Traffic Engineering Fundamentals

Session 1 – Traffic Data and Studies

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Course Objectives:

- Introduce the fundamental concepts of traffic engineering
- Introduce some of the terminology commonly used in traffic engineering
- Point to resources that are available to learn more about the topic

Let me learn about you…

Question – How many years of experience do you have?

Let me learn about you…

Question – What is your field of practice?

Traffic Engineering Fundamentals

Introduction

Definitions:

- Transportation Engineering
  - The application of technology and scientific principles to the planning, design, operation, and management of facilities for any mode of transportation in order to provide for the safe, rapid, comfortable, convenient, economical and environmentally compatible movement of people and goods.

Definitions:

- Traffic Engineering
  - That phase of transportation engineering which deals with the planning, geometric design and traffic operations of roads, streets and highways, their networks, terminals, abutting lands, and relationships with other modes of transportation.

Traffic Engineering

- Transportation Planning
  - Demand Modeling
    - Predicting Travel
  - Influencing Demand
    - Designing System

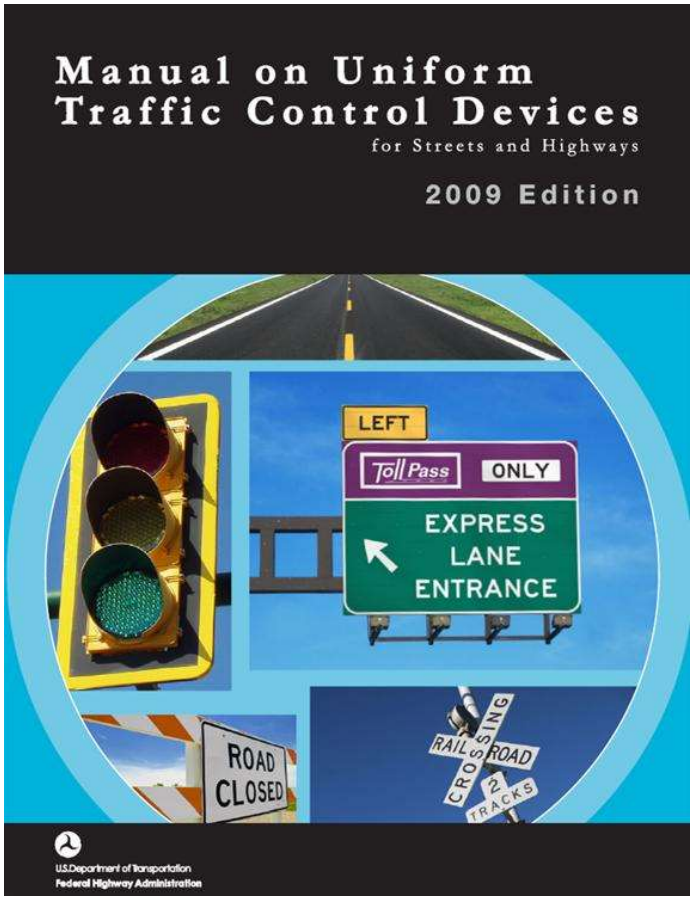
- Traffic Design & Operations
  - Moving People & Goods
    - Operations
    - Safety
    - Efficiency

Traffic Engineering

- Access Management
  - Mobility through policy
  - Implement and maintain
- Site Impact
  - Development pressures
  - Impact analysis and fees
- Capacity
  - Measuring performance
  - Quantifying impacts
  - Setting thresholds
- Operations
  - Traffic control devices
  - Signals and systems

References - MUTCD

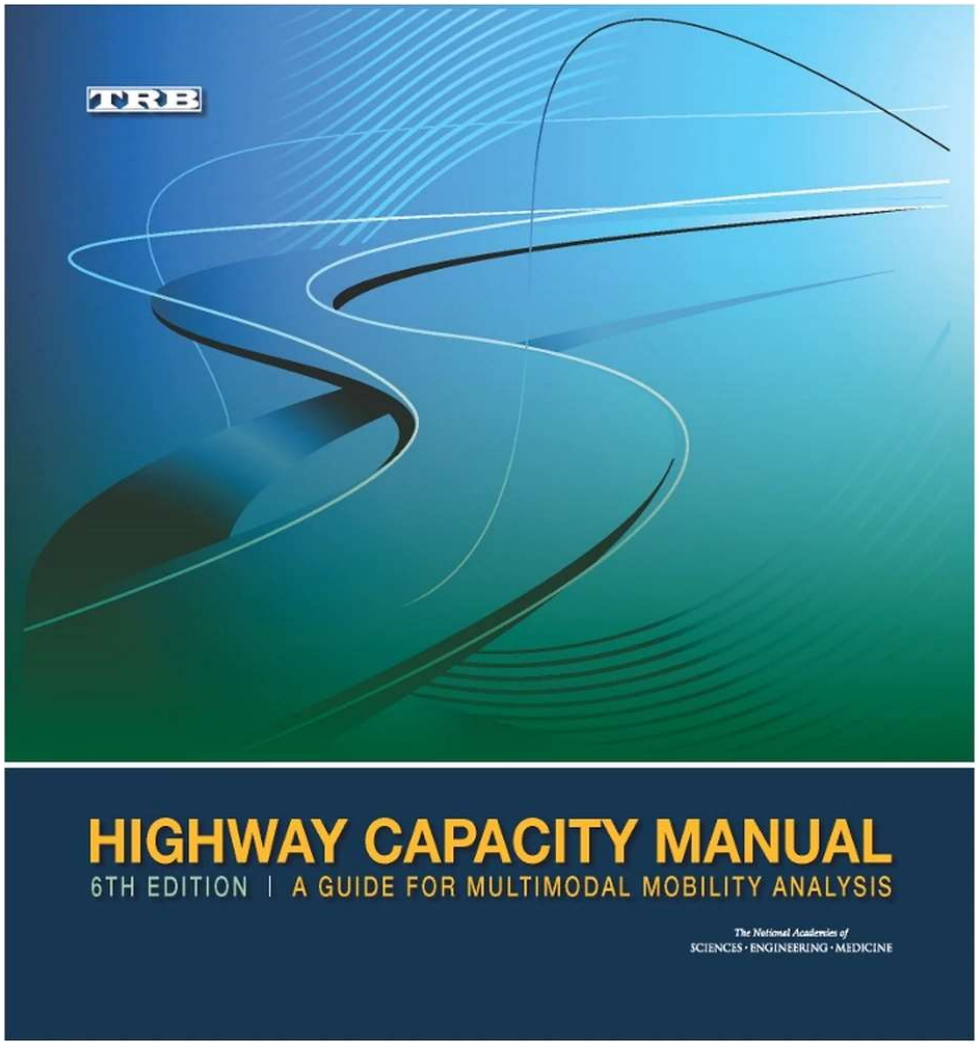
Manual on Uniform Traffic Control Devices



FREE Download:

https://mutcd.fhwa.dot.gov/

References – Highway Capacity Manual



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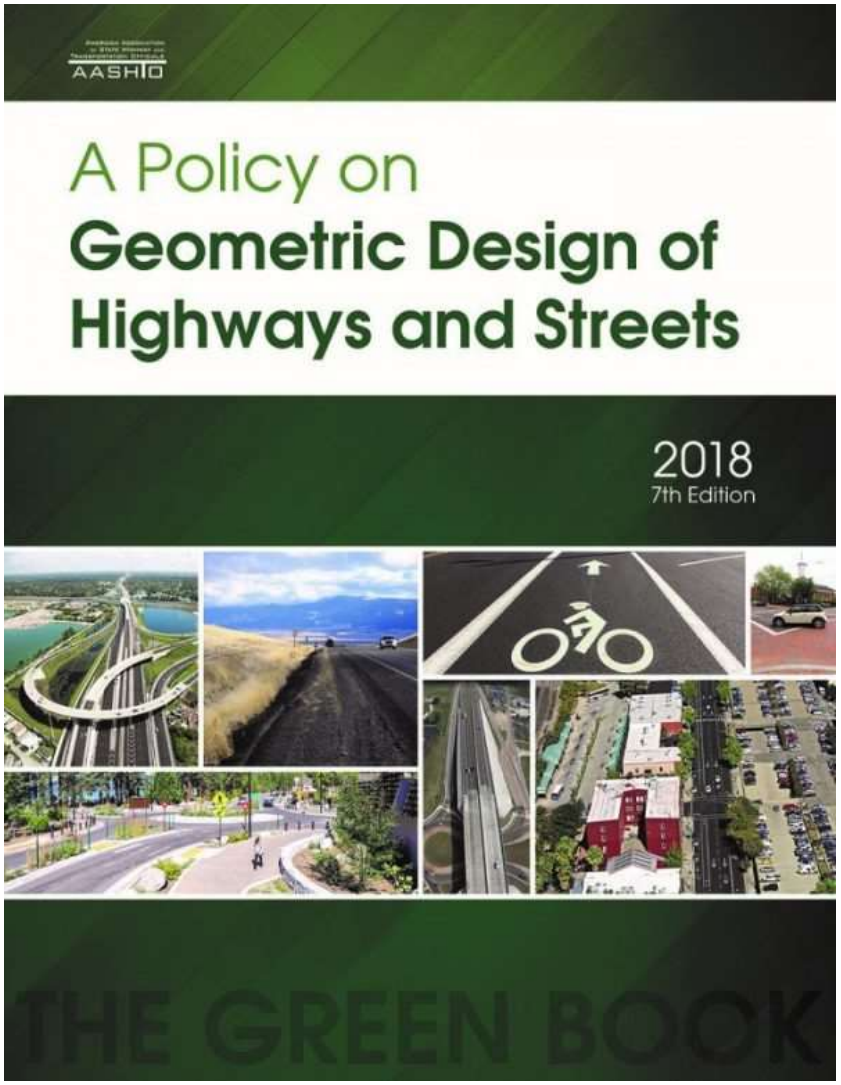
References – AASHTO Green Book



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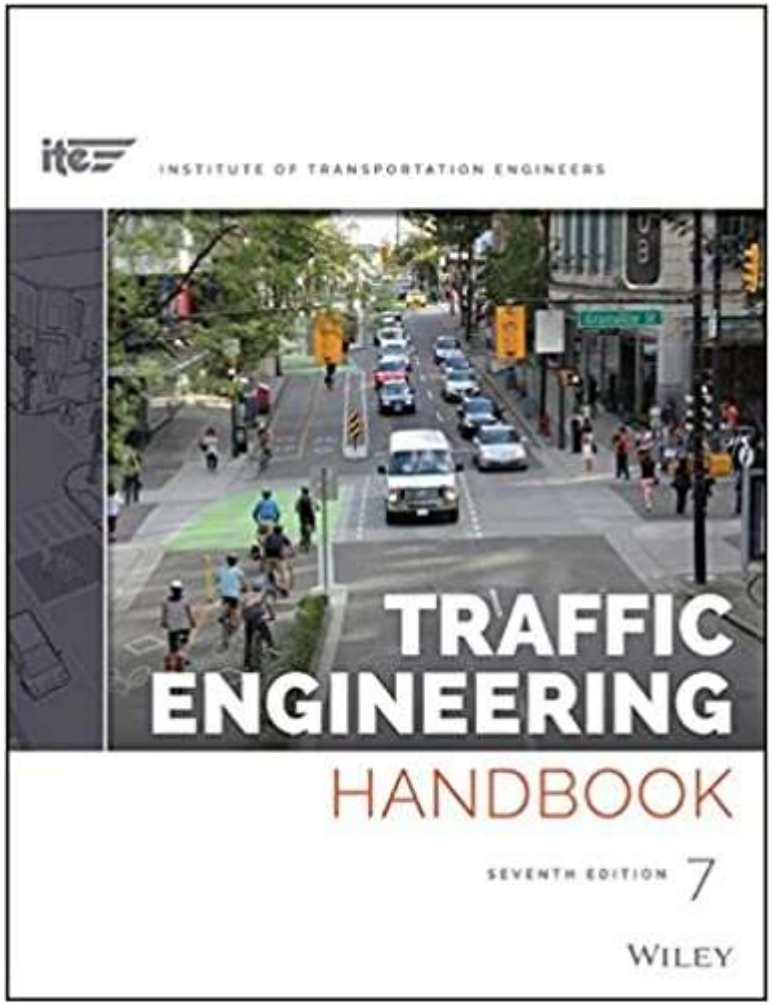
References – ITE Traffic Engineering



