



# Highway Traffic and Safety Analyses

## Lecture 6: Traffic Volume Variability and Studies

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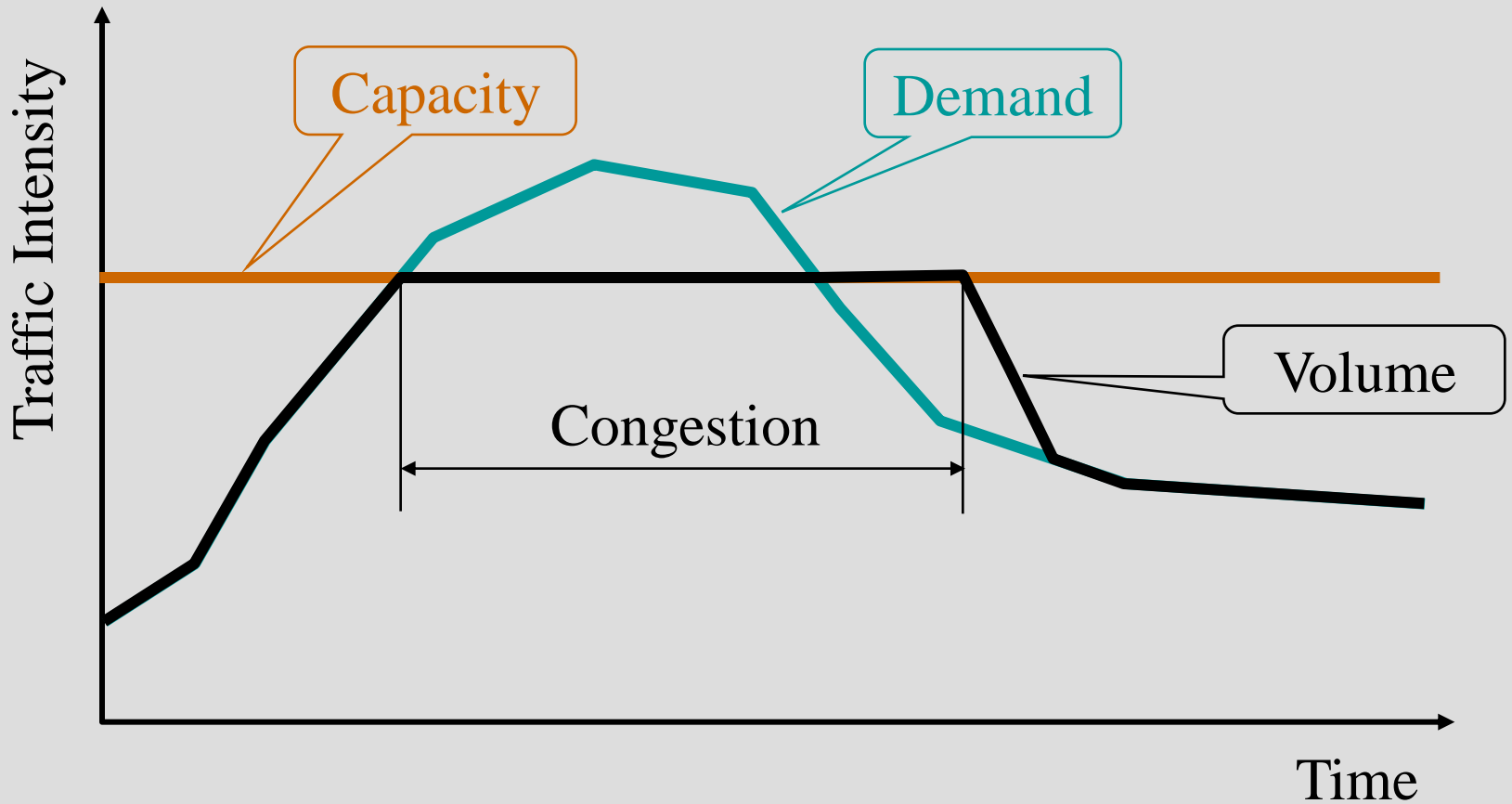
# Lecture Outline

- Definitions
- Volumes variability
- Estimation of AADT
- Design volume
- Counting techniques
- Types of volume studies

