Traffic Engineering Studies

Traffic studies may be grouped into three main categories:

- inventories,
- administrative studies, and
- Dynamic studies.

Inventories provide a list or graphic display of existing information, such as street widths, parking spaces, transit routes, traffic regulations, and so forth.
Some inventories—for example, available parking spaces and traffic regulations—change frequently and therefore require periodic updating; others, such as street widths, do not.

Administrative studies use existing engineering records, available in government agencies and departments. This information is used to prepare an inventory of the relevant data. Inventories may be recorded in files but are usually recorded in automated data processing (ADP) systems. Administrative studies include the results of surveys, which may involve field measurements and/or aerial photography.

Dynamic traffic studies involve the collection of data under operational conditions and include:

1. Studies of speed.
2. Studies of traffic volume.
3. Studies of travel time and delay.
4. Studies of parking, and crashes.

Since dynamic studies are carried out by the traffic engineer to evaluate current conditions and develop solutions.

Traffic Volume Studies

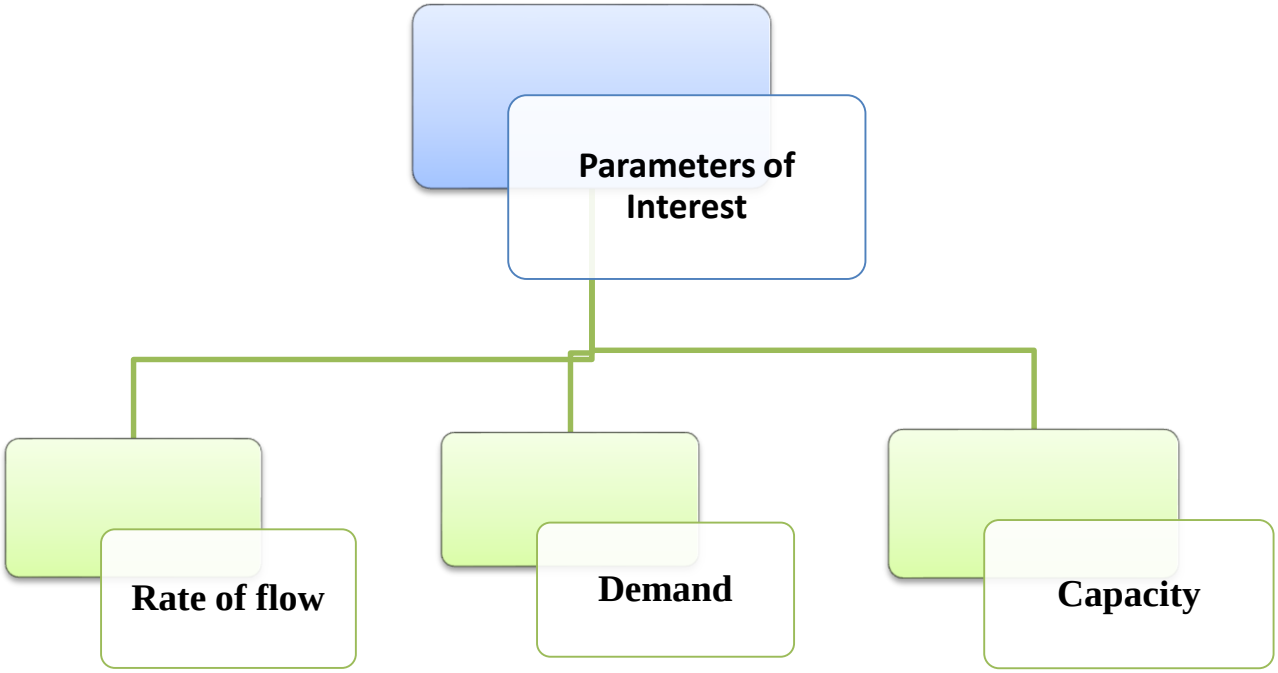
Traffic volume studies are conducted to collect data on the number of vehicles and/or pedestrians that pass a point on a highway facility during a specified time period. This time period varies from as little as 15 minutes to as much as a year depending on the anticipated use of the data. The data collected also may be put into subclasses which may include directional movement, occupancy rates, vehicle classification, and pedestrian age.

Why are Volume Studies Needed?

Transportation planning/forecasts

• Assessing operations
• Impact analysis
• Determining need for traffic control, etc.

Traffic counts provide the primary measure of demand.

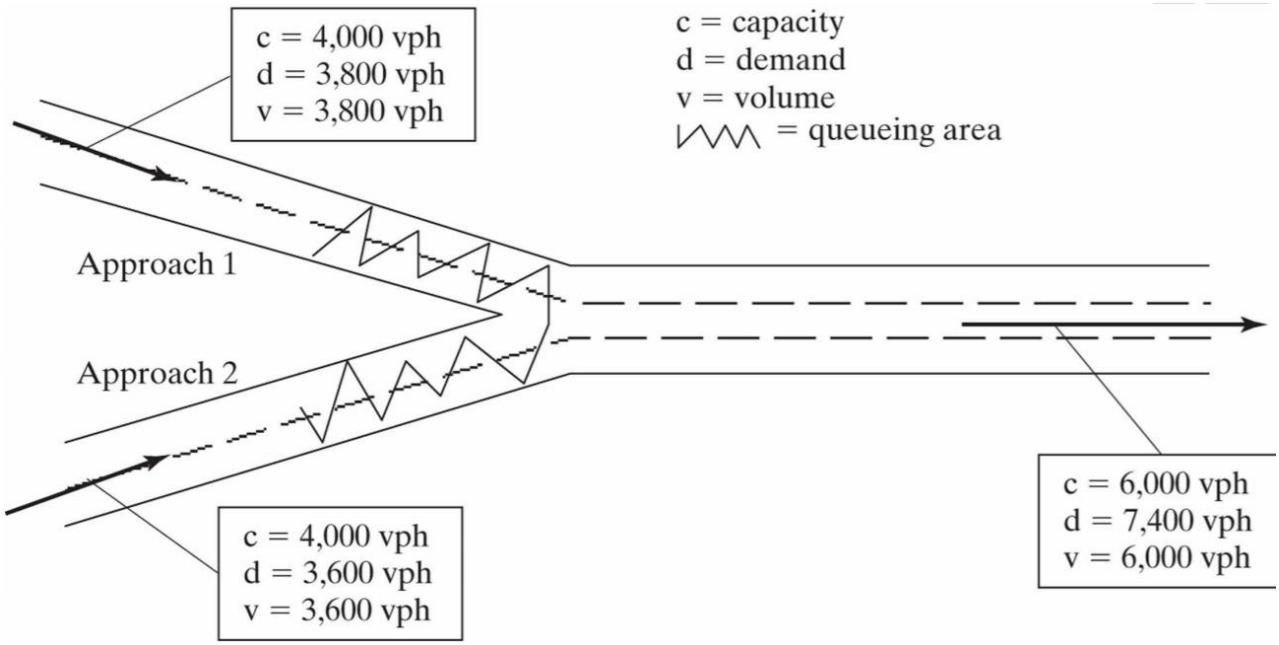


Volume: The number of vehicles (or persons) passing a point during a specified time period which is usually one hour but need not be.

Rate of Flow: The rate at which vehicles (or persons) pass a point during a specified time period less than an hour, expressed as an equivalent hourly rate.