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References – ITE Transportation Studies

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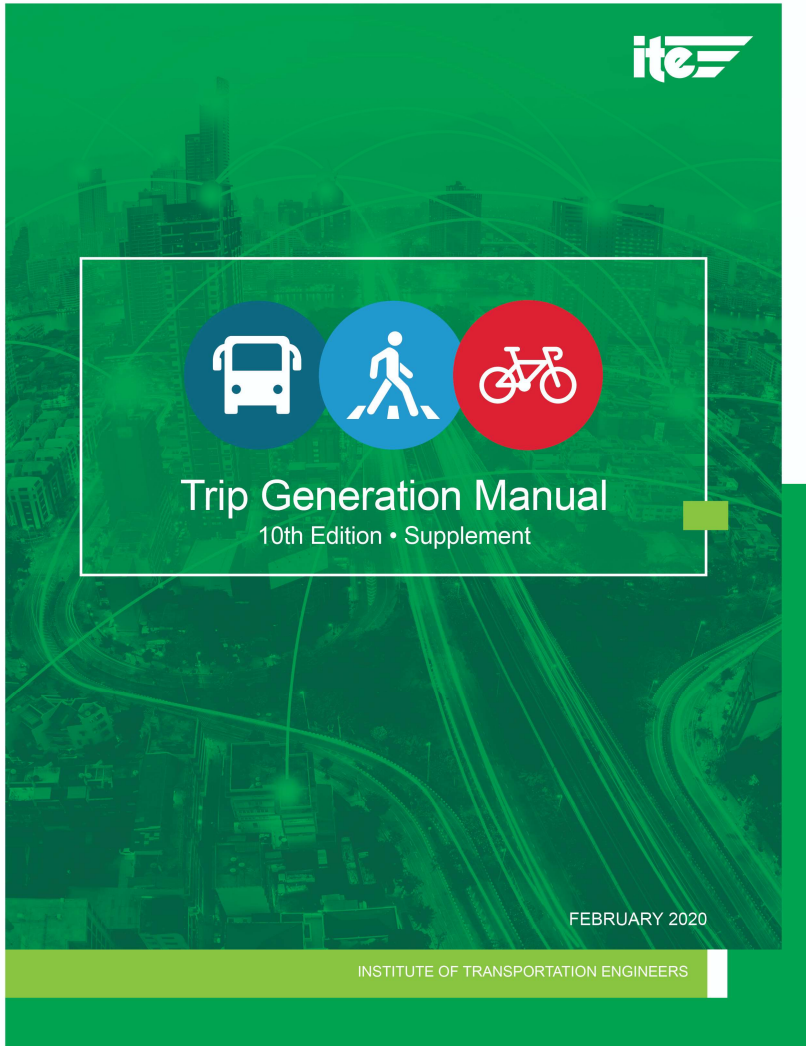
References – ITE Trip Generation



FREE Download:

References – FDOT Standard Plans

FDOT

FY 2020-21 STANDARD PLANS
FOR ROAD CONSTRUCTION

Effective for Projects with Lettings in the Fiscal Year (FY) from
July 1, 2020 through June 30, 2021

FY 2020-21 Standard Plans for
Road and Bridge Construction
Topic No. 625-010-003

State of Florida Department of Transportation
Office of Design
Mail Station 32
605 Suwannee Street
Tallahassee, Florida 32399-0450

FREE Download:

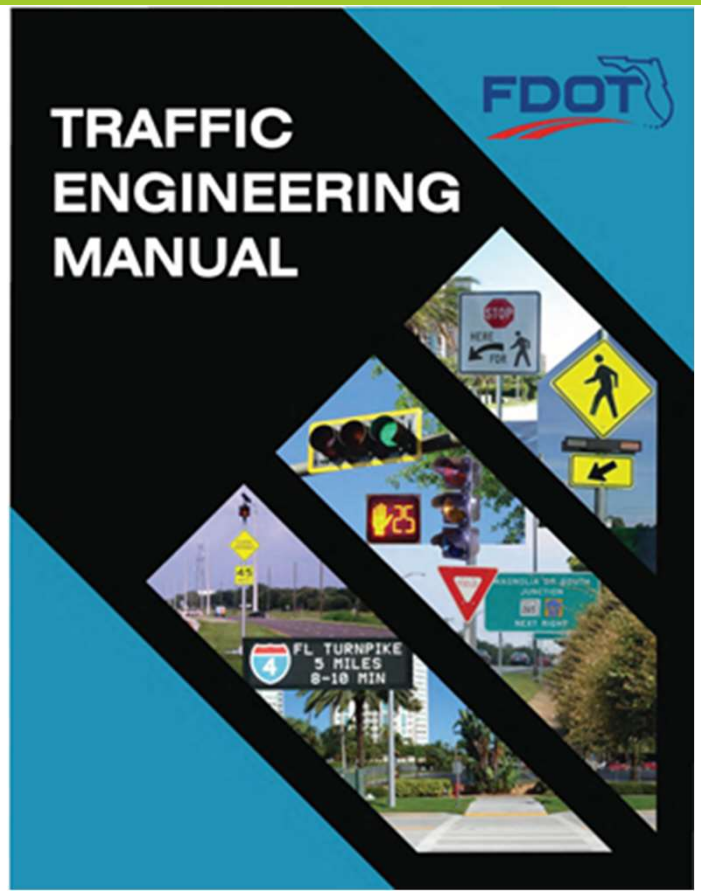
https://www.fdot.gov/design/standardplans/

References – FDOT Design Manual

FREE Download:

https://www.fdot.gov/roadway/fdm/default.shtm

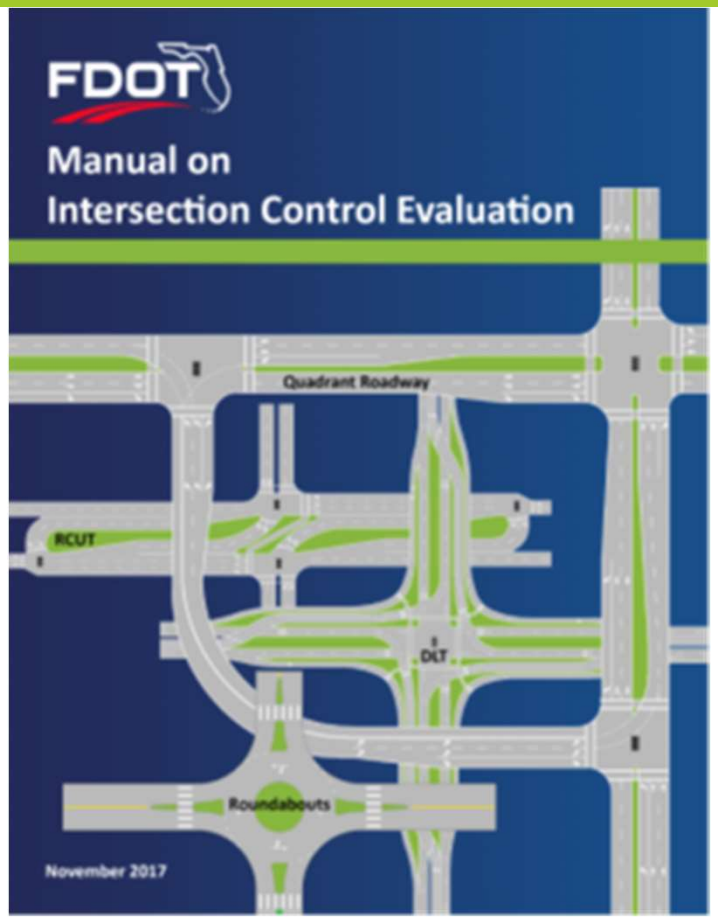
References – FDOT Traffic Engineering



FREE Download:

https://www.fdot.gov/traffic/TrafficServices/Studies/TEM/TEM.shtm

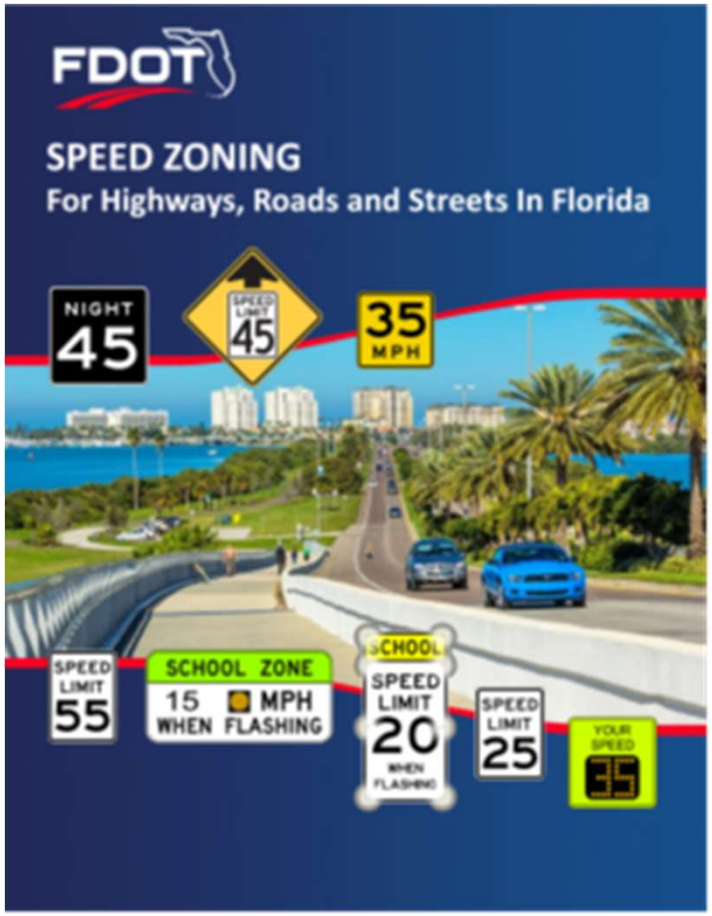
References – FDOT ICE Manual



FREE Download:

https://www.fdot.gov/traffic/trafficservices/intersection-operations.shtm

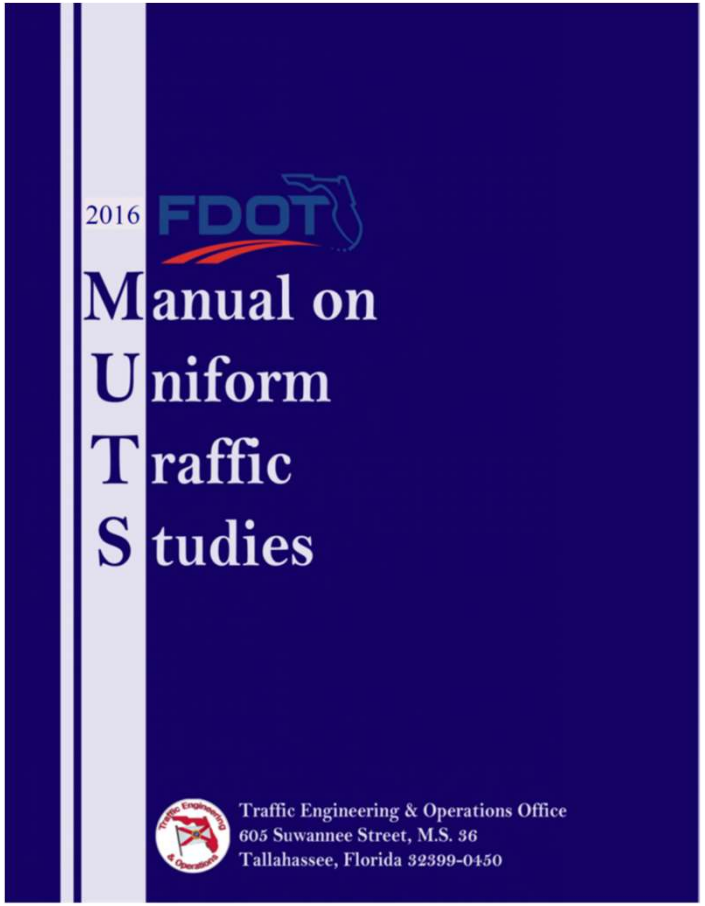
References – FDOT Speed Zoning Manual



FREE Download:

https://www.fdot.gov/traffic/speedzone/Speed-Zone-Manual.shtm

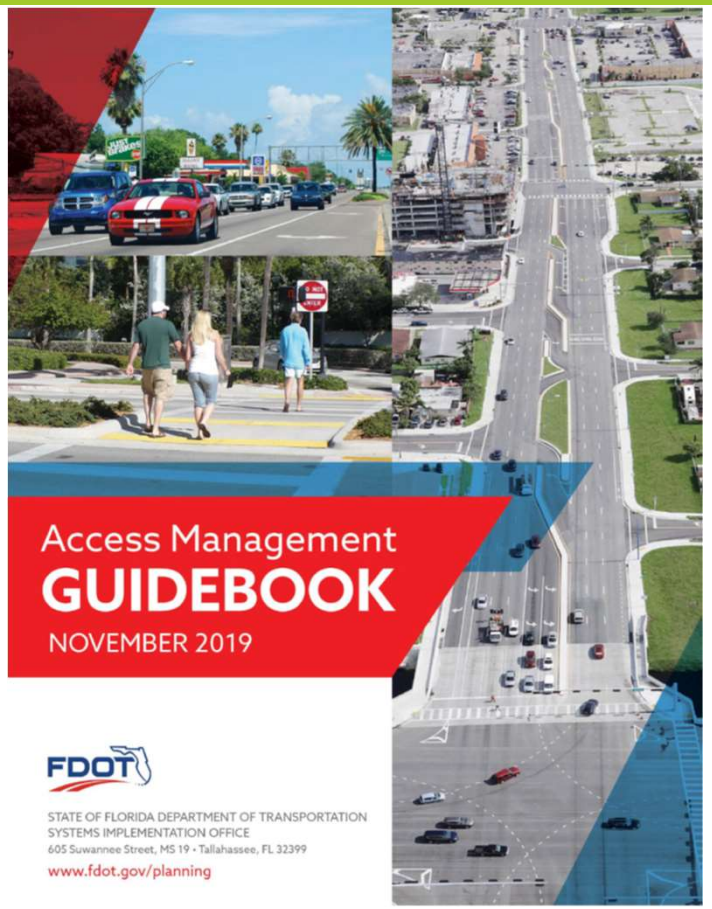
References – FDOT MUTS Manual



FREE Download:

https://www.fdot.gov/traffic/TrafficServices/Studies/MUTS/MUTS.shtm

References – FDOT Access Management



FREE Download:

https://www.fdot.gov/planning/systems/programs/sm/accman/default.shtm

References – FDOT Quality/LOS Handbook

FREE Download:

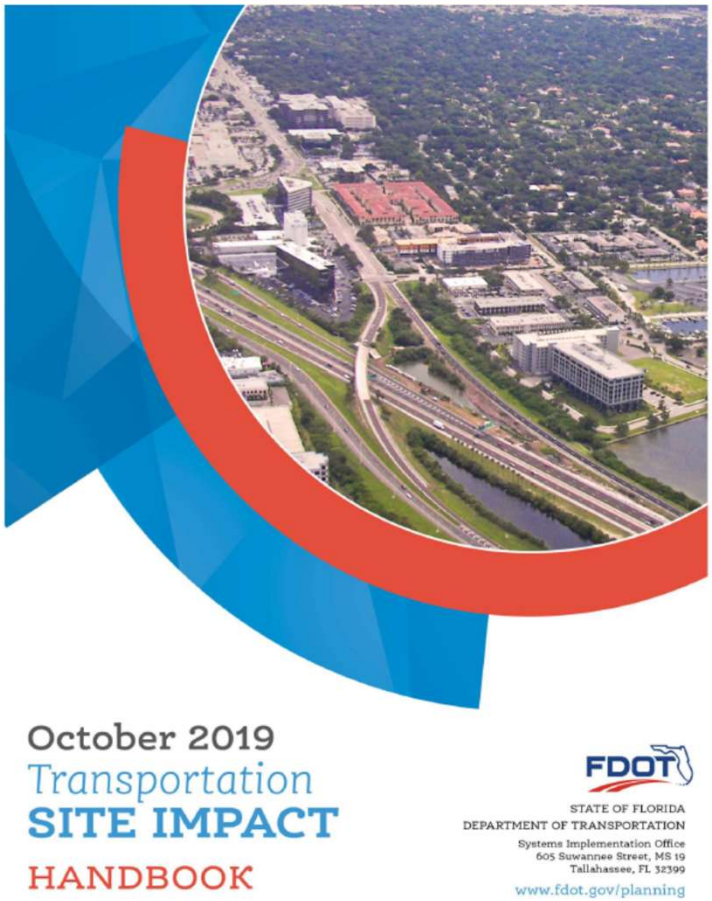
https://www.fdot.gov

References – FDOT Project Traffic Forecast

FREE Download:

https://www.fdot.gov/planning/systems/documents/sm/default.shtm

References – FDOT Project Traffic Forecast



FREE Download:

https://www.fdot.gov/planning/systems/documents/sm/default.shtm

Questions?

Traffic Volumes

Traffic Engineering Fundamentals

Common Traffic Volume Acronyms

- AADT
- DDHV
- PHF
- TMC
- VPH

Volume Studies

- Current Volumes
  - Operational Design
  - Usually Turning Movements

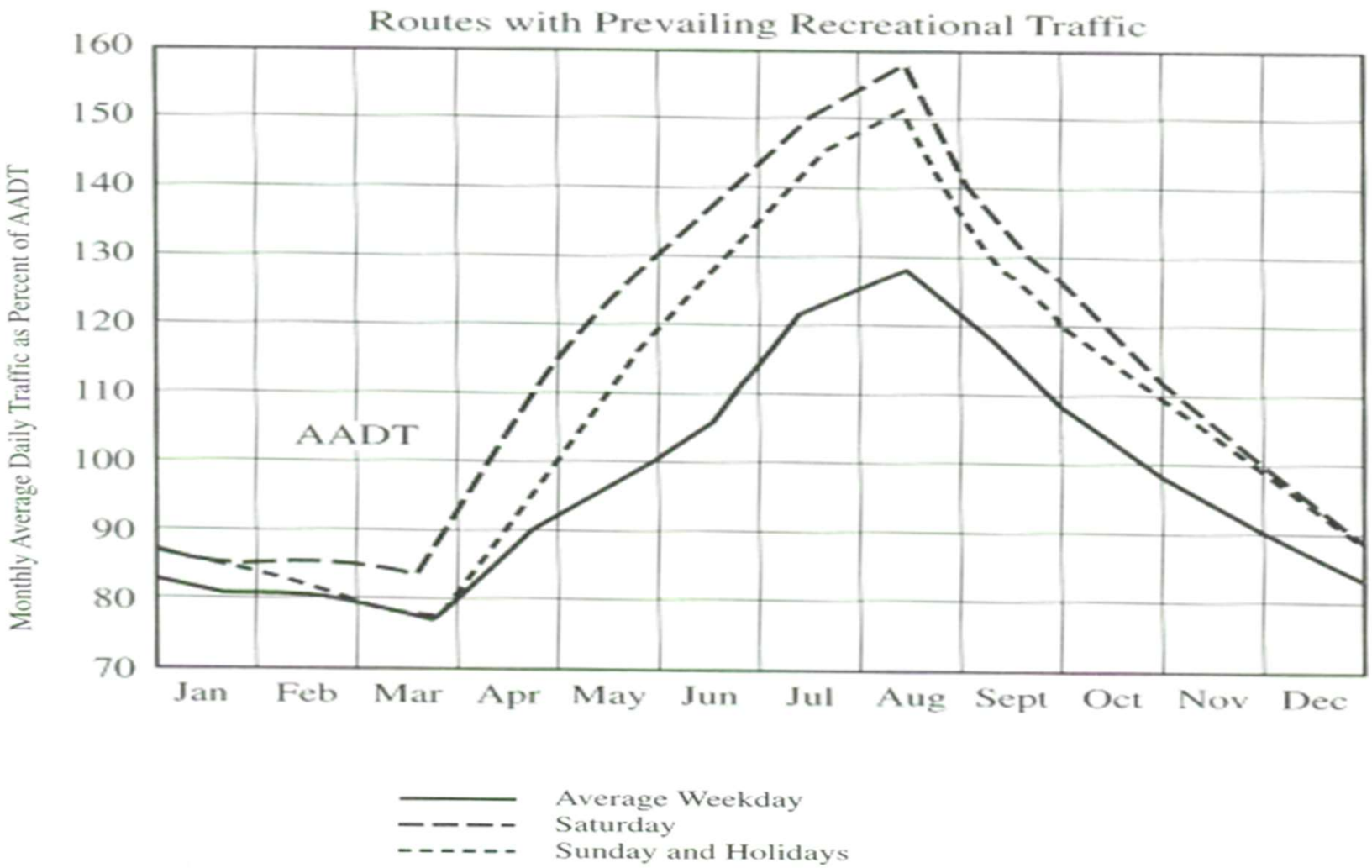
- Projected Volumes
  - Planning Decisions
  - Usually Link Information

AADT – Annual Average Daily Traffic

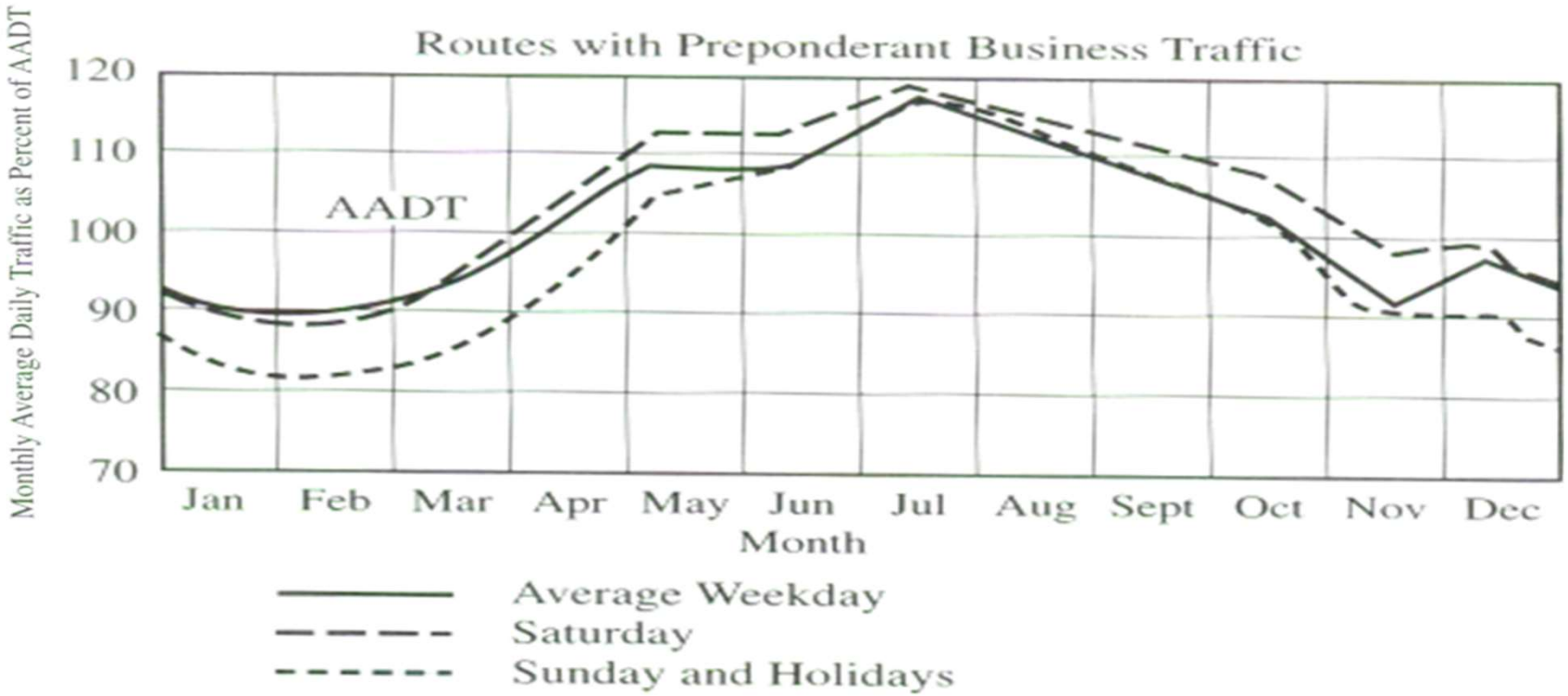
- Annual Average Daily Traffic (AADT) is the total number of vehicles that pass a point in the roadway over the course of a year divided by the number of days in that year (366 for 2020)

