

Ridership and Quality of Service

May 3, 2005

PORTLAND STATE UNIVERSITY

Topics

- **Bus speed factors**
- **Arterial bus lane speed**

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Speed Factors

- **Factors also related to capacity:**
 - Dwell time
 - Traffic signal timing
 - Traffic volumes
 - Bus facility type (bus lane vs. mixed traffic)
- **Other factors:**
 - Stop spacing
 - Scheduled bus volumes

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Arterial Street Procedure

- **Determine the base running time — how fast buses would travel without signal and traffic delays (but with dwell times)**
- **Add additional time losses due to signal & traffic delays (estimate from table or measure in the field)**
- **Convert the total running time into a speed**
- **Adjust for bus congestion**
 - Speeds drop when more than 1/2 of a facility's maximum bus capacity is scheduled

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

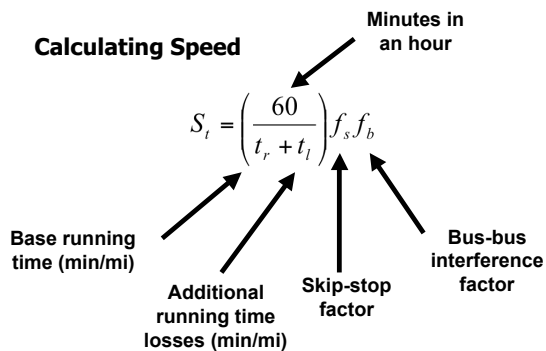
Arterial Street Procedure

- **Sections analyzed should have similar characteristics (traffic volumes, bus volumes, stop frequency, etc.)**
- **Sections should be at least 1/4 mile long and preferably 1/2 mile**
- **Determine overall facility speed from weighted average of individual segments**

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Calculating Speed



PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Determining Running Time

Dwell Time (s)	Stops per mile							
	2	4	5	6	7	8	10	12
10	2.40	3.27	3.77	4.30	4.88	5.53	7.00	8.75
20	2.73	3.93	4.60	5.30	6.04	6.87	8.67	10.75
30	3.07	4.60	5.43	6.30	7.20	8.20	10.33	12.75
40	3.40	5.27	6.26	7.30	8.35	9.53	12.00	14.75
50	3.74	5.92	7.08	8.30	9.52	10.88	13.67	16.75
60	4.07	6.58	7.90	9.30	10.67	12.21	15.33	18.75

NOTE: Data based on field measurements. Interpolation between dwell time values is done on a straight -line basis.

- Values in minutes per mile
- Dwell time is an average of all stops along the portion of the facility being analyzed

Determining Running Time Losses

Condition	Bus Lane	Bus Lane, No Right Turns	Bus Lane With Right Turn Delays	Bus Lanes Blocked by Traffic	Mixed Traffic Flow
CENTRAL BUSINESS DISTRICT					
Typical		1.2	2.0	2.5-3.0	3.0
Signals Set For Buses		0.6	1.4		
Signals More Frequent Than Bus Stops		1.5-2.0	2.5-3.0	3.0-3.5	3.5-4.0
ARTERIAL ROADWAYS OUTSIDE THE CBD					
Typical	0.7				1.0
Range	0.5-1.0				0.7-1.5

NOTE: Data based on field measurements. Traffic delays shown reflect peak conditions.

- Values in minutes per mile

Bus-Bus Interference Factor

Critical Stop v/c Ratio	Bus-Bus Interference Factor
<0.5	1.00
0.5	0.97
0.6	0.94
0.7	0.89
0.8	0.81
0.9	0.69
1.0	0.52
1.1	0.35

NOTE: Capacity should be based on a 25% failure rate (i.e., maximum capacity).

- As the number of buses using the lane increases, there is a greater probability that one bus will delay another bus
- v/c = volume-to-capacity ratio

Example

- **Downtown area**
- **Exclusive bus lane, with right turns allowed**
- **Average stop spacing 650 feet (every 2 blocks)**
- **Traffic signals located every block**
- **Average dwell time of all stops along street: 30 seconds**
- **50 buses scheduled, max. capacity = 60 bus/h**

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Running Time

Dwell Time (s)	Stops per mile							
	2	4	5	6	7	8	10	12
10	2.40	3.27	3.77	4.30	4.88	5.53	7.00	8.75
20	2.73	3.93	4.60	5.30	6.04	6.87	8.67	10.75
30	3.07	4.60	5.43	6.30	7.20	8.20	10.33	12.75
40	3.40	5.27	6.26	7.30	8.35	9.55	12.00	14.75
50	3.74	5.92	7.08	8.30	9.52	10.88	13.67	16.75
60	4.07	6.58	7.90	9.30	10.67	12.21	15.33	18.75

NOTE: Data based on field measurements. Interpolation between dwell time values is done on a straight-line basis.

- **650 ft spacing = 8 stops/mi**
- **Average dwell = 30 sec**
- **Running time = 8.20 min/mi**

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Running Time Losses

Condition	Bus Lane	Bus Lane, No Right Turns	Bus Lane With Right Turn Delays	Bus Lanes Blocked by Traffic	Mixed Traffic Flow
CENTRAL BUSINESS DISTRICT					
Typical		1.2	2.0	2.5-3.0	3.0
Signals Set For Buses		0.6	1.4		
Signals More Frequent Than Bus Stops		1.5-2.0	2.5-3.0	3.0-3.5	3.5-4.0
ARTERIAL ROADWAYS OUTSIDE THE CBD					
Typical	0.7				1.0
Range	0.5-1.0				0.7-1.5

NOTE: Data based on field measurements. Traffic delays shown reflect peak conditions.

- **Signal spacing (every block) shorter than stop spacing (every 2 blocks)**
- **Running time losses: say 2.75 min/mi**

PORTLAND STATE UNIVERSITY

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION PLANNING/TRAFFIC ENGINEERING

Bus-Bus Interference Factor

Critical Stop v/c Ratio	Bus-Bus Interference Factor
<0.5	1.00
0.5	0.97
0.6	0.94
0.7	0.89
0.8	0.81
0.9	0.69
1.0	0.52
1.1	0.35

NOTE: Capacity should be based on a 25% failure rate (i.e., maximum capacity).

- $v/c = 50/60 = 0.83$
- Interpolate to get $f_b = 0.77$

Calculating Speed

$$S_t = \left(\frac{60}{t_r + t_l} \right) f_s f_b$$

$$S_t = \left(\frac{60}{8.20 + 2.75} \right) (1.00)(0.77)$$

$$S_t = 4.2 \text{ mph}$$

Additional Reading

- **TCQSM**
 - Part 4, Chapters 3 & 5