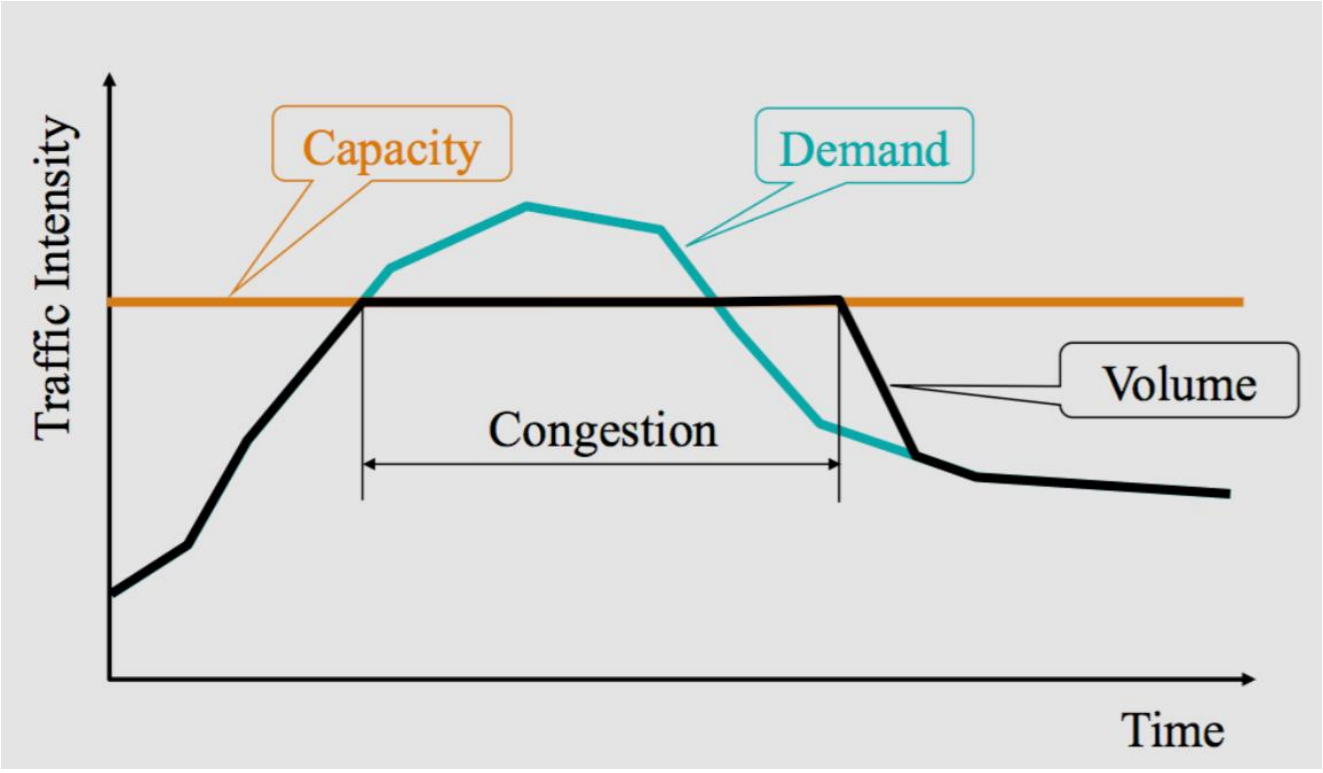
Demand: The number of vehicles (or persons) that desire to travel past a point during a specified time period (usually one hour).

Capacity: The maximum rate at which vehicles can traverse a point or short segment during a specified time period.