- Monthly and seasonal variation can be very significant factors to consider when using AADT volumes in any study

AADT – Annual Average Daily Traffic



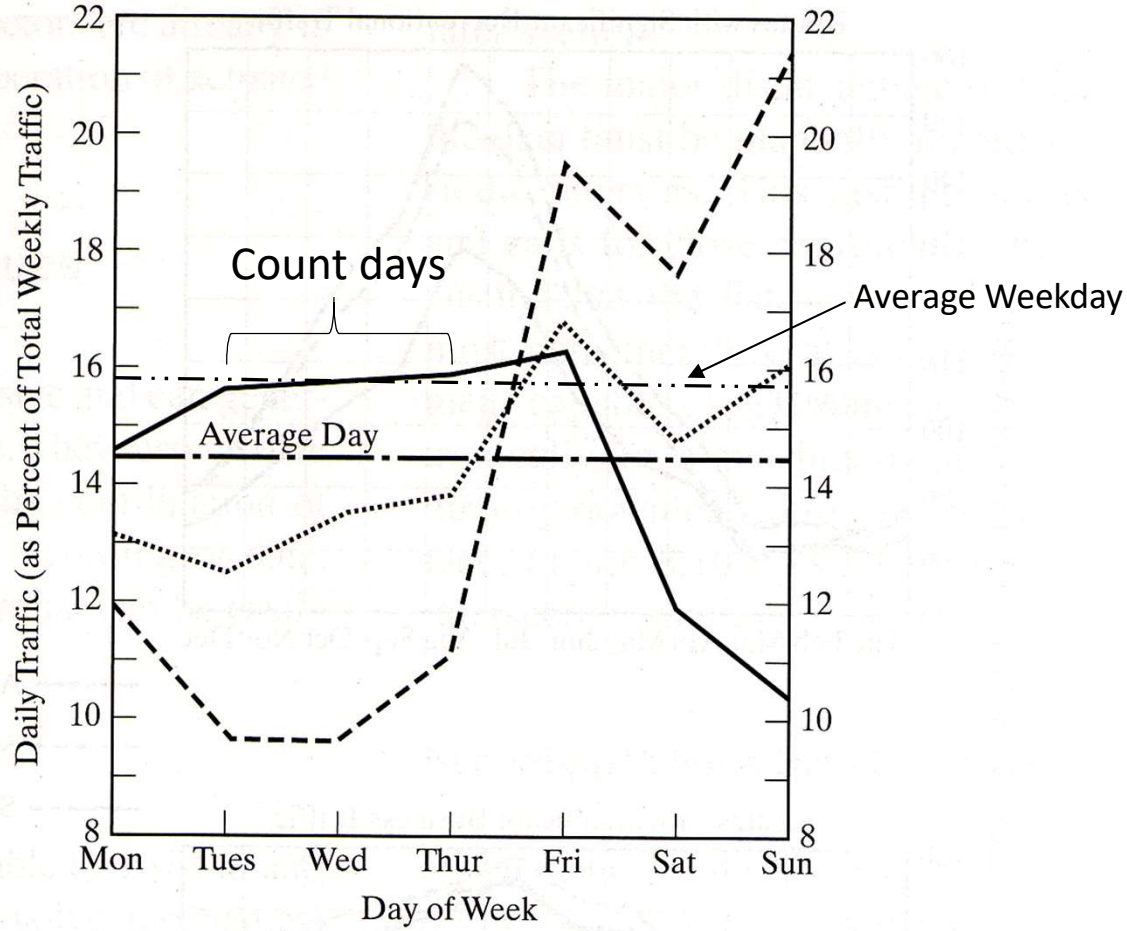
AADT – Annual Average Daily Traffic



AADT – Monthly Variation

Month	Total Traffic (vehicles)	ADT for Month (veh/day)	Monthly Factor (AADT/ADT)
January	197,856	/31 = 6,382	8,032 / 6,382 = 1.26
February	178,659	/28 = 6,381	8,032 / 6,381 = 1.26
March	217,852	/31 = 7,027	8,032 / 7,027 = 1.14
April	247,840	/30 = 8,261	8,032 / 8,261 = 0.97
May	258,367	/31 = 8,334	8,032 / 8,334 = 0.96
June	264,852	/30 = 8,828	8,032 / 8,828 = 0.91
July	275,364	/31 = 8,883	8,032 / 8,883 = 0.90
August	302,749	/31 = 9,766	8,032 / 9,766 = 0.82
September	282,574	/30 = 9,419	8,032 / 9,419 = 0.85
October	263,548	/31 = 8,502	8,032 / 8,502 = 0.94
November	222,906	/30 = 7,430	8,032 / 7,430 = 1.08
December	218,942	/31 = 7,063	8,032 / 7,063 = 1.14
TOTAL	**2,931,509**	**AADT =**	**2,931,509 / 365 = 8,032**

AADT – Weekly Variation



·····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.

Daily Calibration

Day	Yearly Average Volume for Day (vehs/day)	Daily Adjustment Factor DF
Monday	1,820	1,430/1,820 = 0.79
Tuesday	1,588	1,430/1,588 = 0.90
Wednesday	1,406	1,430/1,406 = 1.02
Thursday	1,300	1,430/1,300 = 1.10
Friday	1,289	1,430/1,289 = 1.11
Saturday	1,275	1,430/1,275 = 1.12
Sunday	1,332	1,430/1,332 = 1.07
Total	**10,010**	
Estimated AADT	**1,430**	

Combined Calibration

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

Where:

AADT = Average Annual Daily Traffic (veh/day)

V_{24ij} = 24-hour volume for day i in month j

DF_i = Daily adjustment factor for day i

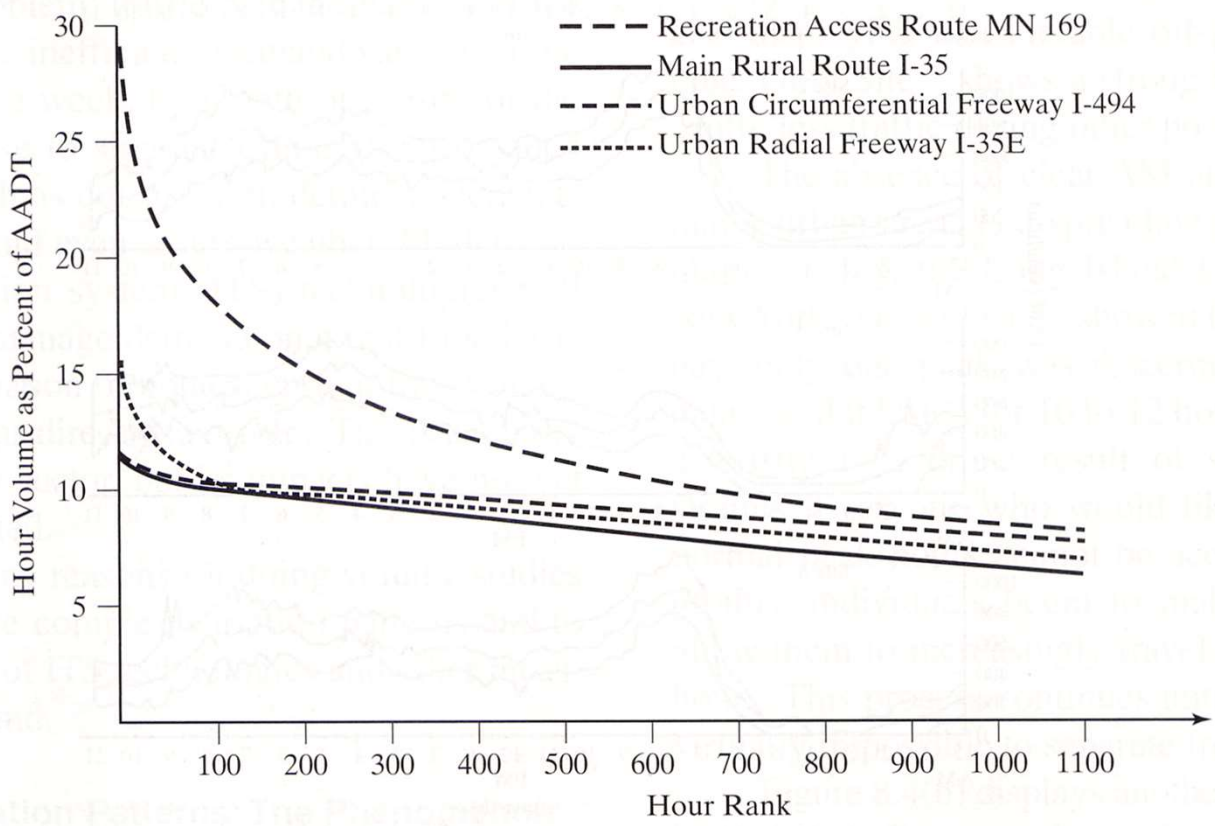
MF_j = Monthly adjustment factor for month j

DDHV = Directional Design Hour Volume

- Directional Design Hourly Volume (DDHV)
- DDHV = AADT (K) (D)
- K Factor
- D Factor

Facility Type	Normal Range of Values	
	K-Factor	*D*-Factor
Rural	0.15–0.25	0.65–0.80
Suburban	0.12–0.15	0.55–0.65
Urban:		
Radial Route	0.07–0.12	0.55–0.60
Circumferential Route	0.07–0.12	0.50–0.55

Design Hour


Recreation Access Route MN 169
Main Rural Route I-35
Urban Circumferential Freeway I-494
Urban Radial Freeway I-35E
Hour Volume as Percent of AADT
30
25
20
15
10
5
100
200
300
400
500
600
700
800
900
1000
1100
Hour Rank

Questions?

Peak Hour Factor

Poll Questions to see what you know about PHF

PHF = Peak Hour Factor

- Peak-Hour Factor (PHF)
- Peak 15-Minute Flow Rate
- Operational Analysis
- Highway Capacity Analysis
- Design

PHF = Peak Hour Factor

- Peak-Hour Factor (PHF)
- $$PHF = \frac{\text{Peak Hour Volume}}{4\ (\text{Peak 15-Minute Volume})}$$
- Peak 15-Minute Flow Rate
- Approach / Time Variance

Peak Hour Factor

Time Interval	Volume for Time Interval (vehs)	Rate of Flow for Time Interval (vehs/h)
5:00–5:15 PM	1,000	1,000/0.25 = 4,000
5:15–5:30 PM	1,100	1,100/0.25 = 4,400
5:30–5:45 PM	1,200	1,200/0.25 = 4,800
5:45–6:00 PM	900	900/0.25 = 3,600
5:00–6:00 PM	Σ = 4,200	

PHF = 4200/4*1200 = 4200/4800 = 0.875

TMC = Turning Movement Count

- Turning Movement Counts (TMC)
- Data Collection
- Uses

TMC = Turning Movement Count

Form 750-020-02
TRAFFIC ENGINEERING
10/15

State of Florida Department of Transportation

SUMMARY OF TURNING MOVEMENT COUNTS

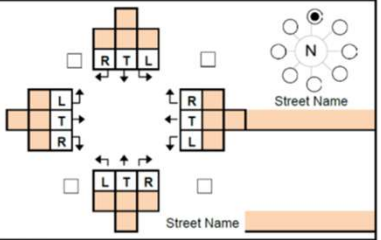
General Information

Analyst/Observer:
Agency or Company:
Date Performed:
Analysis Time Period:

Site Information

City:
County:
Weather:
Remarks:

Intersection Diagram



VEHICLE MOVEMENTS

Time Begins	Northbound				Southbound				Eastbound				Westbound				Total All
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
TOTAL																	
TOTAL																	
TOTAL																	
TOTAL																	
TOTAL																	

Source: Revised from Exhibit E-7 of the ITE Manual of Transportation Engineering Studies, 2nd Edition