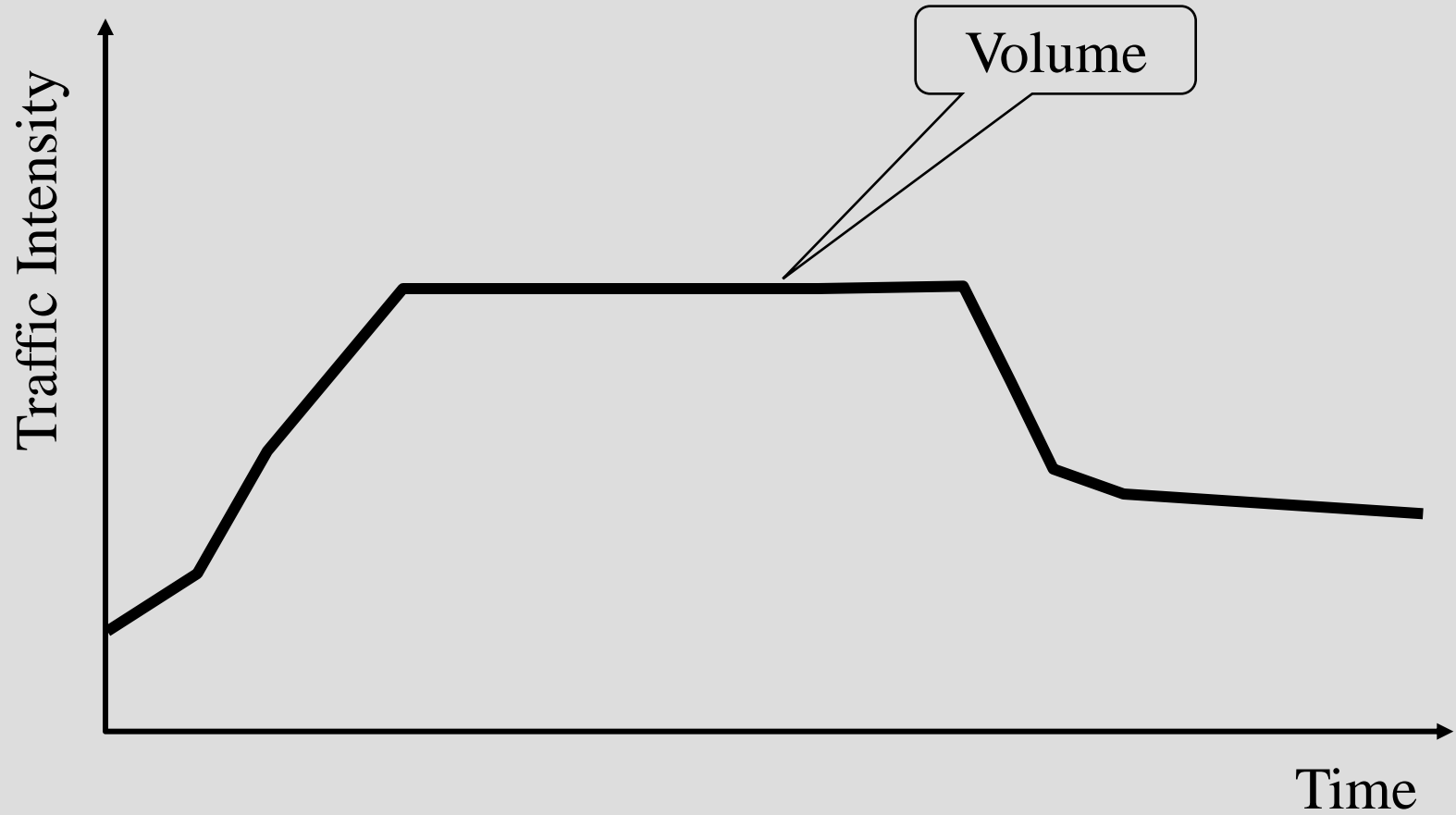
# Definitions

- **Count** – number of vehicles/travelers passing a highway spot in a counting period
- **Volume** – number of vehicles/travelers passing a highway spot per unit time
- **Capacity** – maximum and repeatable volume of vehicles/travelers
- **Demand** – volume not influenced by highway capacity

# Definitions



# Definitions



# AADT vs. ADT

- AADT = Annual Average Daily Traffic (veh/day)
- ADT = Average Daily Traffic (veh/day) represents periods other than a year
- Weekly ADT, Monthly ADT

# Seasonal Variability of Monthly ADT

Counts in August on a rural road have given August Monthly ADT = 10,000 veh/h

What is Annual ADT?