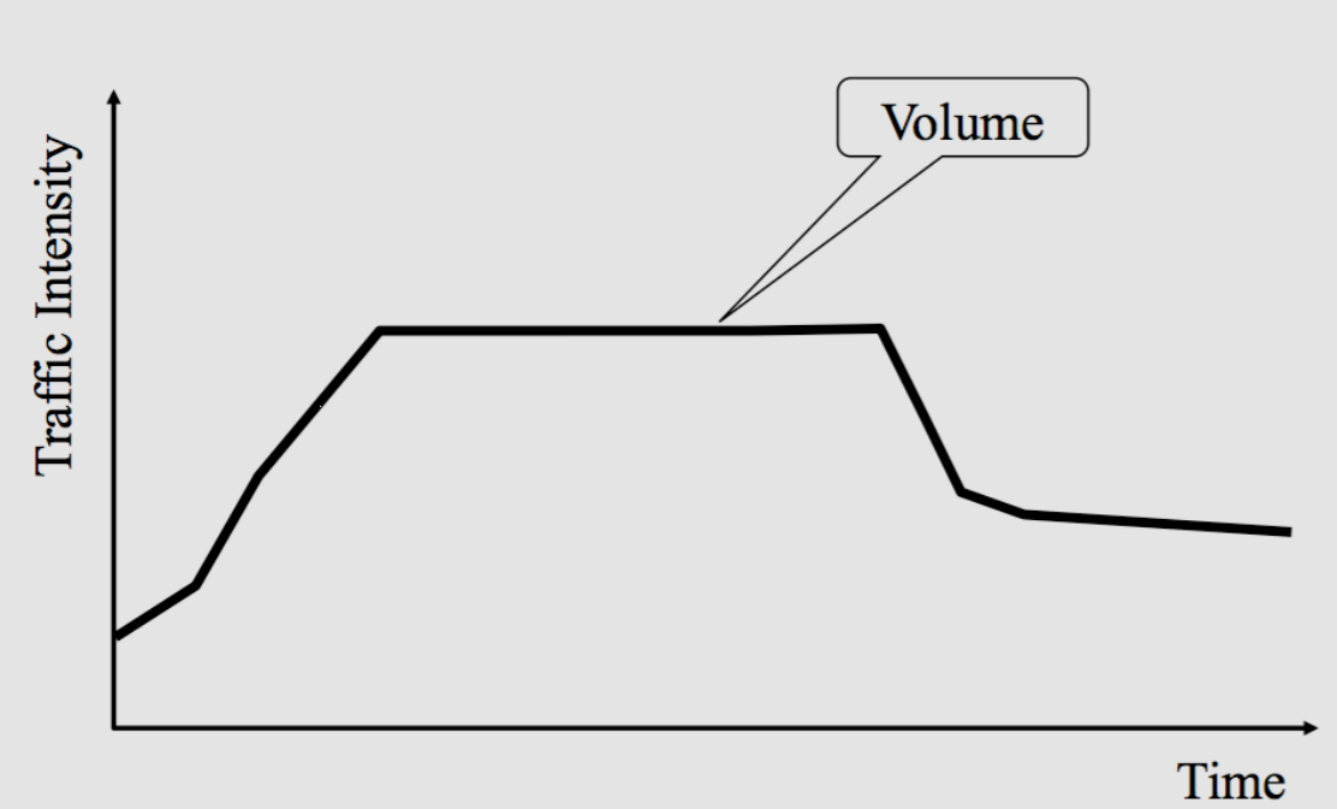


Volume, Demand and Capacity Illustration

Demand Exceeding Capacity



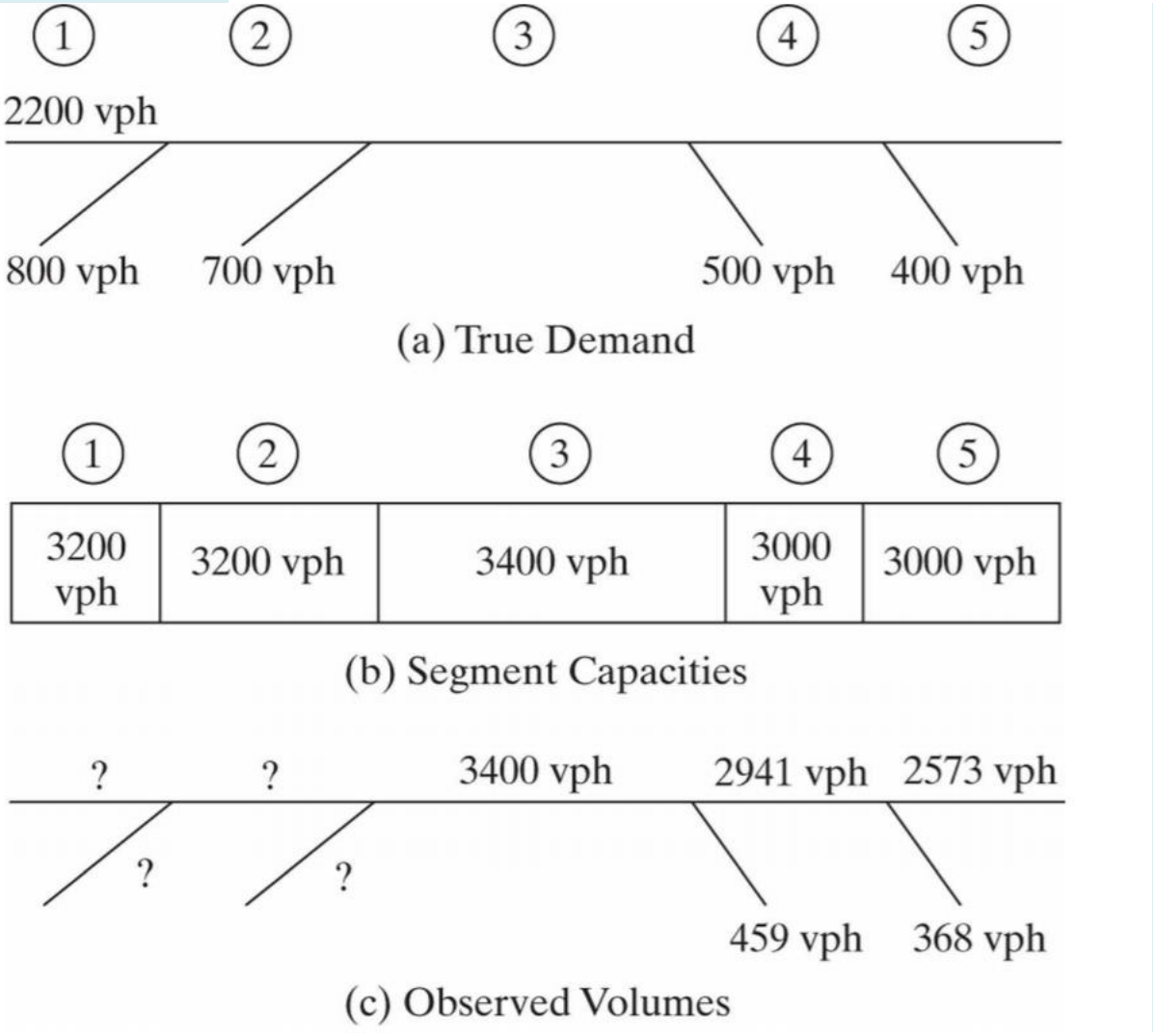
Volume Pattern



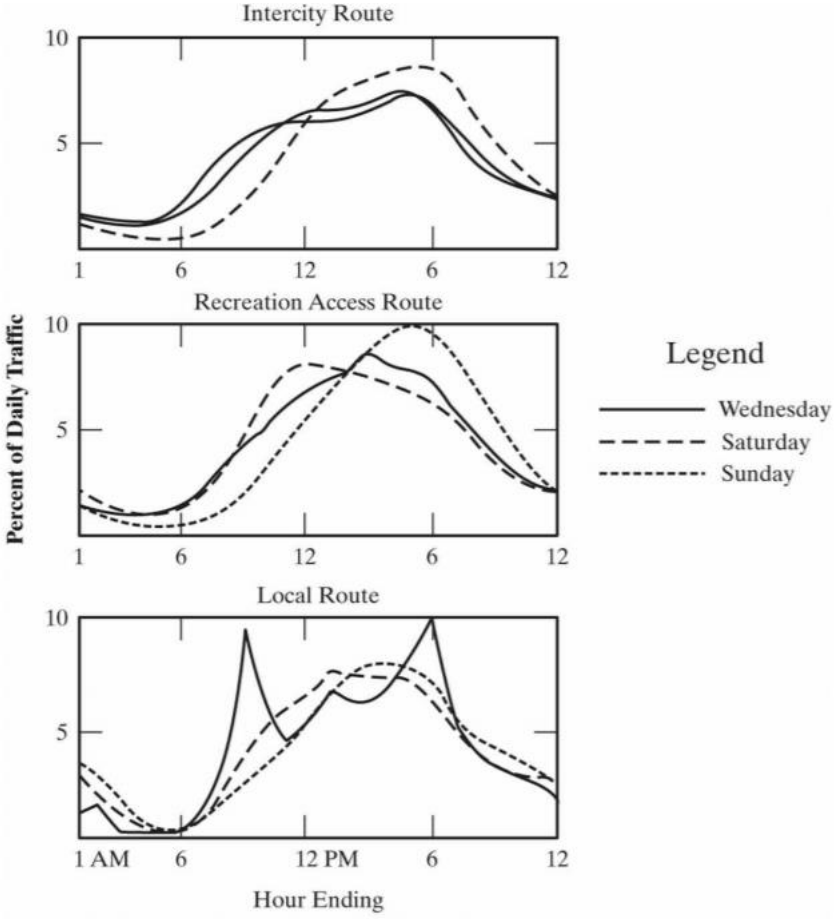
Volume Patterns and Characteristics

- Traffic demand varies!
- Choosing design hour may be complex
- Very important to understand volume variation patterns