Form 750-020-03
TRAFFIC ENGINEERING
10/15

State of Florida Department of Transportation

VEHICLE TURNING MOVEMENT COUNTS

General Information

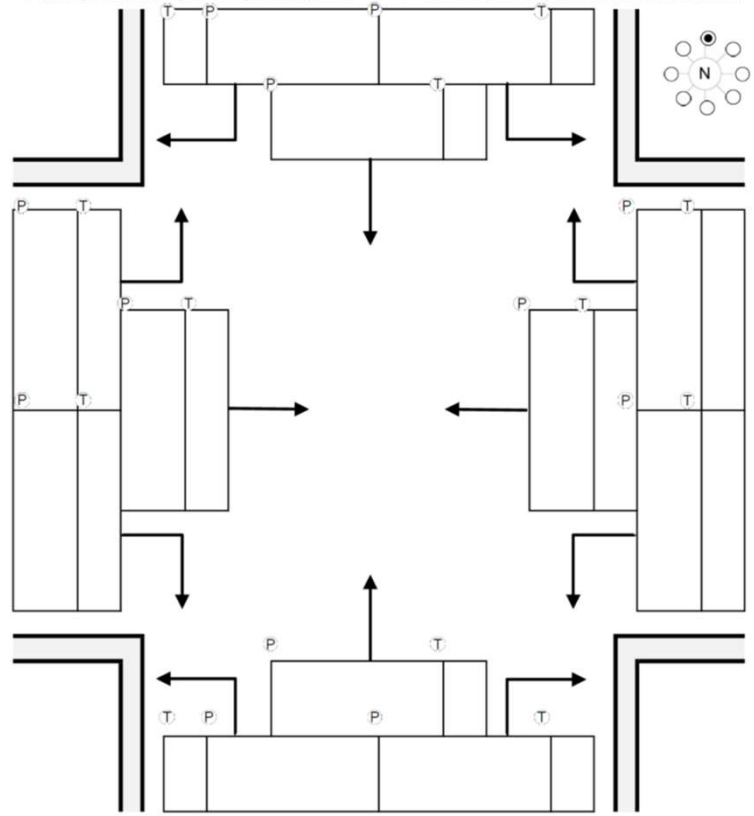
Analyst/Observer:
Agency or Company:
Date Performed:
Time Period From: To:
Weather/Road Condition:
Remarks:

Site Information

Location ID:
City:
County:
N/S Street:
E/W Street:

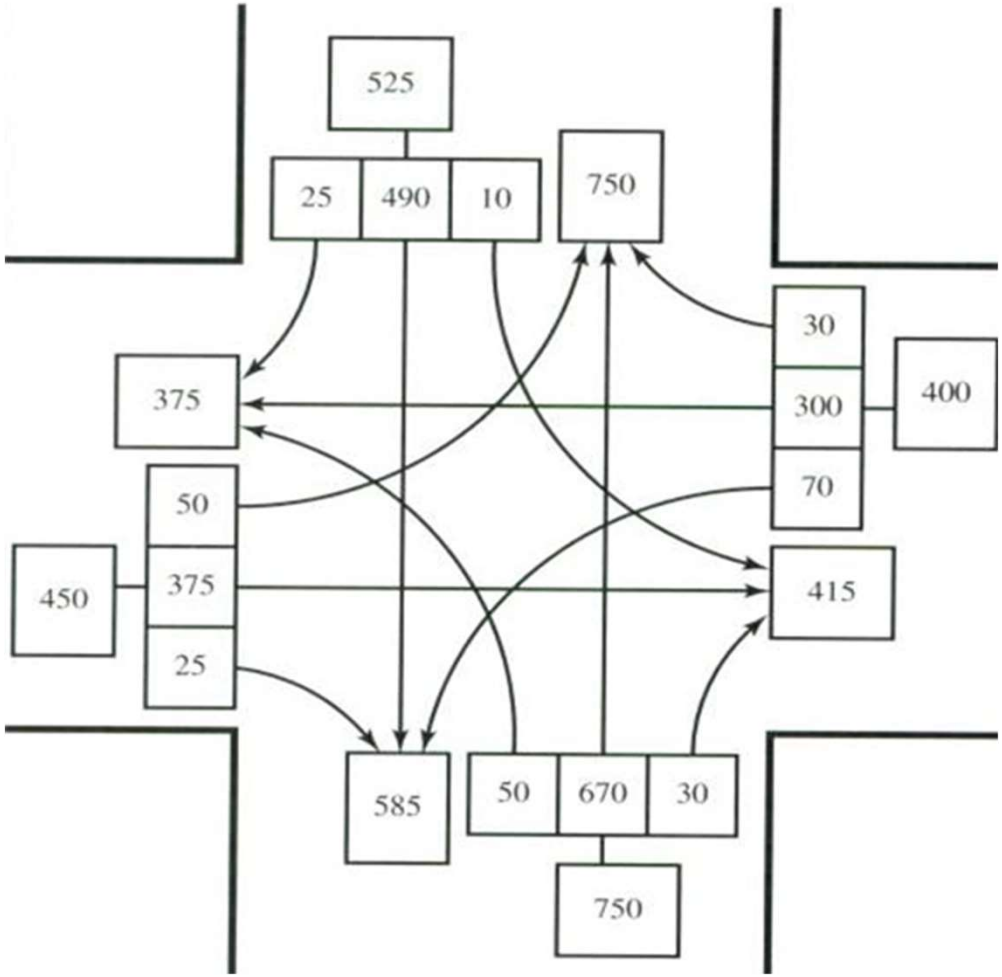
P = passenger cars, stationwagons, motorcycles, pick-up trucks

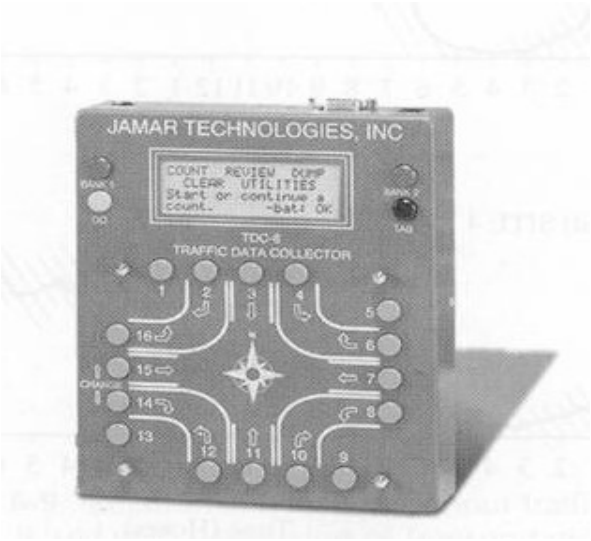
T = other trucks (Record any school bus as SB; other buses as B).



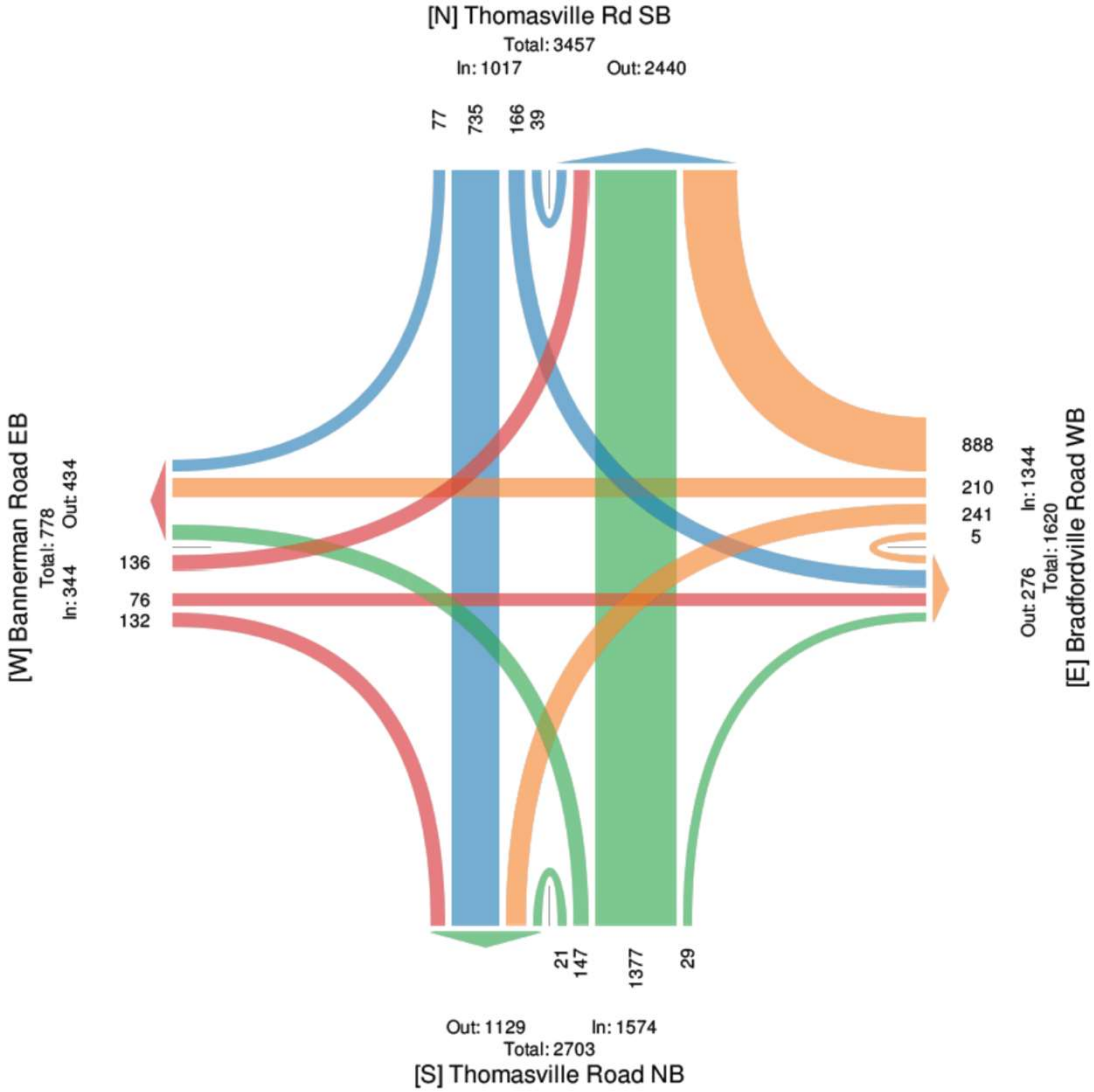
Source: Revised from Exhibit E-6 of the ITE Manual of Transportation Engineering Studies, 2nd Edition

TMC = Turning Movement Count





TMC = Turning Movement Count



VPH = Vehicles Per Hour

- Vehicles per Hour (VPH)
- Volume vs Demand
- Queues
- Estimating

VPH = Vehicles Per Hour

Time Period	Total Departure Count (veh)	Queue Length (veh)	Arrival Volume (veh)
4:00–4:15 P.M.	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
5:15–5:30	60	12	60 + 12 − 10 = 62
5:30–5:45	60	5	60 + 5 − 12 = 53
5:45–6:00	62	0	62 − 5 = 57
	55	0	55
	469		469

Questions?

Speed Studies

Traffic Engineering Fundamentals

Speed

- Rate of Travel of Vehicles
- Usually Measured in Miles per Hour
- Speed Types
  - Travel Speed
  - Running Speed
  - Spot Speed
  - Free-flow Speed

Speed is affected by ...