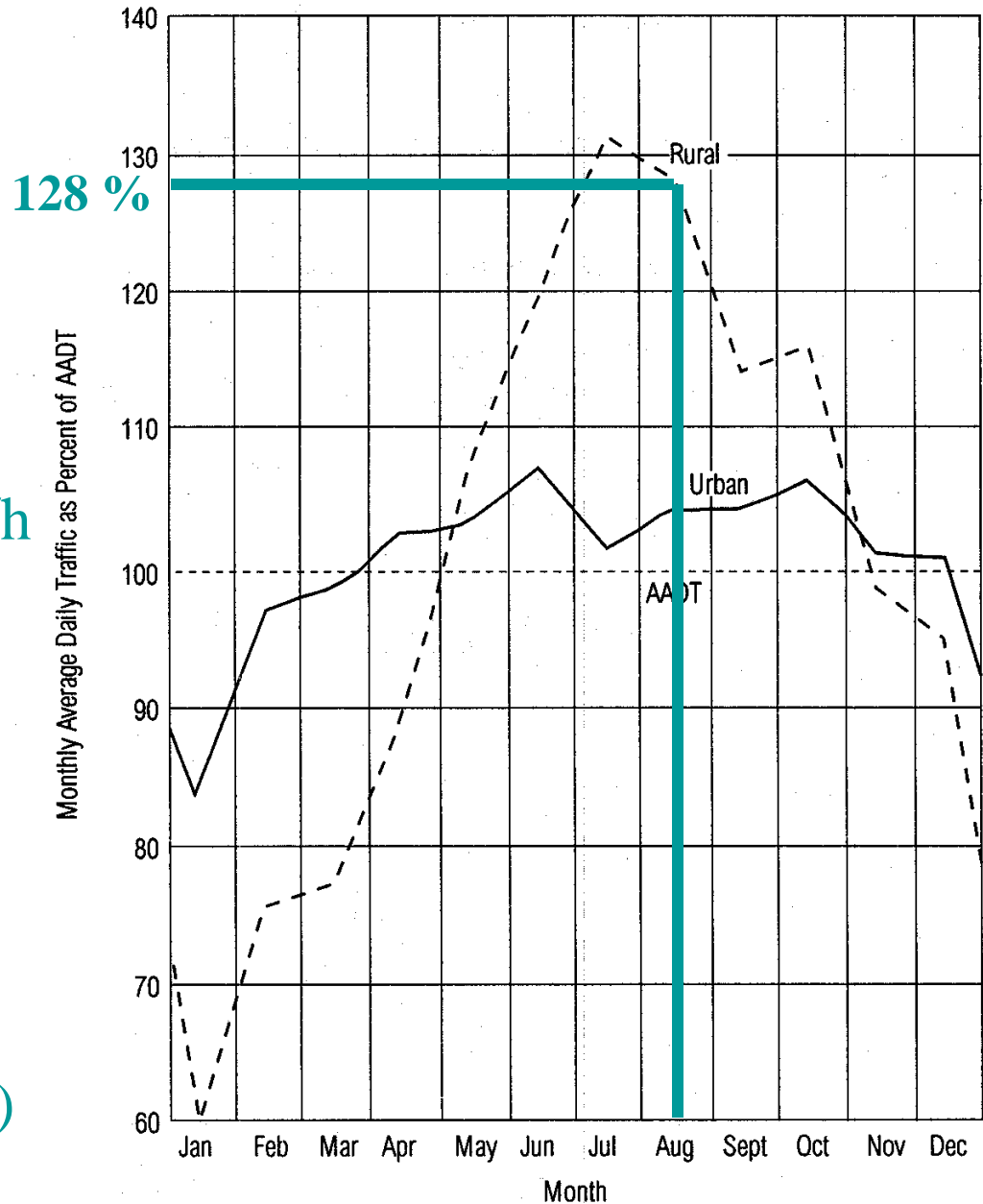
$$\text{AADT} = 10,000 \cdot (1/1.28)$$

$$= 10,000 \cdot 0.781$$

$$\text{AADT} = 7,810 \text{ veh/day}$$

0.781 = Seasonal Factor (SF)

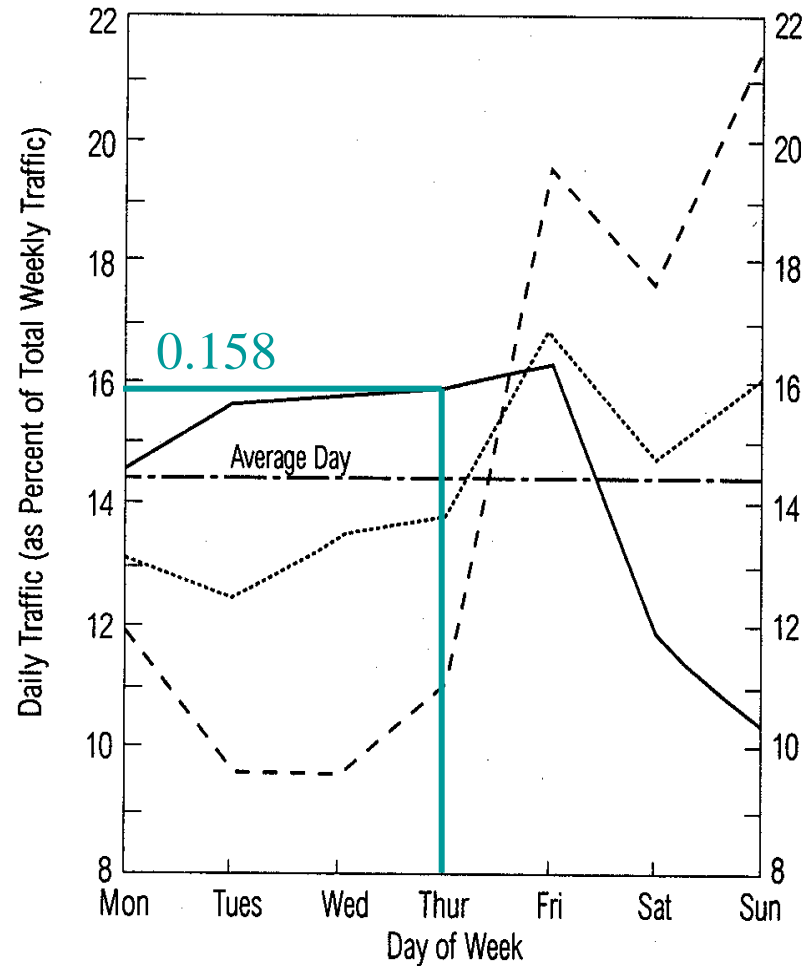
EXHIBIT 8-3. EXAMPLES OF MONTHLY TRAFFIC VOLUME VARIATIONS FOR THE SAME INTERSTATE HIGHWAY (RURAL AND URBAN SEGMENTS)



Source: Muranyi (2).

# Weekly Variability of Daily Volumes

EXHIBIT 8-4. EXAMPLES OF DAILY TRAFFIC VARIATION BY TYPE OF ROUTE



- ..... 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.

Thursday daily traffic on a suburban arterial =

30,000 veh/day

Weekly ADT = ?