Bottleneck Effects

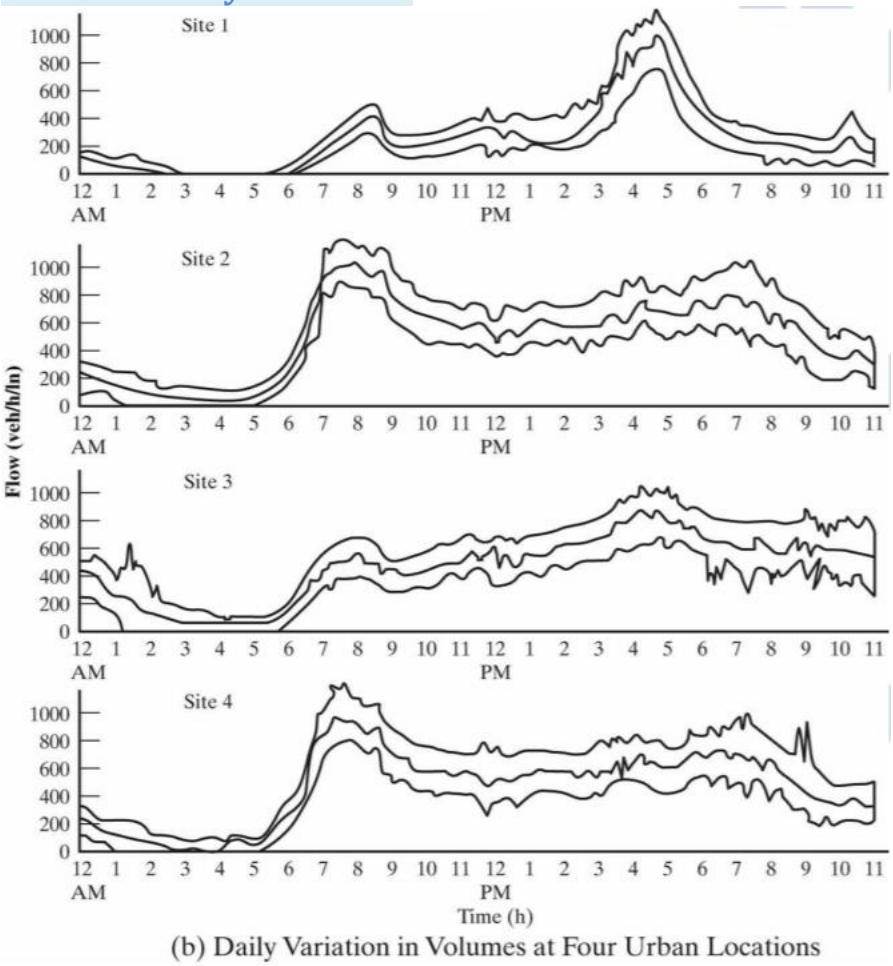


Observed Hourly Traffic Patterns



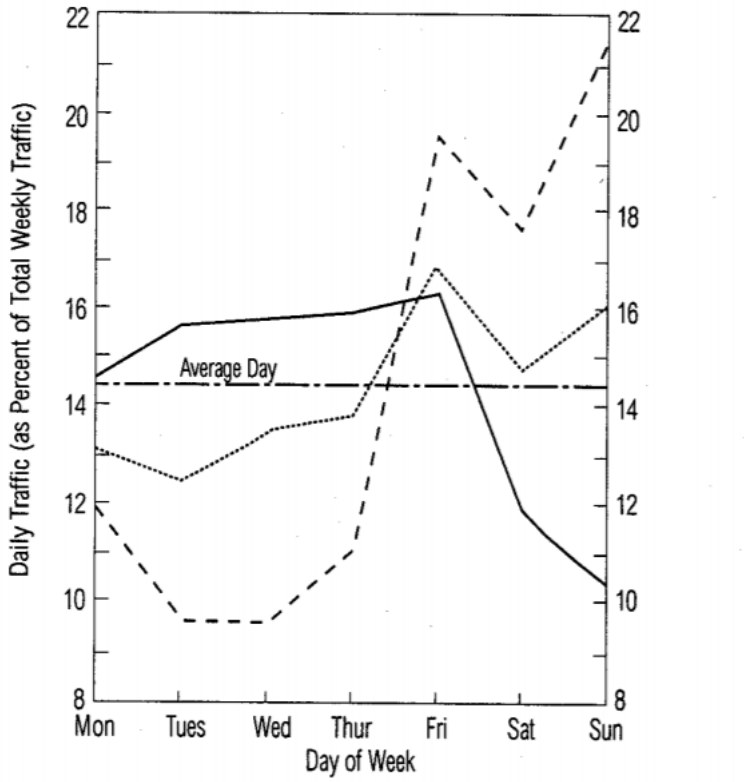
(a) Typical Variations for Rural Routes

Observed Daily Variations



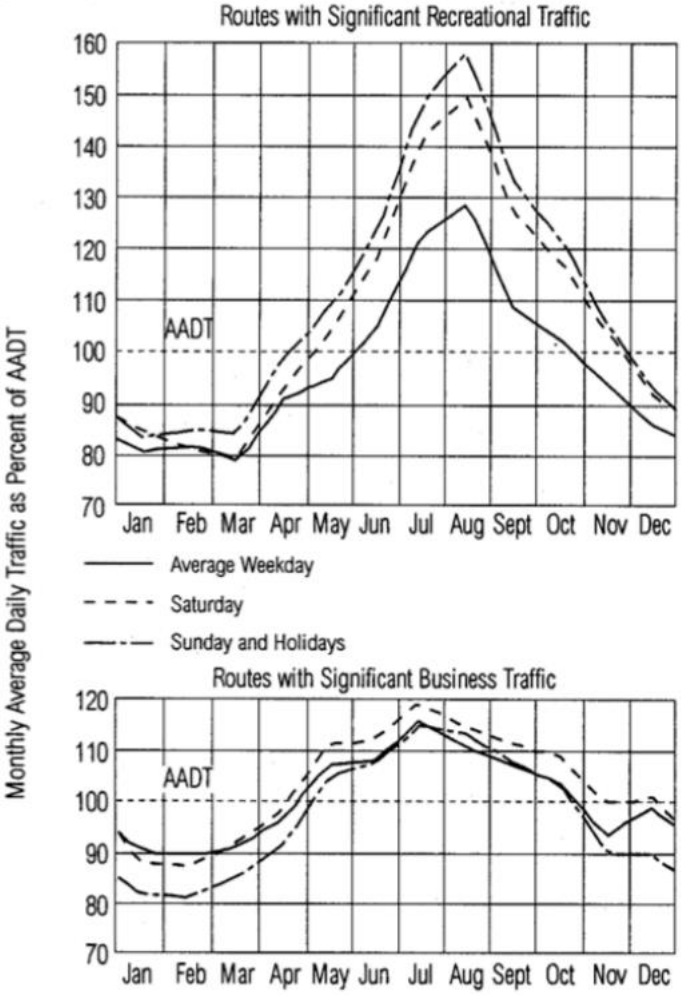
(b) Daily Variation in Volumes at Four Urban Locations

Volume Patterns and Characteristics

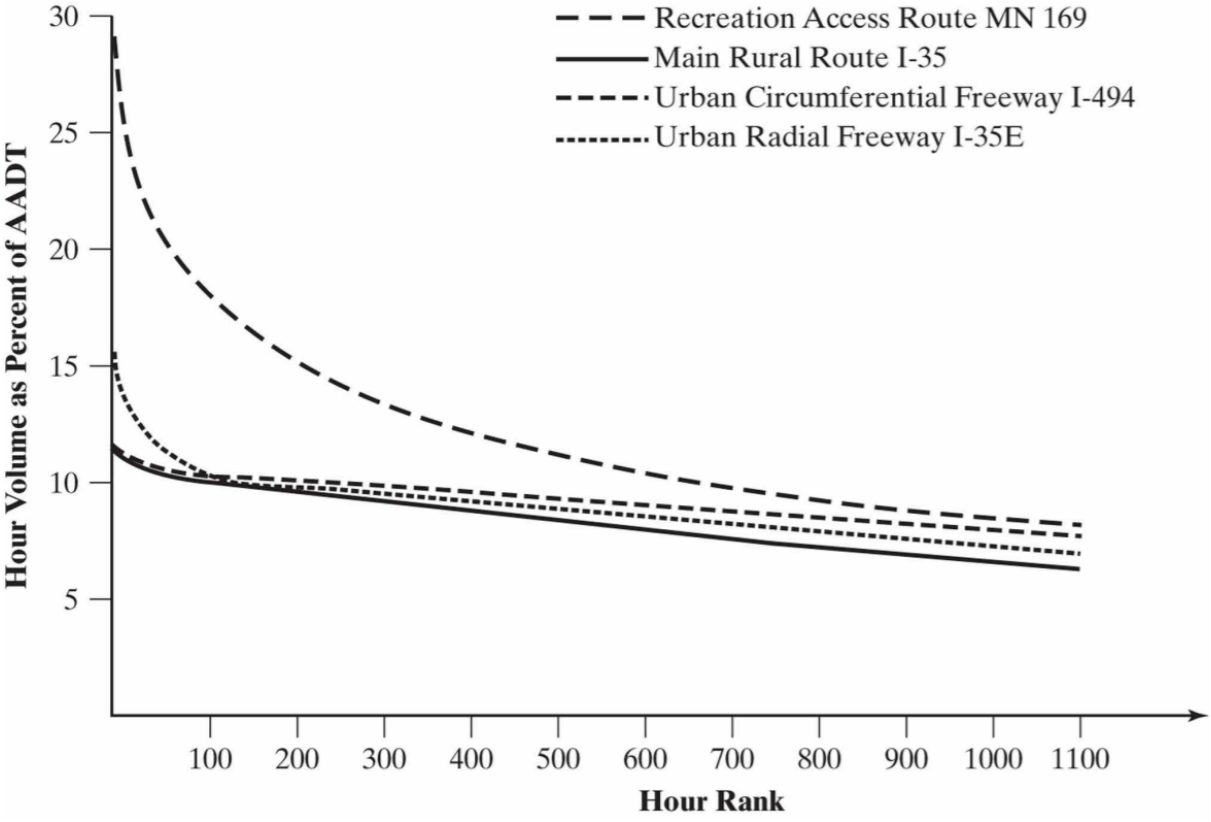


..... Main rural route I-35, Southern Minnesota, AADT 10,823, 4 lanes, 1980.
– – – Recreational access route MN 169, North-Central Lake Region, AADT 3,863, 2 lanes, 1981.
——— Suburban freeway, four freeways in Minneapolis-St. Paul, AADTs 75,000-130,000, 6-8 lanes, 1982.
– – — Average day.
Source: Minnesota Department of Transportation.