- Geometric Characteristics of the Roadway
- Traffic Control Devices
- Traffic Volume and Vehicle Mix
- Weather and Environmental Conditions
- Driver Characteristics and Area

Applications of Speed Studies

- Speed Limits
- Signal Timing
- Sign Locations
- No Passing Zones
- Crash Investigations
- Enforcement Effects
- Trends

Speed Measures

- Time Mean (Spot) Speed
- Space Mean Speed
- 85th Percentile Speed
- 10 MPH Pace Speed
- Percent in Pace

Spot Speed Data

- Straight, Level, Open Sections (Rural)
- Mid-block Locations (Urban)
- Not Near Intersections or Driveways
- Concealed and Inconspicuous

Spot Speed Studies

- Observe an Adequate Number
- Observe the First Vehicle in Platoon
- Select Every N-th Vehicle
- Record Observations at Each Speed

Observations

- Observe an Adequate Number
- 100-225 Vehicles or 2 Hours
  - 100 for 95% ± 1.0 mph
  - 225 for 99.7% ± 1.0 mph
  - 400 for 95% ± 0.5 mph

Speed Data – Form from MUTS

State of Florida Department of Transportation

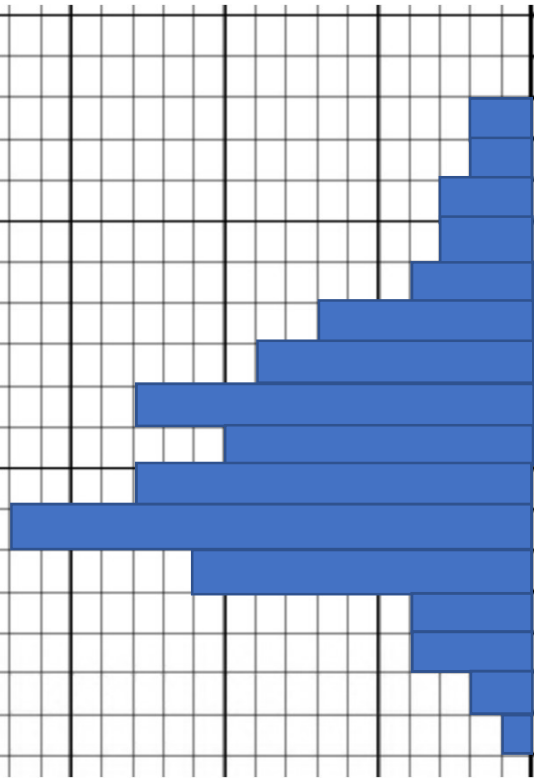
Form 750-010-03
TRAFFIC ENGINEERING
February 2015

VEHICLE SPOT SPEED STUDY

General Information		Site Information	
Analyst/Observer:	BPP	Location:	SR 112/ W 41st Street
Agency or Company:	FDOT	City:	Miami Beach
Date Performed:	Wednesday, March 19, 2014	County:	Miami-Dade
Time Period From:	11:00 AM To: 12:00 PM	Roadway ID:	87016000
Weather/Road Condition:	Dry	Milepost :	0.088
Posted Speed (mph):	30	Remarks:	N/A

| Vehicles traveling East bound | | |

Speed Data – Form from MUTS

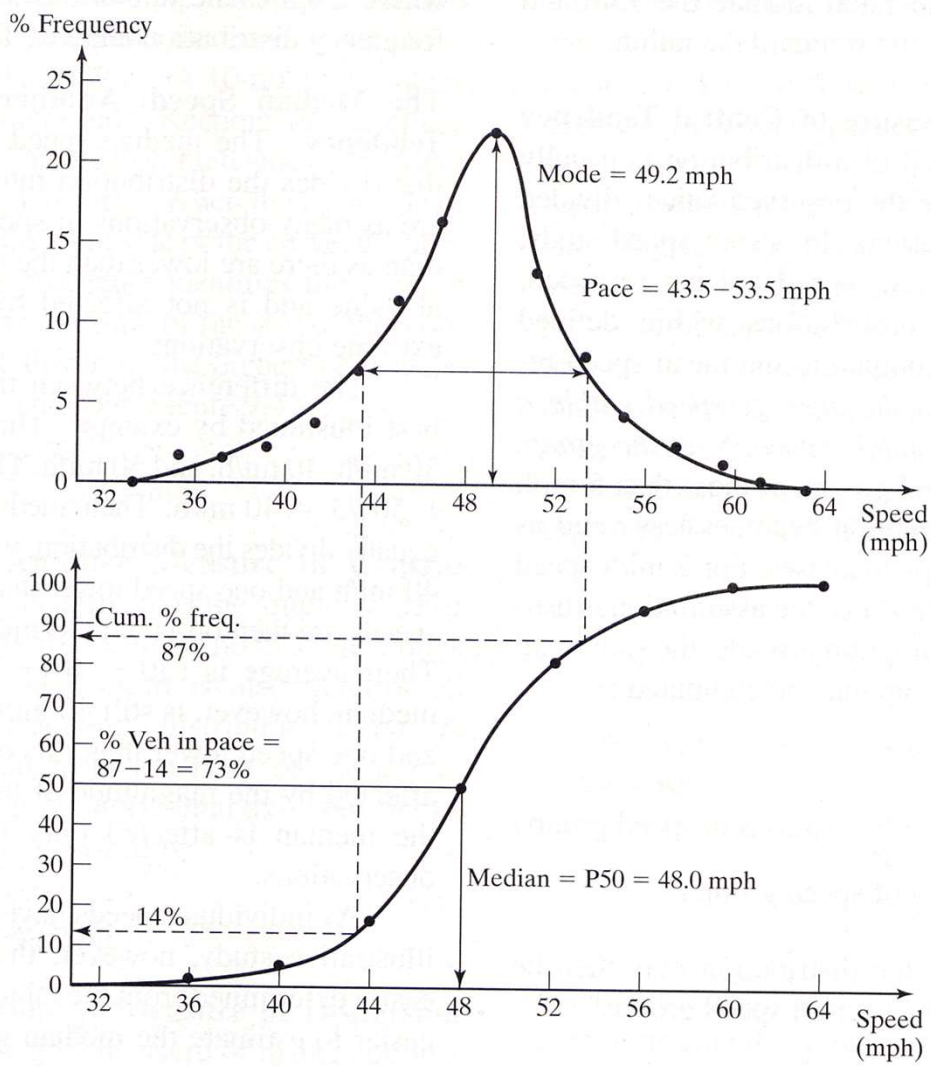


		58 - 59.9																							
		56 - 57.9																							
105	2	54 - 55.9																							215
103	2	52 - 53.9																						2	213
101	3	50 - 51.9	1																			1	110	4	211
98	3	48 - 49.9	1	1	1																	3	109	6	207
95	4	46 - 47.9	1																			1	106	5	201
91	7	44 - 45.9	1	1	1	1	1	1	1	1	1											9	105	16	196
84	9	42 - 43.9	1	1	1	1	1	1	1	1	1	1										10	96	19	180
75	13	40 - 41.9	1	1	1	1	1	1	1	1	1	1										10	86	23	161
62	10	38 - 39.9	1	1	1	1	1	1	1	1	1	1										10	76	20	138
52	13	36 - 37.9	1	1	1	1	1	1	1	1	1	1	1	1								12	66	25	118
39	17	34 - 35.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				16	54	33	93
22	11	32 - 33.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					15	38	26	60
11	4	30 - 31.9	1	1	1	1	1	1	1	1	1	1	1	1								12	23	16	34
7	4	28 - 29.9	1	1	1	1	1	1	1	1	1	1										10	11	14	18
3	2	26 - 27.9	1																			1	1	3	4
1	1	24 - 25.9																						1	1

Speed Analysis

Speed Group		Middle Speed S (mi/h)	Observed Freq. in Group n	% Freq. in Group (%)*	Cum. % Freq (%)*	nS**	nS^2**
Lower Limit (mi/h)	Upper Limit (mi/h)						
32	34	33	0	0.0%	0.0%	0	0
34	36	35	5	1.8%	1.8%	175	6,125
36	38	37	5	1.8%	3.5%	185	6,845
38	40	39	7	2.5%	6.0%	273	10,647
40	42	41	13	4.6%	10.6%	533	21,853
42	44	43	21	7.4%	18.0%	903	38,829
44	46	45	33	11.7%	29.7%	1,485	66,825
46	48	47	46	16.3%	45.9%	2,162	101,614
48	50	49	62	21.9%	67.8%	3,038	148,862
50	52	51	37	13.1%	80.9%	1,887	96,237
52	54	53	24	8.5%	89.4%	1,272	67,416
54	56	55	14	4.9%	94.3%	770	42,350
56	58	57	9	3.2%	97.5%	513	29,241
58	60	59	5	1.8%	99.3%	295	17,405
60	62	61	2	0.7%	100.0%	122	7,442
62	64	63	0	0.0%	100.0%	0	0
			283	**100.0%**		**13,613**	**661,691**

Speed Graph


% Frequency
25
20
15
10
5
0
Mode = 49.2 mph
Pace = 43.5−53.5 mph
32
36
40
44
48
52
56
60
64
Speed (mph)
100
90
80
70
60
50
40
30
20
10
0
Cum. % freq.
87%
% Veh in pace =
87−14 = 73%
14%
Median = P50 = 48.0 mph
32
36
40
44
48
52
56
60
64
Speed (mph)

Speed Limits

- 85th Percentile Speed
- Roadway Surface and Geometry
- Roadside Development and Friction
- Curves and Hazardous Conditions
- Parking and Pedestrians
- Crash Records

Example: What is 85th% speed?

Speed	Frequency	Cumulative
51	1	
50	2	
49	6	
48	14	
47	17	
46	19	
45	16	
44	12	
43	7	
42	4	
41	5	
40	3	

Example: What is 85th% speed?

Speed	Frequency	Cumulative
51	1	106
50	2	105
49	6	103
48	14	97
47	17	83
46	19	66
45	16	47
44	12	31
43	7	19
42	4	12
41	5	8
40	3	3

Example: What is 85th% speed?