$$= 30,000 \cdot (1/0.158/7) =$$

$$= 30,000 \cdot 0.904 =$$

Weekly ADT = 27,100 veh/day

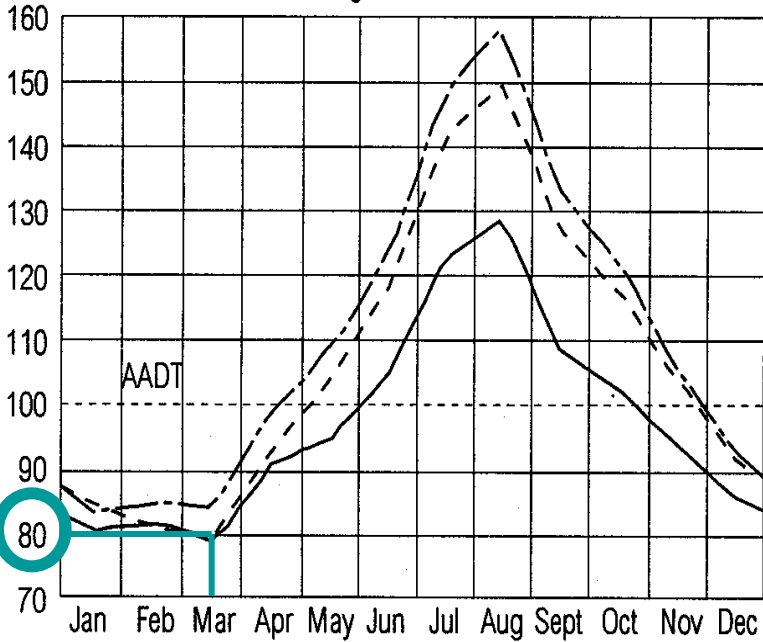
0.904 = Weekly Factor (WF)

**Weekly ADT  $\approx$  Monthly ADT**



EXHIBIT 8-2. EXAMPLES OF MONTHLY TRAFFIC VOLUME VARIATIONS FOR A FREEWAY

Routes with Significant Recreational Traffic



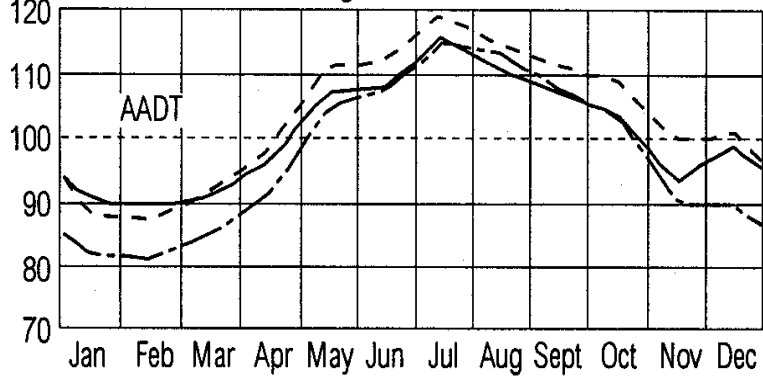
Counts in average weekday in March, recreational road, in Minnesota,

March Weekday ADT = 20,000 veh/day

AADT=?

# Seasonal and Weekly Variability of Daily Volumes

Routes with Significant Business Traffic



$$AADT = 20,000 \cdot (1/0.80) = 20,000 \cdot 1.25$$

$$AADT = 25,000 \text{ veh/day}$$

$$1.25 = WF \cdot SF$$

Source: Minnesota Department of Transportation.

# Daily Variability of Hourly Traffic

Vehicle counts on a local road on Wednesday between 4-7 PM gave total 2,350 vehicles

Wednesday ADT = ?