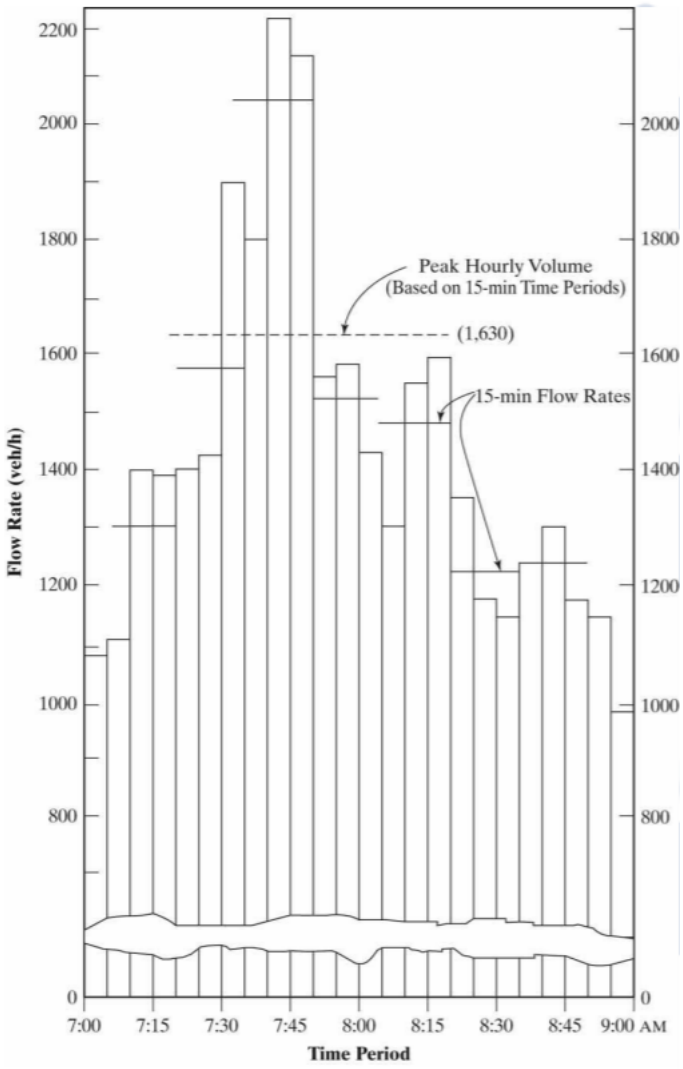
Monthly Variations



Peak Hour Volume



Within Peak Hour



Volume Studies

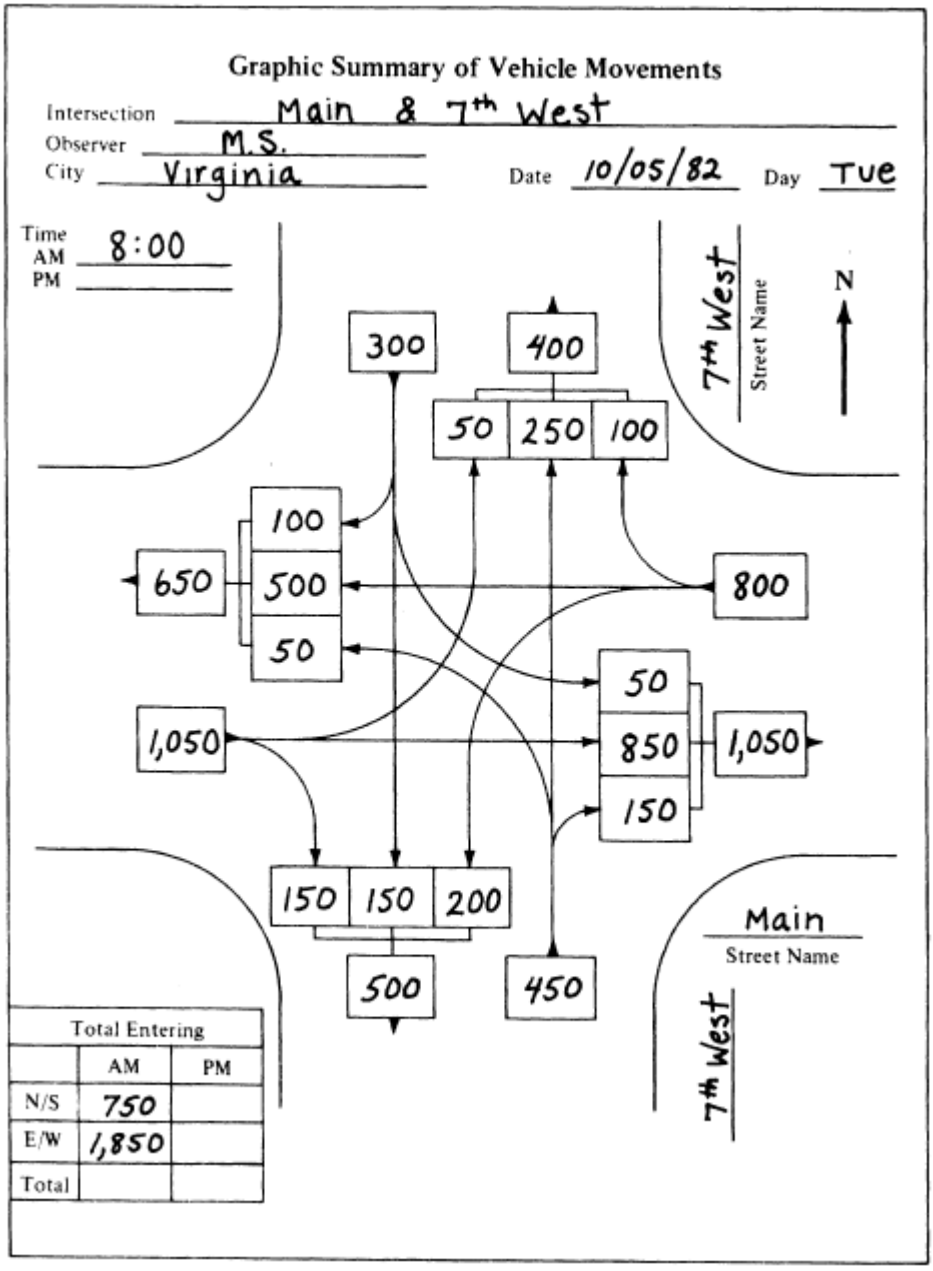
Manual counts

- Useful when data is needed quickly, duration of study is short, or scope is limited
- Useful when more detail is needed such as:
  - Vehicle occupancy
  - Pedestrians
  - Turning movements
  - Vehicle classifications

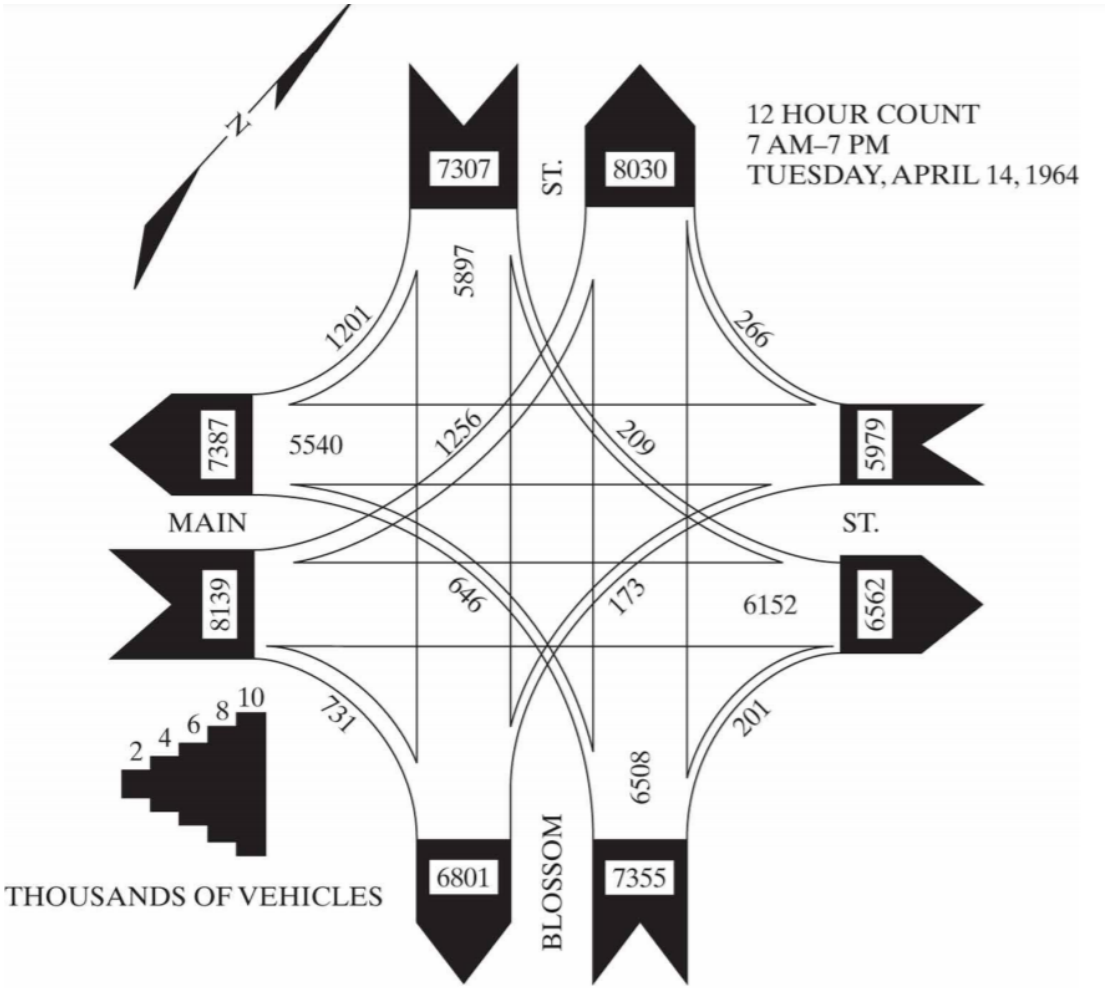
Automatic counts

- Useful when complex classifications not necessary.
- Useful when data is needed over an extended period of time.