$$106 \times 0.85 = 90$$

Number of Observations

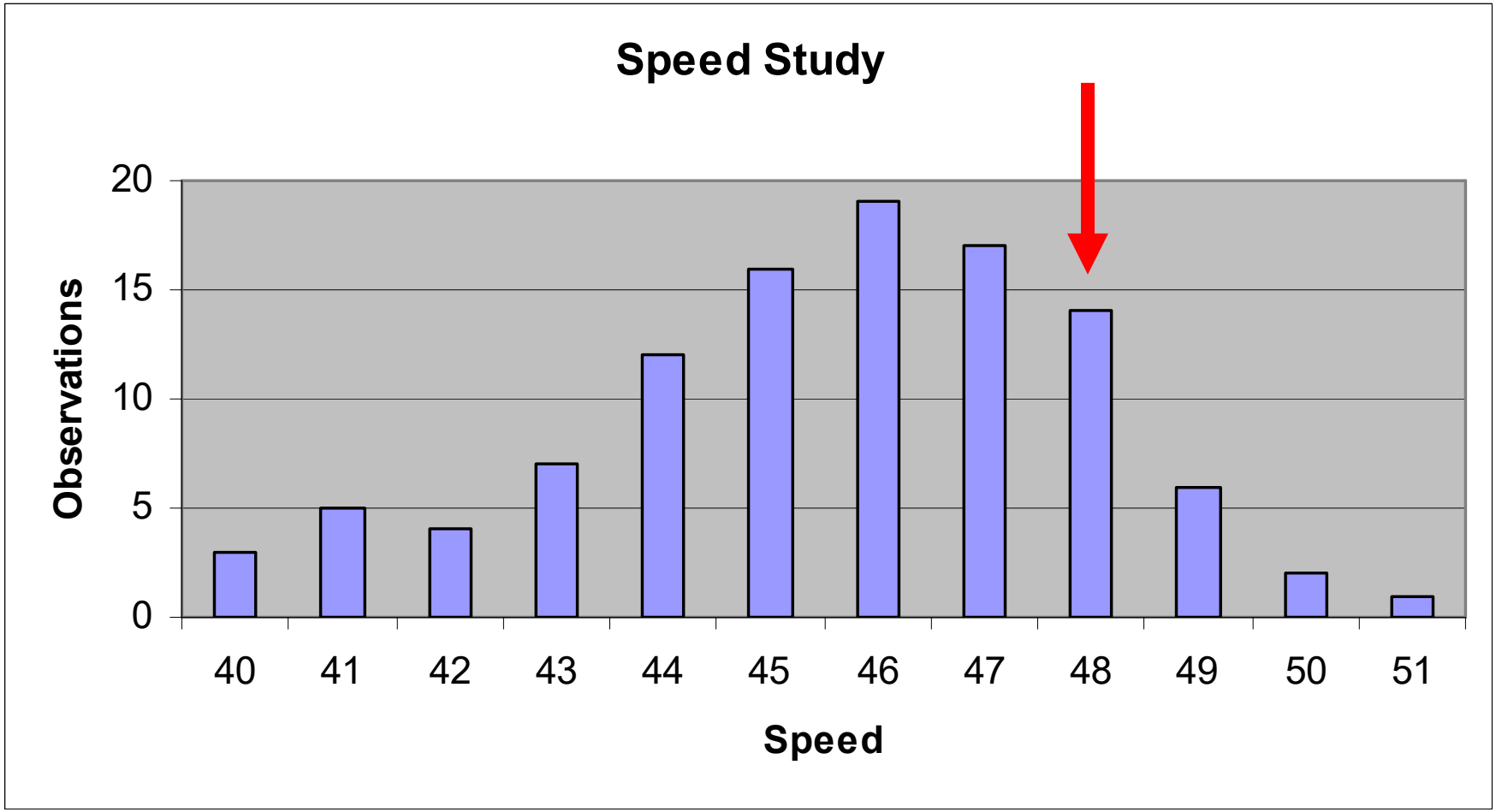
85th %ile

Observation Number of 85th % Speed

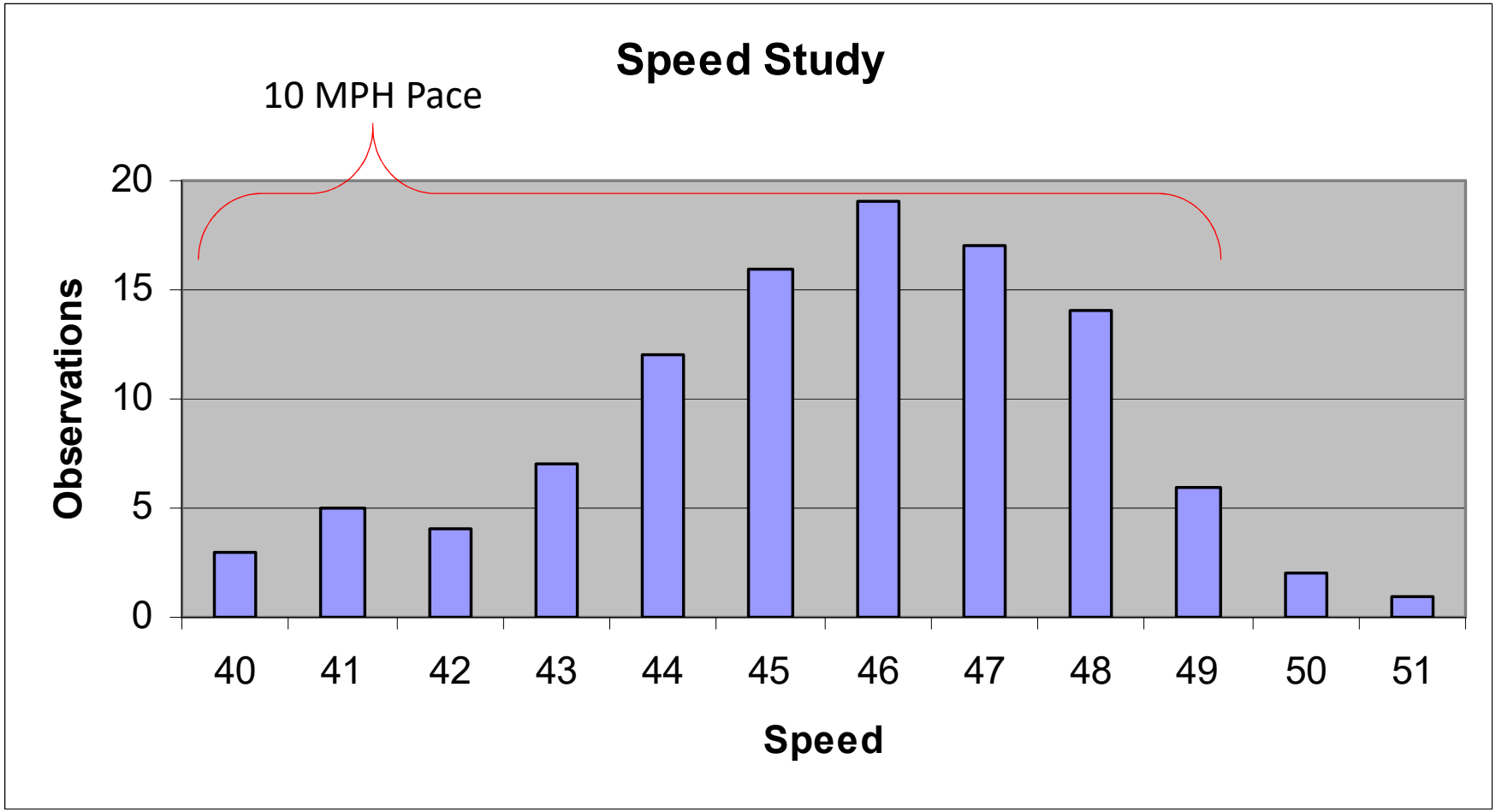
Example: What is 85th% speed?

Speed	Frequency	Cumulative
51	1	106
50	2	105
49	6	103
48	14	97
47	17	83
46	19	66
45	16	47
44	12	31
43	7	19
42	4	12
41	5	8
40	3	3

Example: What is 85th% speed?



Example: What is 10 MPH pace?



Travel Time and Delay Studies

- Evaluate coordinated signal timing
- Before-and-after timing changes
- Quantify levels of congestion
- Identify location of delays
- System performance monitoring

Travel Time and Delay Studies

Using the test vehicle method, three techniques that can be used are:

- Average car method: speed of travel based on driver's judgment of the average speed of traffic
- Floating car method: the driver floats with traffic by passing as many vehicles as they are passed by
- Maximum car method: the speed of travel is based on posted speed limit

Travel Time and Delay Studies

Three methods commonly used for travel time and delay studies:

- Manual method – forms and procedures for manual collection are in the MUTS
- Automatic method – typically uses GPS for location information and either GPS or computer for time
- Video method – uses dash cam video (with time stamp) and distance information from other source (typically straight line diagram)

Manual Method:

State of Florida Department of Transportation

Form 750-020-14
TRAFFIC ENGINEERING
February 2015

TRAVEL TIME AND DELAY STUDY FIELD DATA

SITE INFORMATION		GENERAL INFORMATION	
Roadway ID:	SR 960	Analyst/Observer:	BPP
Site:	Miller through 1st Street	Agency or Company:	FDOT
City:	Wausau	Date:	Monday, March 31, 2014
County:	Washington	Time Period:	From: 7:30 AM To: 8:40 AM
Milepost (MP):	BMP: 0.000 EMP: 2.230	Weather/Road Condition:	Clear, Dry
Posted Speed (mph):	55	Remarks:	N/A

Sheet 1 of 2

DELAY CODES			
TS = TRAFFIC SIGNAL	SS = STOP SIGN	LT = LEFT TURNS	P=PARKING CARS
PED = PEDESTRIANS	I = INCIDENT	B = BUS STOPPING	C = CONGESTION
OTHER: -			

CONTROL PT		0	DELAY		1	DELAY		2	DELAY		3	DELAY		4	DELAY		5
LOCATION		Miller			Holly Dr			Oak St			Rega Rd			Poe St			Lowell
MP		0.000	Sec.	Cause	0.410	Sec.	Cause	0.710	Sec.	Cause	0.860	Sec.	Cause	1.140	Sec.	Cause	1.900
RUN NUMBER	1	Time			Cum Time (s)	10	TS	Cum Time (s)	2	C	Cum Time (s)	4	LT	Cum Time (s)	3	P	Cum Time (s)
					0:51			1:45			2:07	2	LS	2:58			4:39
		7:30 AM			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)
					51			54			22			51			101
	2	Time	5	C	Cum Time (s)	12	TS	Cum Time (s)	6	C	Cum Time (s)			Cum Time (s)	20	TS	Cum Time (s)
					1:02			2:01			2:29			3:11	2	PED	5:08
		7:42 AM			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)
					62			59			28			42			117
	3	Time			Cum Time (s)			Cum Time (s)			Cum Time (s)			Cum Time (s)	28	TS	Cum Time (s)
					0:54			1:23			1:42			2:26			4:30
		8:10 AM			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)
					54			39			19			44			124
	4	Time	4	C	Cum Time (s)	3	TS	Cum Time (s)	1	C	Cum Time (s)	9	TS	Cum Time (s)			Cum Time (s)
			11	TS	1:13			1:57			2:20			3:12			4:47
		8:10 AM			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)
					73			44			23			52			95
	5	Time	10	TS	Cum Time (s)	6	TS	Cum Time (s)			Cum Time (s)			Cum Time (s)	3	LT	Cum Time (s)
					1:00			1:48			1:08			2:55			4:41
		8:24 AM			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)
					60			48			20			47			106
	6	Time	3	P	Cum Time (s)	12	TS	Cum Time (s)			Cum Time (s)	3	LT	Cum Time (s)	19	TS	Cum Time (s)
					0:57			1:51			2:12			3:00			5:00
		8:37 AM			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)			Lapse (s)
					57			54			21			48			120

Manual Method:

State of Florida Department of Transportation

Form 750-020-19
TRAFFIC ENGINEERING
February 2015

TRAVEL TIME AND DELAY STUDY FIELD SUMMARY

SITE INFORMATION		GENERAL INFORMATION	
Roadway ID:	SR 960	Analyst/Observer:	BPP
Site:	Miller through 1st Street	Agency or Company:	FDOT
City:	Wausau	Date:	Sunday, August 31, 2014
County:	Washington	Time Period From:	7:30 AM To: 8:40 AM
Milepost (MP):	BMP: 0.000 EMP: 2.230	Weather/Road Condition:	Cloudy, Dry
Posted Speed (mph):	55	Remarks:	N/A

Sheet 1 of 1

CONTROL POINT	TRIP LENGTH (MILES)	RUN NUMBER (Travel Time and Delay in seconds) 1 Travel Time	1 Delay	2 Travel Time	2 Delay	3 Travel Time	3 Delay	4 Travel Time	4 Delay	5 Travel Time	5 Delay	6 Travel Time	6 Delay	AVG. TRAVEL TIME (ATT)	AVG. TRAVEL SPEED (ATS)	AVG. DELAY (AD)	AVG. RUNNING TIME (ART)	AVG. RUNNING SPEED (ARS)
0 1	0.410	51	0	62	5	54	0	73	15	80	10	57	3	62.8	23.5	5.5	57.3	25.7
1 2	0.300	54	10	59	12	39	0	44	3	48	6	54	12	49.7	21.7	7.2	42.5	25.4
2 3	0.150	22	2	28	6	19	0	23	1	20	0	21	0	22.2	24.4	1.5	20.7	26.1
3 4	0.280	51	6	42	0	44	0	52	9	47	0	48	3	47.3	21.3	3.0	44.3	22.7
4 5	0.760	101	3	117	22	124	28	95	0	106	3	120	19	110.5	24.8	12.5	98.0	27.9
5 6	0.330	60	2	49	0	76	12	80	14	52	0	61	5	63.0	18.9	5.5	57.5	20.7
6 7																		
7 8																		
8 9																		
9 10																		
10 11																		
11 12																		
13 14																		
TOTAL TRIP LENGTH	2.230	SUM OF TRAVEL TIME AND DELAY PER RUN												TOTAL AVERAGES				
		339	23	357	45	356	40	367	42	353	19	361	42	(ATTT)	(ATTS)	(ATTD)	(ATRT)	(ATRS)
RUNNING TIME PER RUN		316		312		316		325		334		319		355.5	22.6	35.2	320.3	25.1

Manual Method:

$$Average\ Travel\ Time\ (ATT) = \frac{\text{Sum of TT}}{\text{Total No. of Runs}}$$

$$Average\ Travel\ Speed\ (ATS) = \frac{Miles\ x\ 3600\ seconds\ per\ hour}{ATT}$$

$$Average\ Delay\ (AD) = \frac{Sum\ of\ Delay}{Total\ No.\ of\ Runs}$$

$$Average\ Running\ Time\ (ART) = ATT - AD$$

$$Average\ Running\ Speed\ (ARS) = \frac{Miles\ x\ 3600\ seconds\ per\ hour}{ART}$$

