

Appendix MKE – Milwaukee, Wisconsin 2003 Annual Report on Freeway Mobility and Reliability

This report is a supplement to: *Monitoring Urban Freeways in 2003: Current Conditions and Trends from Archived Operations Data*. Texas Transportation Institute and Cambridge Systematics, Inc., Report No. FHWA-HOP-05-018, December 2004, available at <http://mobility.tamu.edu/mmp>.

Exhibit MKE-1: Current Measures and Trends

Measures	Current Year	Last Year		Two Years Ago	
	2003	2002	Change	2001	Change
Performance Measures					
Travel Time Index	1.10	1.08	+2% ↑	1.07	+2% ↑
Planning Time Index	1.25	1.21	+3% ↑	1.20	+4% ↑
Buffer Index	12%	10%	+2% ↑	10%	+2% ↑
% Congested Travel	34%	36%	-2% ↓	40%	-6% ↓
Total Delay (veh-hours) per 1000 VMT	1.84	1.80	+3% ↑	2.07	-11% ↓
Explanatory Measures					
Peak Period VMT (000)	2,960	2,490	+19% ↑	2,330	+27% ↑
Avg. Annual DVMT (000)	10,950	7,900	+39% ↑	8,600	+27% ↑
Data Quality Measures					
% complete	77%	65%	+12% ↑	71%	+6% ↑
% valid	80%	83%	-3% ↓	72%	+8% ↑
% of VMT covered	120%	92%	+28% ↑	83%	+37% ↑
% of freeway miles	106%	110%	-4% ↓	110%	-4% ↓

* See pages 7 and 8 for maps of freeway coverage, measure definitions, and further documentation.

Exhibit MKE-2: 2000 to 2003 Annual Trends

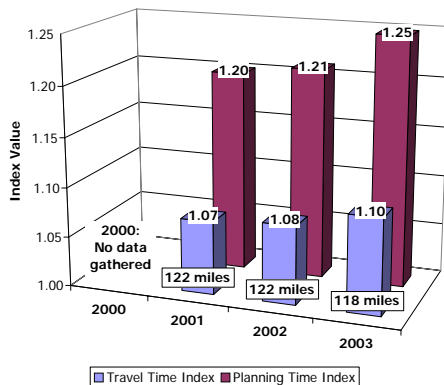
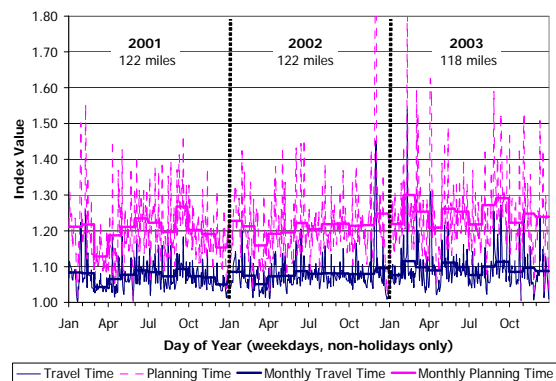


Exhibit MKE-3: Daily and Monthly Trends



Comments

- The travel time index and buffer index have shown modest increases (2-4%) since 2001, despite large annual increases (19-27%) in vehicle travel (DVMT).
- The percentage of congested travel is the only performance measure to improve since 2001.
- Data quality has remained somewhat stable since 2001.

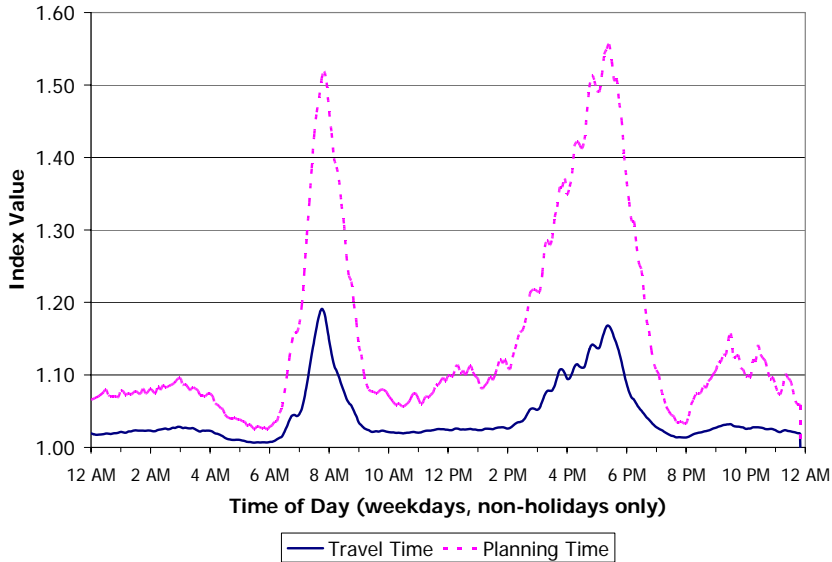
Data Source(s): Wisconsin DOT (<http://www.dot.state.wi.us/> and <http://www.gcmtravel.com>)

