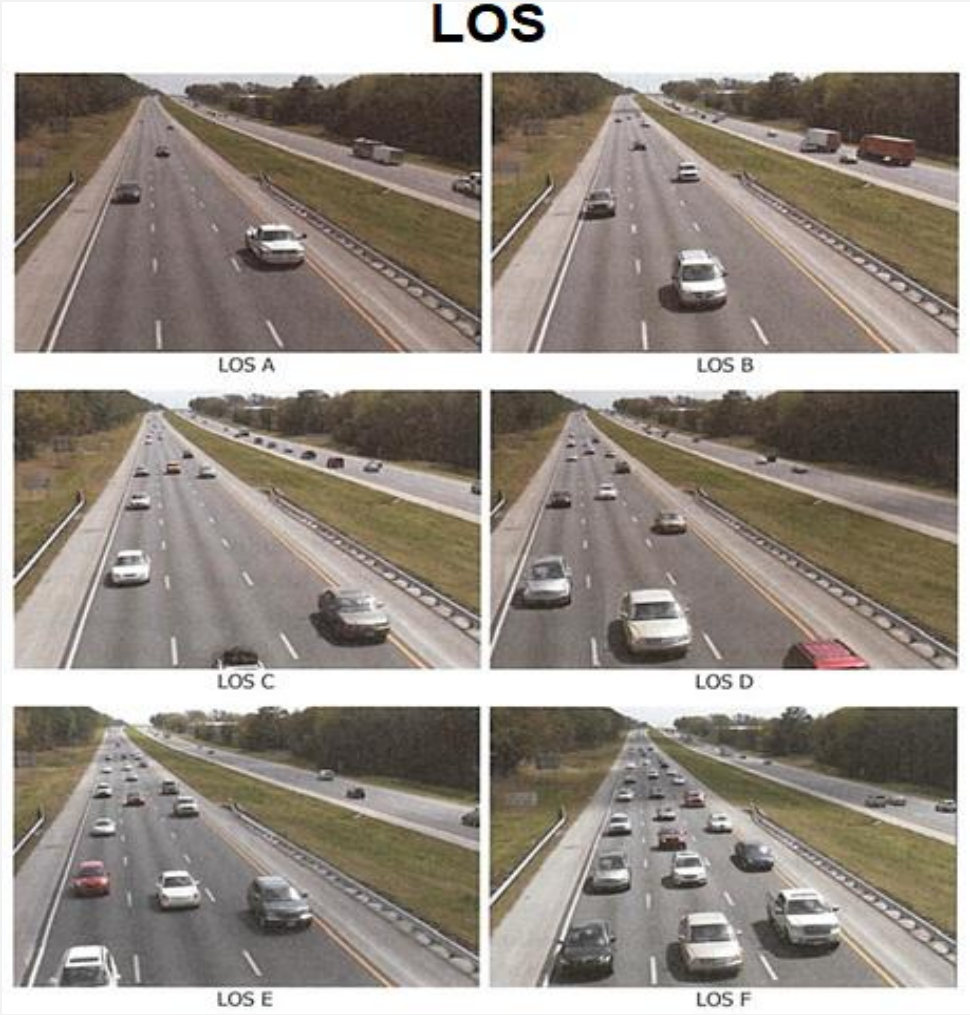
Source: Austroads (2020a)

LOS – Uninterrupted Flow Facilities

See Section 4, Austroads (2020a)

Austroads

For Multi-lane Highways and Freeways



Free Flow

Reasonably Free Flow

Speed near Free Flow

Fluctuating Flow

Operation at/near Capacity

Unstable Flow

Source: UWS (2019)

LOS – Uninterrupted Flow Facilities

See Section 4, Austroads (2020a)