Counting Hour	Percent of Daily Traffic
4-5	8.5
5-6	10.6
6-7	6.0
Total	25.1

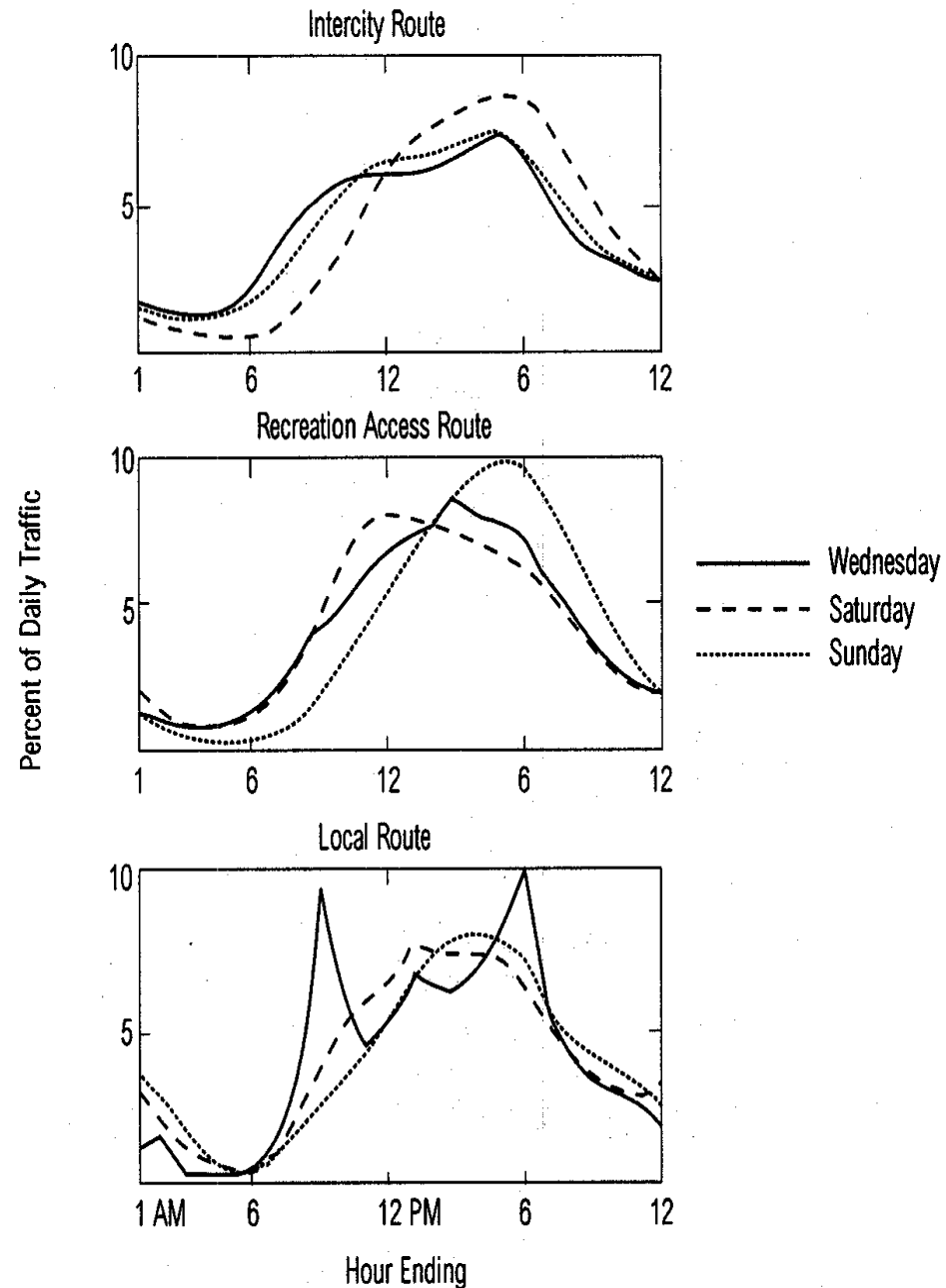
Wednesday ADT =

$$2,350 \cdot (1/0.251) = 2,350 \cdot 3.98$$

$$= 9,360 \text{ veh/h}$$

$$3.98 = \text{Daily Factor (DF)}$$

EXHIBIT 8-6. EXAMPLES OF HOURLY TRAFFIC VARIATIONS FOR RURAL ROUTES



Source: *Transportation and Traffic Engineering Handbook* (3).

# AADT Estimation with Short Counts

$$AADT = V \cdot DF \cdot WF \cdot SF$$

where:

AADT = Annual Average Daily Traffic,

V = count in veh,

DF = Daily Factor,

WF = Weekly Factor,

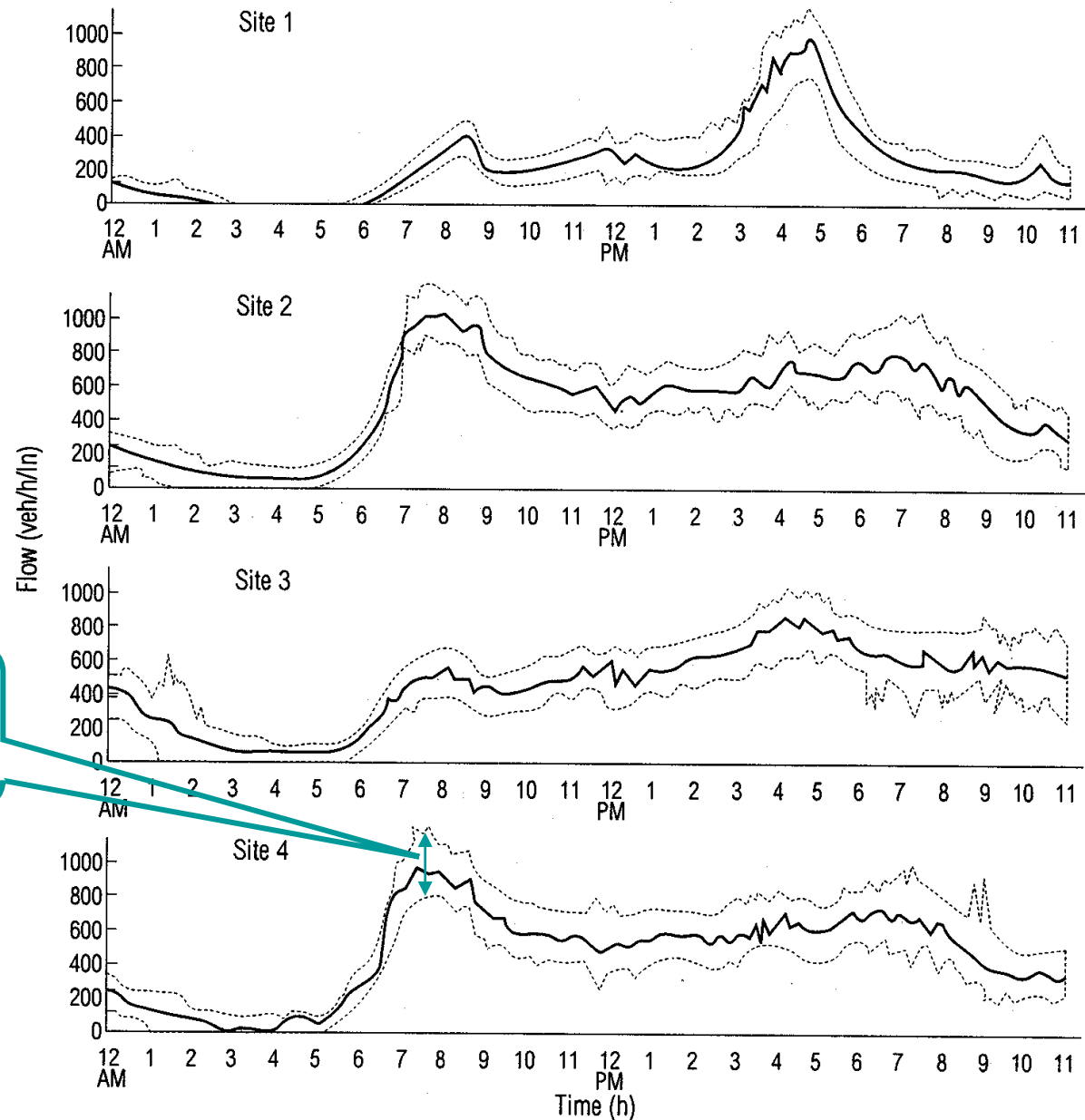
SF = Seasonal Factor,

More than one day of counting (three days) and extended count periods each day are recommended