Intersection Traffic Volume Count



Intersection Traffic Volume Count



Limited Network Volume Studies

- Sampling techniques are used along with statistical manipulation to develop an hourly volume map for the network.
- Requires identification of locations with similar demand patterns over time.
- Uses control and coverage counts.
- Control count - maintained throughout study period; selected locations are measured to identify demand variation patterns.
- Coverage count – taken at all locations in study area for a portion of study period (samples).
- Midblock counts.

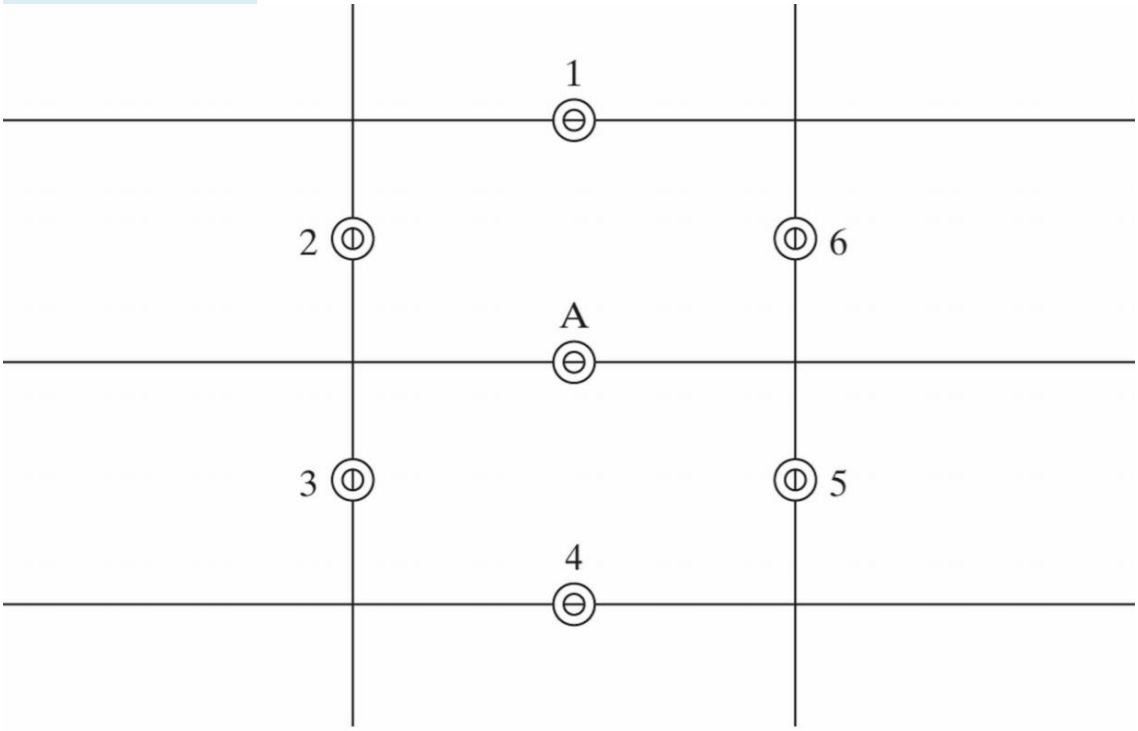
Control Count

- One control for every 10- 20 coverage locations.
- Different control for each class of facility.
- Different control for significantly different land-use type.
- Used to establish volume patterns.

Coverage Count

- These are sample locations which will be expanded with control information.
- All network links should be counted at least once during study period.

Control Count



Network wide Studies

Control-Count Data Location A		Coverage-Count Data		
Time (PM)	Count (vehs)	Location	Time (PM)	Count (vehs)
12–1	825	1	12–1	840
1–2	811	2	1–2	625
2–3	912	3	2–3	600
3–4	975	4	4–5	390
4–5	1,056	5	5–6	1,215
5–6	1,153	6	6–7	1,440
6–7	938			
7–8	397			

(a) Data from a One-Day Study

Time (PM)	Count (vehs)	Proportion of 8-Hour Total
12–1	825	825/7,067 = 0.117
1–2	811	811/7,067 = 0.115
2–3	912	912/7,067 = 0.129
3–4	975	975/7,067 = 0.138
4–5	1,056	1,056/7,067 = 0.149
5–6	1,153	1,153/7,067 = 0.163
6–7	938	938/7,067 = 0.133
7–8	397	397/7,067 = 0.056
Total	**7,067**	**1.000**

(b) Computation of Hourly Volume Proportions From Control-Count Data

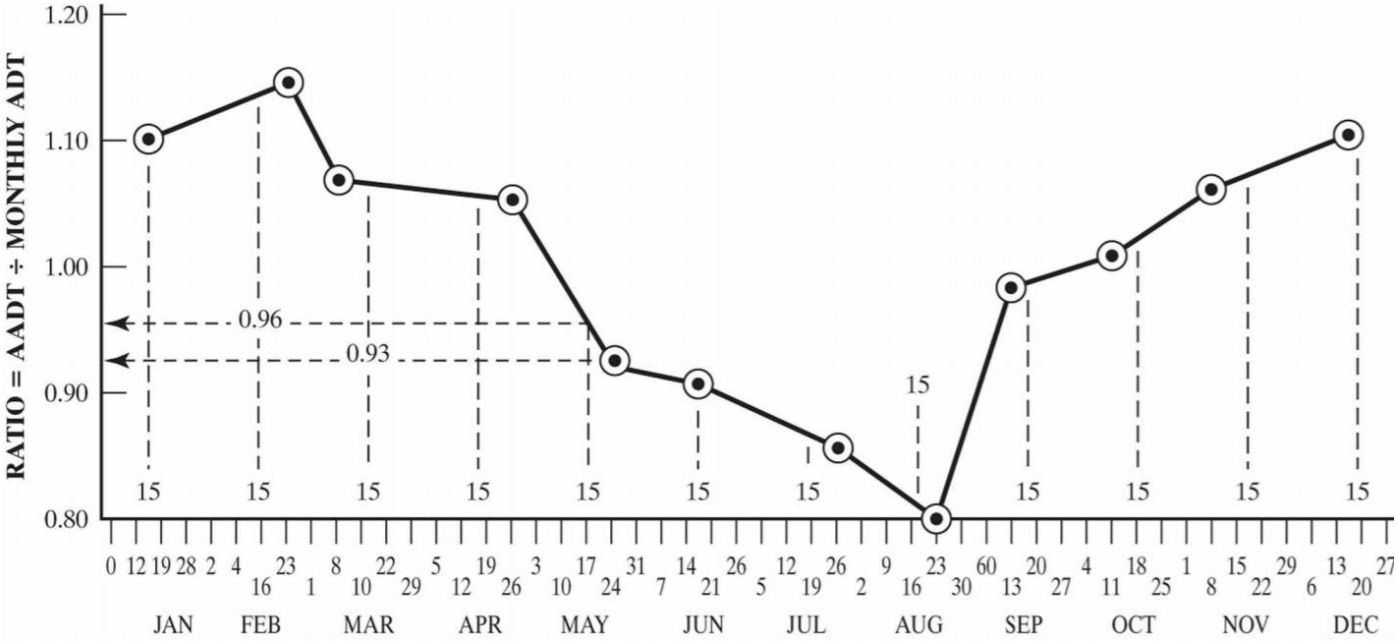
Location	Time (PM)	Count (vehs)	Estimated 8-Hr Volume (vehs)	Estimated Peak Hour Volume (vehs)
1	12–1	840	840/0.117 = 7,179	× 0.163 = 1,170
2	1–2	625	625/0.115 = 5,435	× 0.163 = 886
3	2–3	600	600/0.129 = 4,651	× 0.163 = 758
4	4–5	390	390/0.149 = 2,617	× 0.163 = 427
5	5–6	1,215	1,215/0.163 = 7,454	× 0.163 = 1,215
6	6–7	1,440	1,440/0.133 = 10,827	× 0.163 = 1,765

(c) Expansion of Hourly Counts

Daily Variation Factor

Day	Yearly Average Volume for Day (vehs/day)	Daily Adjustment Factor (DF)
Monday	1820	1430/1820 = 0.79
Tuesday	1588	1430/1588 = 0.90
Wednesday	1406	1430/1406 = 1.02
Thursday	1300	1430/1300 = 1.10
Friday	1289	1430/1289 = 1.11
Saturday	1275	1430/1275 = 1.12
Sunday	1332	1430/1332 = 1.07
Total	**10,010**	
Estimated AADT	**1,430**	

Weekly Variation Factor



Daily and Monthly Adjustment Factors

Daily Factors (DF)		Monthly Factors (MF)			
Day	**Factor**	**Month**	**Factor**	**Month**	**Factor**
Monday	1.072	January	1.215	July	0.913
Tuesday	1.121	February	1.191	August	0.882
Wednesday	1.108	March	1.100	September	0.884
Thursday	1.098	April	0.992	October	0.931
Friday	1.015	May	0.949	November	1.026
Saturday	0.899	June	0.918	December	1.114
Sunday	0.789				

Network wide AADT

$AADT = V_{24ij} * Df_i * MF_j$

- AADT: Average annual daily traffic
- V24ij:24-hour volume for day i, in month j
- Dfi : Daily adjustment factor for day i
- MFj : Monthly adjustment factor for month j

Vehicle Miles Travelled

VMT_{365} = AADT * L *365

- Annual vehicle miles travelled over the segment.
- AADT for the segment (veh/day).
- Length of the segment.