Manual Method:

$$Total\ Trip\ Length\ (TTL) = Total\ distance\ between\ all\ control\ points\ (miles)$$

$$Travel\ Time\ Total\ (TTT) = Sum\ of\ travel\ times\ between\ control\ points\ for\ an\ individual\ run$$

$$Average\ Total\ Travel\ Time\ (ATTT) = \frac{Sum\ of\ all\ TTT's}{Total\ No.\ of\ Runs} = Sum\ of\ ATT's$$

$$Average\ Total\ Travel\ Speed\ (ATTS) = \frac{TTL\ x\ 3600\ seconds\ per\ hour}{ATTT}$$

$$Average\ Total\ Trip\ Delay\ (ATTD) = \frac{Sum\ of\ Delay\ Totals}{Total\ No.\ of\ Runs} = Sum\ of\ AD's$$

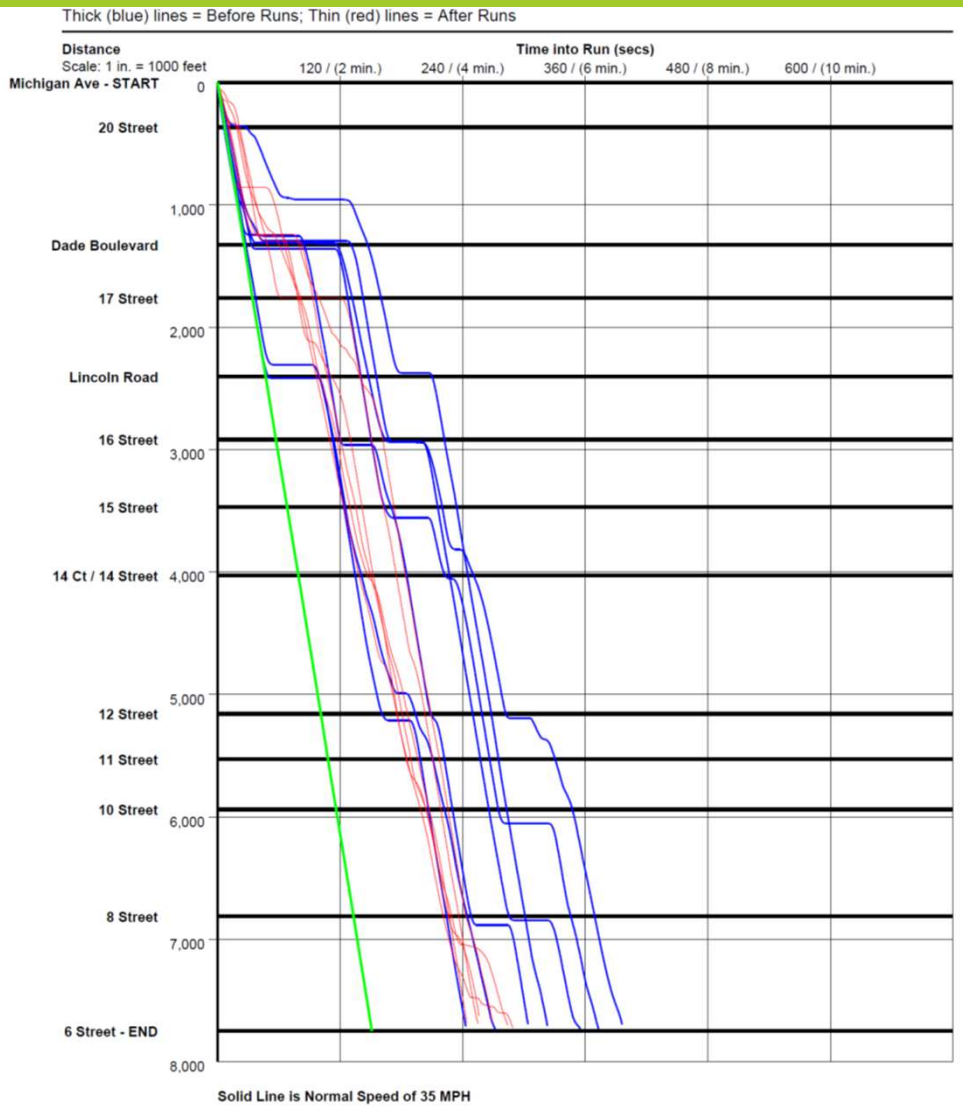
$$Average\ Total\ Running\ Time\ (ATRT) = \frac{Sum\ of\ RT's}{Total\ No.\ of\ Runs} = Sum\ ART's$$

$$Average\ Total\ Running\ Speed\ (ATRS) = \frac{TTL\ x\ 3600\ seconds\ per\ hour}{ATRT}$$

Automated Method:

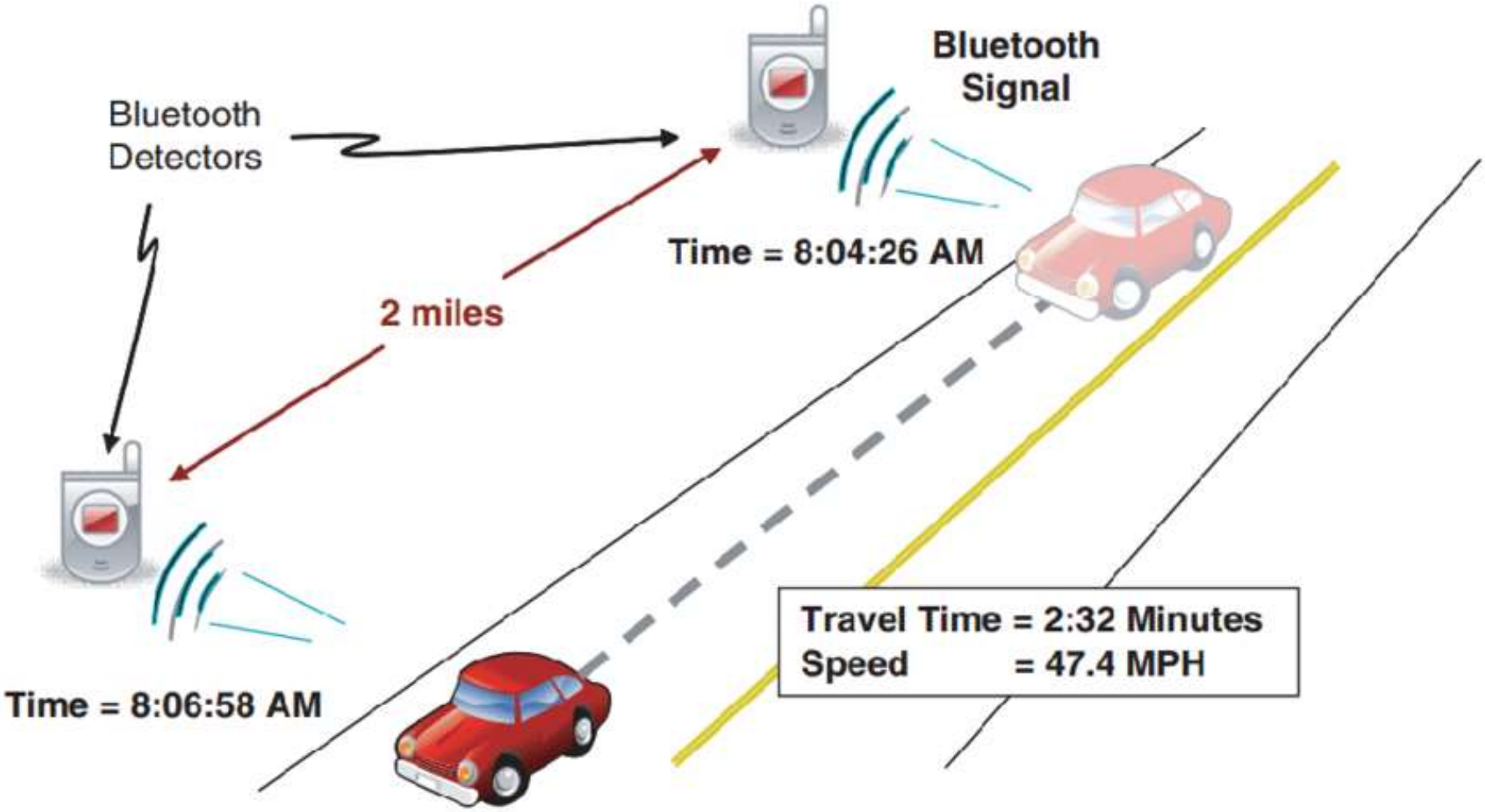
Node #	Length	Node Name		Travel Time	# of Stops	Avg Speed	Total Delay	Time <= 5 MPH	Time <= 15 MPH	Time <= 23 MPH
1	0	Michigan Ave - START								
2	367	20 Street	Before	11.9	0.1	21.1	4.4	2.1	2.7	4.9
			After	16.2	0.7	15.5	8.5	2.5	8.2	12.0
			Change	4.3	0.5	-5.6	4.1	0.4	5.5	7.1
3	959	Dade Boulevard	Before	70.3	0.7	9.3	51.3	41.1	52.6	56.0
			After	52.7	0.8	12.4	33.7	23.3	31.0	38.2
			Change	-17.6	0.1	3.1	-17.6	-17.8	-21.6	-17.8
4	434	17 Street	Before	23.4	0.1	12.6	14.6	11.6	12.7	15.3
			After	24.5	0.2	12.1	15.8	9.8	14.0	19.7
			Change	1.1	0.0	-0.6	1.3	-1.7	1.3	4.4
5	643	Lincoln Road	Before	26.1	0.3	16.8	13.1	10.6	12.3	13.6
			After	23.8	0.7	18.4	10.8	2.5	10.3	14.5
			Change	-2.3	0.4	1.6	-2.3	-8.1	-2.0	0.9
6	513	16 Street	Before	19.7	0.1	17.7	9.7	7.1	8.1	10.1
			After	15.7	0.0	22.3	5.5	0.0	3.5	6.5
			Change	-4.0	-0.1	4.6	-4.2	-7.1	-4.6	-3.6
7	552	15 Street	Before	28.7	0.4	13.1	17.6	14.3	16.3	18.9
			After	12.8	0.0	29.3	1.7	0.0	0.0	0.0
			Change	-15.9	-0.4	16.2	-15.9	-14.3	-16.3	-18.9
8	558	14 Ct / 14 Street	Before	22.1	0.3	17.2	10.9	6.9	10.1	13.1
			After	13.3	0.0	28.5	2.3	0.0	0.2	2.5
			Change	-8.8	-0.3	11.4	-8.5	-6.9	-10.0	-10.6
9	1131	12 Street	Before	30.7	0.3	25.1	8.7	2.9	5.0	10.9
			After	30.8	0.2	25.0	8.3	0.3	2.8	10.0
			Change	0.1	-0.1	-0.1	-0.4	-2.5	-2.2	-0.9
10	372	11 Street	Before	20.0	0.4	12.7	12.3	7.7	12.7	15.0
			After	9.0	0.0	28.2	1.3	0.0	0.0	0.0
			Change	-11.0	-0.4	15.5	-11.0	-7.7	-12.7	-15.0
11	409	10 Street	Before	9.7	0.0	28.7	1.7	0.0	0.9	2.9
			After	12.3	0.0	22.6	4.2	0.0	2.7	7.3
			Change	2.6	0.0	-6.1	2.5	0.0	1.8	4.5
12	872	8 Street	Before	27.1	0.1	21.9	9.9	6.6	7.4	9.0
			After	20.7	0.0	28.8	3.3	0.0	0.0	2.7
			Change	-6.5	-0.1	6.9	-6.5	-6.6	-7.4	-6.3
13	938	6 Street - END	Before	35.9	0.3	17.8	17.9	10.1	13.1	19.1
			After	36.3	0.8	17.6	18.5	8.5	16.0	24.8
			Change	0.5	0.5	-0.2	0.6	-1.6	2.9	5.7
Totals	**7,748**		**Before**	**325.7**	**3.3**	**16.2**	**172.0**	**121.0**	**154.0**	**188.7**
			After	**268.2**	**3.3**	**19.7**	**114.0**	**47.0**	**88.7**	**138.2**
			Change	**-57.5**	**0.0**	**3.5**	**-58.0**	**-74.0**	**-65.3**	**-50.5**

Automated Method:



Video Method:

Blue Tooth Method



US 1 – Coral Gables – Univ. of Miami

Questions?

Thank you for attending!

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