# Day-to-day Variability of Daily Profile

95% of  
volumes

EXHIBIT 8-7. REPEATABILITY OF HOURLY TRAFFIC VARIATIONS FOR URBAN STREETS



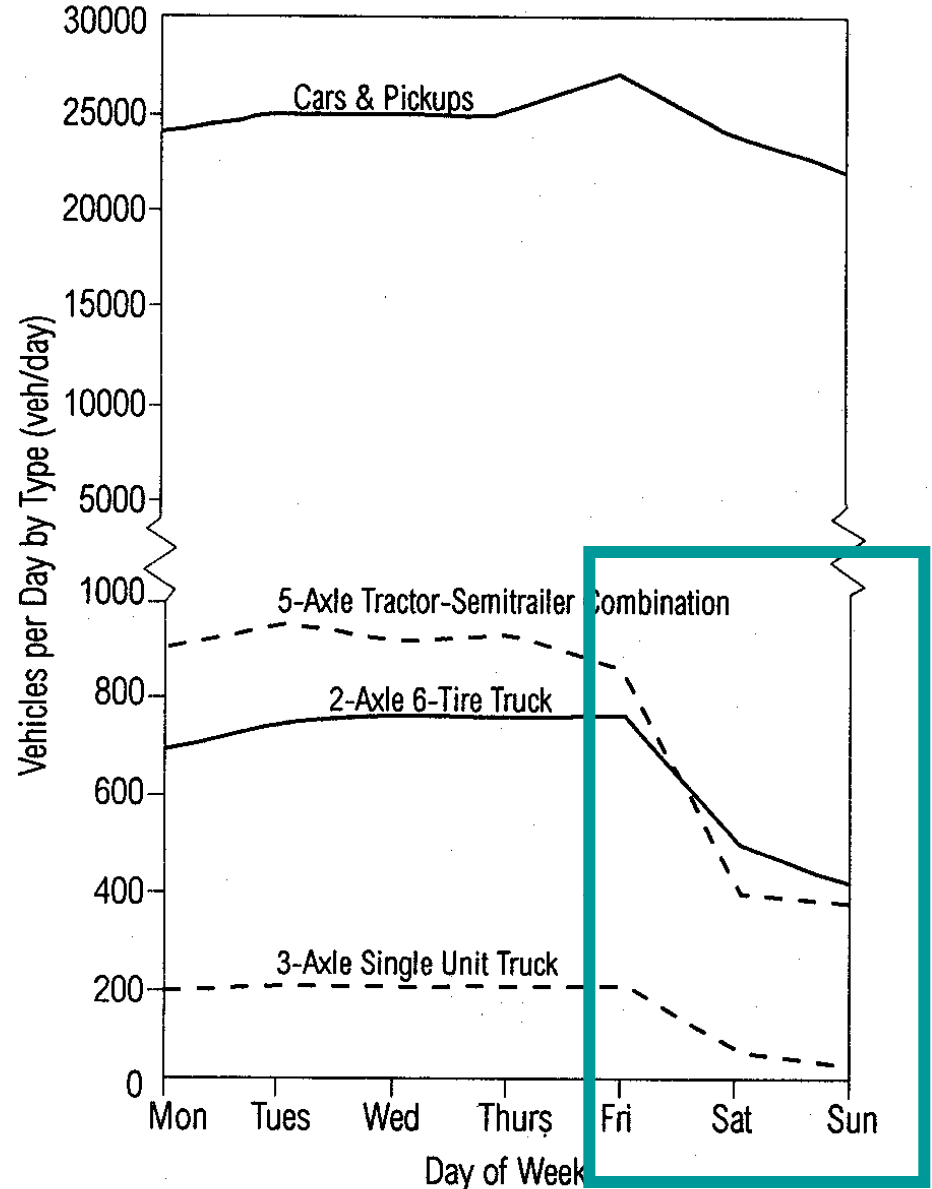
Note:

- a. Sites 2 and 4 are one block apart on same street, in same direction.
- b. All sites are two moving lanes in one direction.

Source: McShane and Crowley (4).

# Within-Week Variability of Daily Flow Composition

EXHIBIT 8-5. DAILY VARIATION IN TRAFFIC BY VEHICLE TYPE FOR RIGHT LANE OF AN URBAN FREEWAY



Data were collected on I-494, 4 lanes, in Minneapolis-St. Paul.  
Source: Minnesota Department of Transportation.

# AADT Estimation - Exercise

- Vehicle counts have been conducted in mid March on Thursday between 3 and 5 PM.
- Known:
  - Total count  $V=2,000$  veh,
  - Volume between 3 and 4 PM equals 6 % of daily traffic
  - Volume between 4 and 5 PM equals 7 % of daily traffic
  - Thursday daily traffic equals 16 % of weekly traffic
  - March daily traffic equals 98 % of AADT
- Calculate
  - Daily Factor DF
  - Weekly Factor WF
  - Seasonal Factor SF
  - AADT