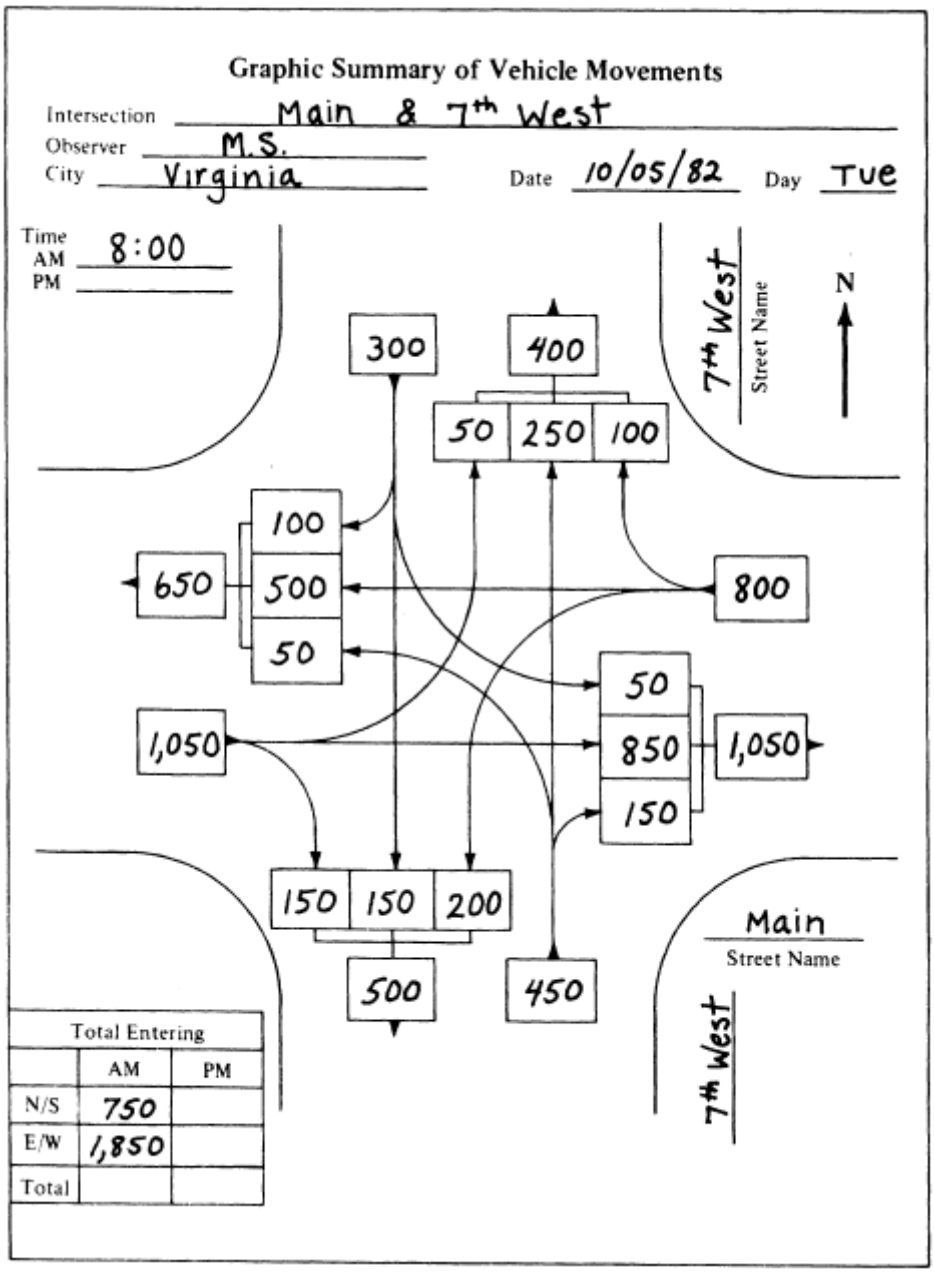
Manual Counts

Figure 1 – Manual Count Checklist

Project:_____
Count Location:_____
Date:_____
Time of Count:_____

____ 1. Check data collection equipment for proper operation and calibration
____ 2. Label the field equipment as needed
____ 3. Bring necessary accessory equipment (Batteries, flashlight, etc)
____ 4. Stopwatch
____ 5. Bring data collection forms and fill in as much data as possible before leaving the office.
____ 6. Extra pens and paper for taking notes
____ 7. Clipboard or writing surface
____ 8. Business cards of the engineer to contact and be prepared to answer the question "What are you doing here?"
____ 9. A map to the site
____ 10. Weather condition equipment (Sunscreen, umbrella, jacket or warm coat)
____ 11. Safety equipment (Flags, Signs, safety vests, or other reflective materials)

Intersection Summary Sheet



TABULAR SUMMARY OF VEHICLE COUNTS

Observer: _____ Date: _____ Day: _____ City: _____

R=Right Turn
S=Straight
L=Left Turn

Intersection of: _____ AND _____

Time Begins	from North				from South				TOTAL North/South	from East				from West				TOTAL East/West	TOTAL ALL
	R	S	L	TOTAL	R	S	L	TOTAL		R	S	L	TOTAL	R	S	L	TOTAL		

Field Considerations

- Everyone should be familiar with count procedure/labels/equipment
- Must have enough members in field to adequately record, provide relief, and to address safety concerns.
- Be prepared!!!
- Observer locations (manual studies).
- Count location (automatic studies).
- Be sure to secure equipment for automatic counts.
- Install equipment during very low volume time periods.
- Safety vests!

Count Periods

- 2 hours, peak period
- 4 hours, am/pm peak period
- 6 hours, am/midday/pm peak periods
- 12 hours daytime (7am-7pm)
- 24 hours, week, month, etc. (automatic)

Typical Peak Flow Traffic Hours

Land Use	Typical Peak Hours
Residential	7:00-9:00 am weekday 4:00-6:00 pm weekday
Regional Shopping center	5:00-6:00 pm weekday 2:30-3:30 pm Saturday 12:30-1:30 pm Saturday
Office	7:00-9:00 am weekday 4:00-6:00 pm weekday
Industrial	Varies
Recreational	Varies
Hospital	Varies based on shift changes
School	Varies based on school release times

Intersection Studies

- Typical 4-leg intersection has 12 separate movements
- Vehicles usually counted as they depart the intersection, but cannot do this when $D>Q_{cap}$
- Must record queue size

$$V_{ai} = V_{di} + N_{qi} - N_{qi-1}$$

V_{ai} = arrival volume in period i, vehs.

V_{di} = departure volume in period i, vehs.

N_{qi} = number of queued vehs at end of period i, vehs.

N_{qi-1} = number of queued vehs at end of period i -1, vehs.

Time Period	Total Departure Count (veh)	Queue Length (veh)	Arrival Volume (veh)
4:00-4:15 pm	50	0	50
4:15-4:30	55	0	55
4:30-4:45	62	5	62 + 5 = 67
4:45-5:00	65	10	65 + 10 - 5 = 70
5:00-5:15	60	12	60 + 12 - 10 = 62
5:15-5:30	60	5	60 + 5 - 12 = 53
5:30-5:45	62	0	62 - 5 = 57
5:45-6:00	55	0	55
	Total = 469		Total = 469

Specialized Counting Studies

Origin and destination counts
- Weaving areas.
- Freeway studies.
- Major activity centers.