Austroads

Freeways

Criteria	LOS				
	A	B	C	D	E
FFS = 120 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	120.0	120.0	114.6	99.6	85.7
Maximum (v/c)	0.35	0.55	0.77	0.92	1.00
Maximum service flow rate (pc/h/ln)	840	1320	1840	2200	2400
FFS = 110 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	110.0	110.0	108.5	97.2	83.9
Maximum (v/c)	0.33	0.51	0.74	0.91	1.00
Maximum service flow rate (pc/h/ln)	770	1210	1740	2135	2350
FFS = 100 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	100.0	100.0	100.0	93.8	82.1
Maximum (v/c)	0.30	0.48	0.70	0.90	1.00
Maximum service flow rate (pc/h/ln)	700	1100	1600	2065	2300
FFS = 90 km/h					
Maximum density (pc/km/ln)	7	11	16	22	28
Minimum speed (km/h)	90.0	90.0	90.0	89.1	80.4
Maximum (v/c)	0.28	0.44	0.64	0.87	1.00
Maximum service flow rate (pc/h/ln)	630	990	1440	1955	2250

Source: Austroads (2020a)

Merge and Diverge Sections

LOS	Density (pc/km/ln)
A	≤ 6
B	> 6–12
C	> 12–17
D	> 17–22
E	> 22
F	Demand exceeds capacity

Source: Austroads (2020a)

Weaving Sections

LOS	Density (pc/km/ln)	
	Freeway weaving segment	Multi-lane and collector-distributor weaving segments
A	≤ 6.0	≤ 8.0
B	> 6.0–12.0	> 8.0–15.0
C	> 12.0–17.0	> 15.0–20.0
D	> 17.0–22.0	> 20.0–23.0
E	> 22.0-27	> 23.0-25
F	> 27 or demand exceeds capacity	> 25 or demand exceeds capacity

Source: Austroads (2020a)

LOS – Interrupted Flow Facilities

See Section 5, Austroads (2020a)

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Arterial Roads

LOS	Traffic Condition
A	• Free flow operation, travel speed exceeds 80% of the BFFS • Unimpeded manoeuvering of vehicles.
B	• Reasonably unimpeded operation, speed is between 67% and 85% of the BFFS • Ability to manoeuvre is slightly restricted.
C	• Stable operation, speed is between 50% and 67% of the BFFS • Ability to manoeuvre is more restricted.
D	• Less stable operation, speed is between 40% and 50% of the BFFS • Small increase in flow may cause substantial increase in delay.
E	• Unstable operation, speed is between 30% and 40% of the BFFS.
F	• Unstable operation, speed is less than 30% of the BFFS • High delay and extensive queuing.

BFFS – Base Free-flow Speed

Multi-modal LOS

See Section 3.4, Austroads (2020a)

- How well a facility or service operates from a user's perspective?
- Determining LOS for each mode
- Multi-modal LOS framework for network operation involving multiple modes (Austroads, 2015)
  - Recognises transport needs *e.g. mobility, safety, access, information and amenity*
  - Enables integrated planning and decision making
- Multi-modal LOS framework applied in the implementation of the Austroads Movement and Place (M&P) Framework (Austroads, 2020b)

Degree of Saturation

Austroads

Degree of Saturation

See Section 3.2.4, Austroads (2020a)

Austroads

Also referred to as the *Volume to Capacity Ratio (VCR)*

$$X = \frac{V}{C} \quad X\colon X > 0$$

Conditions:

- Undersaturated: X is close to 0 — *E.g. LOS A, B and C*
- Saturated: X is close to 1 — *E.g. LOS D and E*
- Oversaturated: X exceeds 1 — *E.g. LOS F*

Recommended X:

- Signalised: 0.90
- Roundabouts: 0.85
- Unsignalised: 0.80

Time to Reflect

2. Which of the following LOS corresponds to Saturated conditions? Select all that apply.

A. A

B. B

C. D

D. F

Answer:

Option C is correct!

LOS D and E have a VCR close to 1 and thus represent saturated traffic conditions.

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Tutorial available for this learning module!

Thank you for participating

Austroads