# AADT Estimation - Exercise

- **DF**

$$DF = 1/(\text{Proportion of Daily Traffic})$$

$$DF = 1/(0.06+0.07) = 7.69$$

- **WF**

$$WF = 1/(\text{Proportion of Weekly Traffic})/7$$

$$WF = 1/0.16/7 = 0.89$$

- **SF**

$$SF = 1/(\text{Proportion of AADT})$$

$$SF = 1/0.98 = 1.02$$

- **AADT**

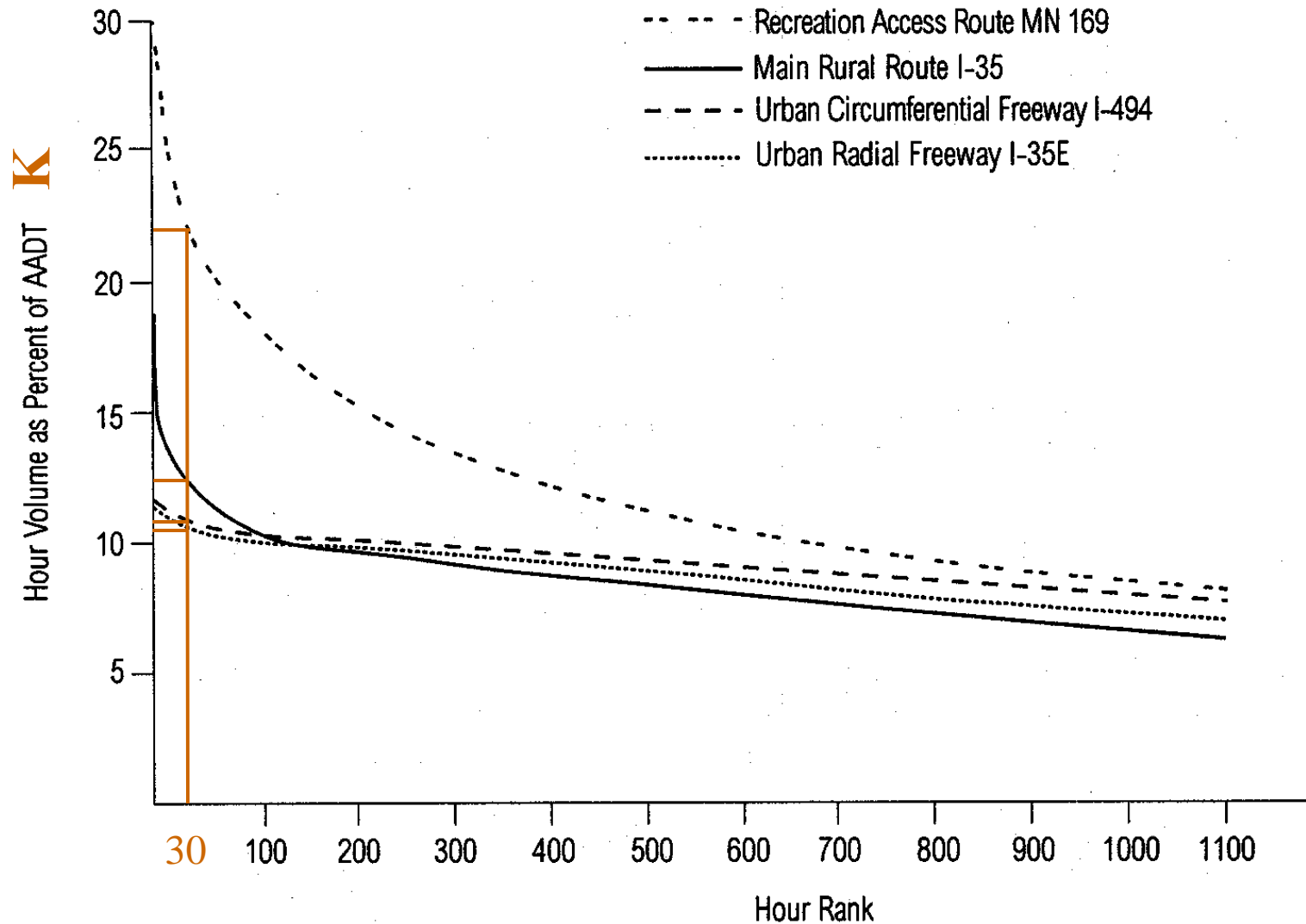
$$AADT = V \cdot DF \cdot WF \cdot SF$$

$$V = 2,000 \text{ vehicles}$$

$$AADT = 2,000 \cdot 7.69 \cdot 0.89 \cdot 1.02 = 13,800 \text{ veh/day}$$

# Design Volume Definition

EXHIBIT 8-8. RANKED HOURLY VOLUMES



Source: Minnesota Department of Transportation.



# Design Volume Estimation Using Factor K

$$\text{DHV} = \text{AADT} \cdot \mathbf{K} \cdot \text{D}$$

- AADT in the horizon year (veh/day)
- K = proportion of AADT during the 30th rank hour (other ranks may be used too)
- D = directional split (busier direction)

# Design Volume Estimation Using Factor K

EXHIBIT 8-9. TYPICAL K-FACTORS

Area Type	K-Factor
Urbanized	0.091
Urban	0.093
Transitioning/Urban	0.093
Rural Developed	0.095
Rural Undeveloped	0.100

Source: Florida Department of Transportation (7).

EXHIBIT 8-11. DIRECTIONAL DISTRIBUTION CHARACTERISTICS

Highest Hour of the Year	Percentage of Traffic in Peak Direction		
	Type of Facility		
	Urban Circumferential	Urban Radial	Rural
1st	53	66	57
10th	53	66	53
50th	53	65	55
100th	50	65	52

Source: Minnesota Department of Transportation.