Cordon counts
- Estimate vehicle and person accumulation within the cordon.
- Used to supplement O-D studies or for trend analysis.

Screen-line
- Record travel from one area to another.
- Used to adjust results of O-D studies.

For specialized counts, must have more than just count data.

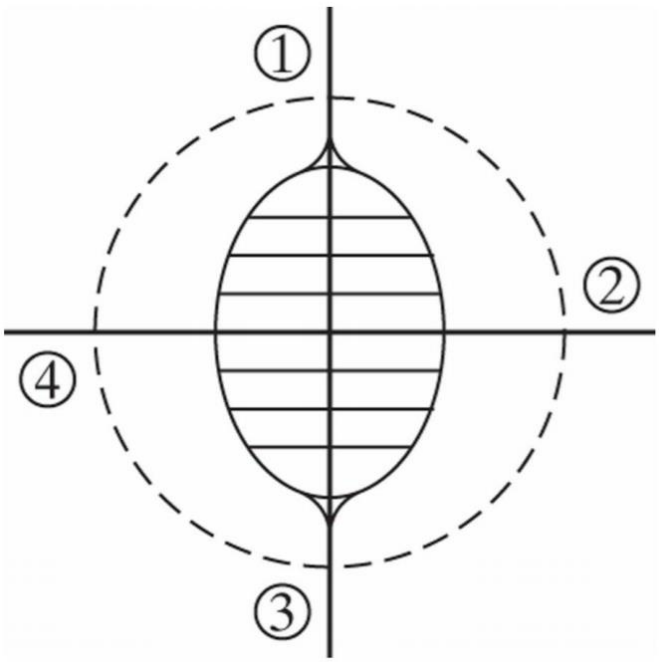
Types of Volume Studies

- Intersection counts (duration depends on the purpose, 15-minute intervals or shorter, turning volumes).
- Pedestrian counts (duration depends on the purpose, 5-minute intervals or longer).
- Cordon counts (one weekday + travelers' survey).
- Screen line counts (hourly counts for a weekday).
- Area wide counts.
  - Control counts (hourly counts with permanent stations).
  - Coverage counts (hourly counts for one or two days).

Origin-Destination Counts

- License plate studies
  - Recording license plates at entry and exit.
- Postcard studies
  - Handing out color coded post cards at entry points and collecting them at exit.
- Interview studies
  - Stopping vehicles and interviewing them about trip details.

O-D Counts Example



Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	50	8	20	17	**95**	250	2.63
2	10	65	21	10	**106**	310	2.92
3	15	12	38	15	**80**	200	2.50
4	13	14	18	42	**87**	375	4.31
T_i	**88**	**99**	**97**	**84**	**368**		
V_i	210	200	325	400		**1135**	
F_i	2.39	2.02	3.35	4.76			

(a) Field Data and Factors for Iteration 0

$$T_{ijN} = T_{ijN-1}\left(\frac{F_i + F_j}{2}\right)$$

F_i: Adjustment factor for origin i
F_j: Adjustment factor for origin j
T_{ijN}: Number of trips from station i to station j after Nth iteration
T_i: Sum of matched trips from station i
T_j: Sum of matched trips from station j
V_i: Observed total volume at Station i
V_j: Observed total volume at Station j

Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	125	19	60	63	**267**	250	0.94
2	27	161	66	38	**292**	310	1.06
3	37	27	111	54	**229**	200	0.87
4	44	44	69	191	**347**	375	1.08
T_i	**232**	**251**	**306**	**346**	**1135**		
V_i	210	200	325	400		**1135**	
F_i	0.90	0.80	1.06	1.16			

(b) Initial Expansion of O-D Matrix (Iteration 0)

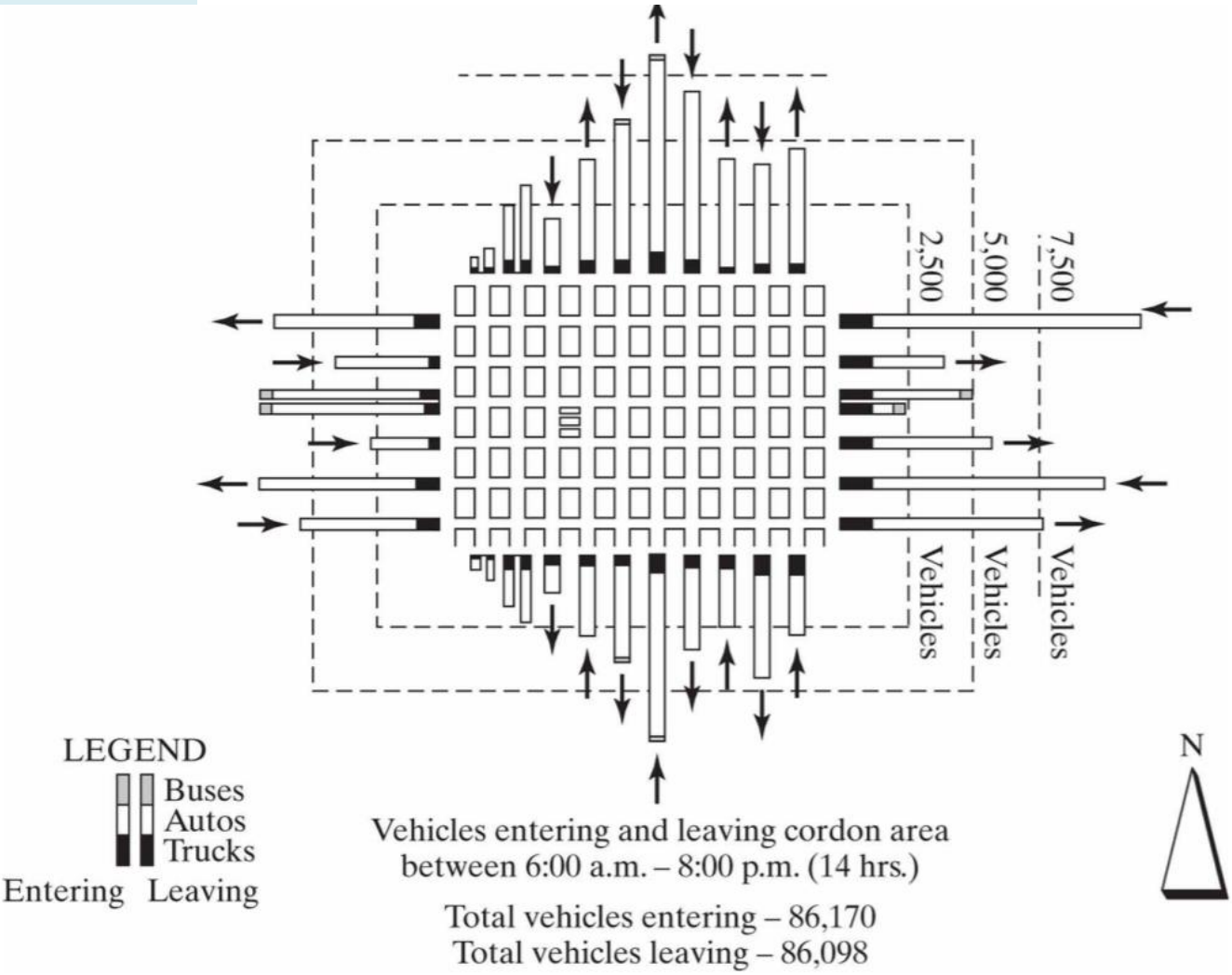
Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	116	16	60	66	**257**	250	0.9
2	26	150	70	43	**288**	310	1.0
3	33	23	108	55	**218**	200	0.9
4	43	42	74	213	**372**	375	1.0
T_i	**217**	**230**	**311**	**376**	**1135**		
V_i	210	200	325	400		**1135**	
F_i	0.97	0.87	1.04	1.06			

(c) First Iteration of O-D Matrix

Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	112	15	60	67	**254**	250	0.98
2	27	145	74	46	**292**	310	1.06
3	31	20	105	55	**211**	200	0.95
4	43	39	76	221	**378**	375	0.99
T_i	**212**	**220**	**316**	**388**	**1135**		
V_i	210	200	325	400		**1135**	
F_i	0.99	0.91	1.03	1.03			

(d) Second Iteration of O-D Matrix

Cordon Counts



Screen-Line Counts