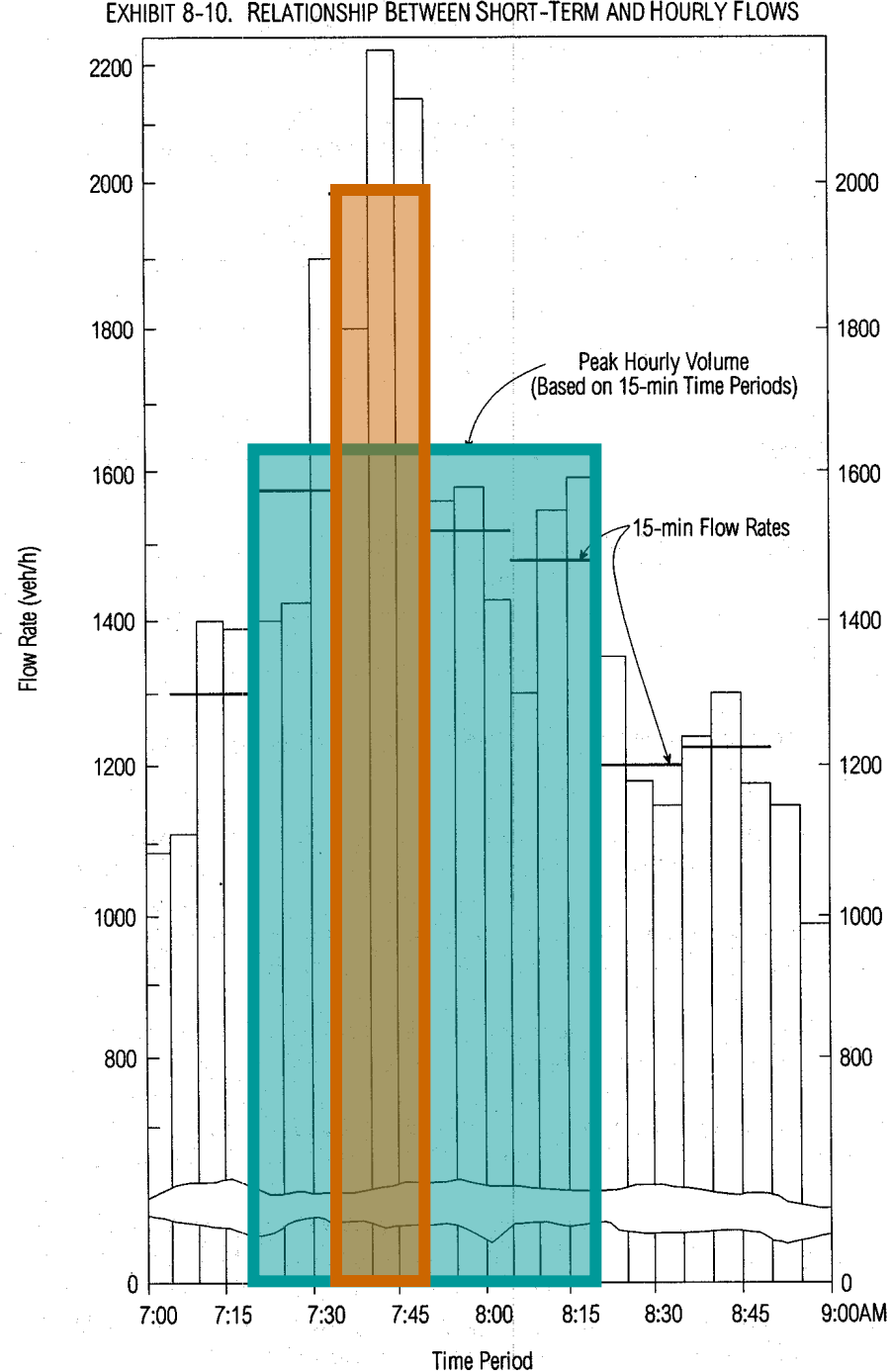
# Alternative Estimation of Design Volume

1. Estimate  $AADT_1$  for the year with available vehicle counts,  
 $AADT_1 = V \cdot DF_1 \cdot WF_1 \cdot SF_1$
2. Predict  $AADT_2$  for the future year using a growth factor  
 $AADT_2 = AADT_1 \cdot GF$
3. Select month, day of week, and hour in the future year when the volume is likely to be close to the design volume
4. Convert the predicted  $AADT_2$  to the hourly volume for the hour selected in step 3,  $DHV = AADT_2 / DF_2 / WF_2 / SF_2$

or  $DHV = V \cdot (DF_1 / DF_2) \cdot (WF_1 / WF_2) \cdot (SF_1 / SF_2) \cdot GF$

# Short-Term Volume Variability

Traffic performance is checked for the worst 15 minutes of the design hour



Source: Minnesota Department of Transportation.

# Peak Hour Factor

## Estimation of PHF

$$\text{PHF} = \text{Hourly Count} / (4 \cdot \text{Highest 15-min Count})$$

## Use of PHF

$$\text{Peak Volume Rate} = \text{DHV} / \text{PHF}$$

# 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)

# Counting Techniques

- Manual counting
  - For one day or less
  - Turning volumes, pedestrians, test counts
  - Pencil and paper
  - Electronic manual recorders
- Machine counting
  - For longer counting periods: one day or longer
  - Permanent stations (inductive loops, WIM)
  - Portable stations (pneumatic, inductive, magnetic, video, etc.)

# Origin-Destination Studies

- External (on the road)
  - Cordon studies
  - Roadside interviews
  - Postcard studies
  - License plate studies
  - Tag-on vehicle method
  - Lights-on studies
  - Transit passenger questionnaire



# Origin-Destination Studies

- Internal (off the road)
  - Dwelling unit interviews
  - Vehicle owner mail questionnaires
  - Interview at traffic generators (workplace, etc)
  - Truck and taxi surveys