Includes 118 of 111 (106%, 7 miles are outside urban area) total freeway miles in Milwaukee; collected using loop detectors; see page 7 for additional information on the data source

Data Analysis: Texas Transportation Institute, analysis completed September 2004

Time of Day Patterns and Trends

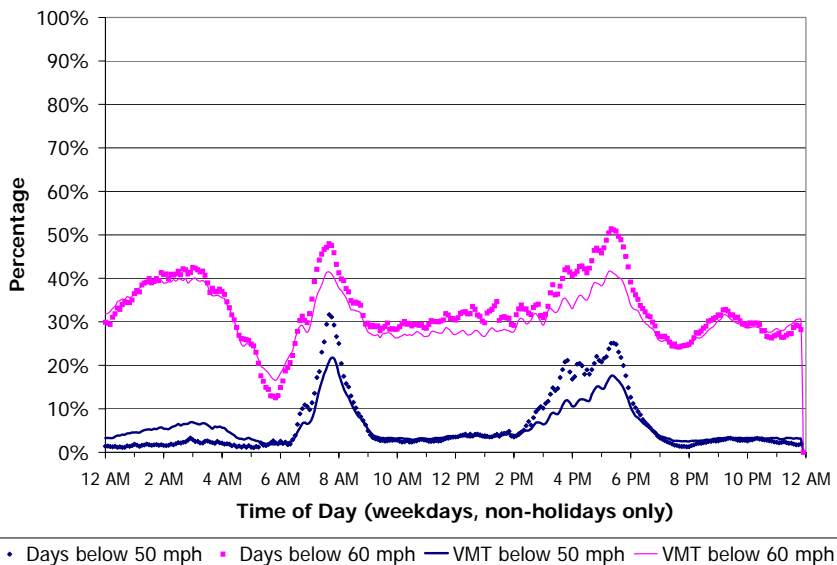
The charts on this page illustrate average weekday (no holidays included) traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors.



Comments

- This chart shows areawide congestion and reliability patterns. The difference between the solid line (travel time index) and the dashed line (planning time index) is the additional “buffer” or “time cushion” that travelers must add to average trip times to ensure 95% on-time arrival.
- The morning and evening congestion levels are similar, but the evening congestion lasts longer.
- Travelers must add 20-30% additional buffer time during peak times to account for traffic unreliability.

Exhibit MKE-4: Mobility and Reliability by Time of Average Weekday



Comments

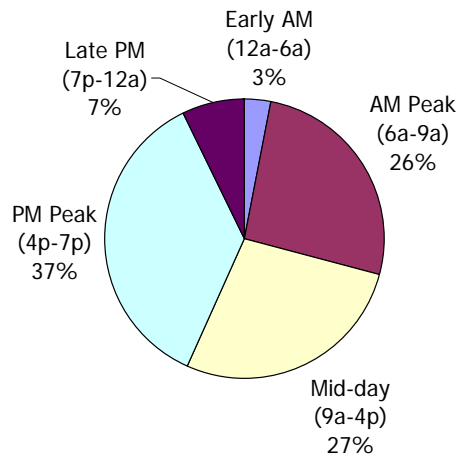
- This chart illustrates the difference in using two different speed thresholds (50 and 60 mph) in computing the percent of congested days as well as the percent of congested travel.
- There are early morning speeds in the 50-60 mph range that cause a “rounded peak” for the 60 mph threshold lines.

Exhibit MKE-5: Frequency and Percentage of Congested Travel by Time of Average Weekday

Time Period of the Day Patterns and Trends

The charts on this page illustrate average weekday (no holidays included) traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. The time periods are defined uniformly for all cities to facilitate trend analysis over time and between cities. The time periods are defined as follows:

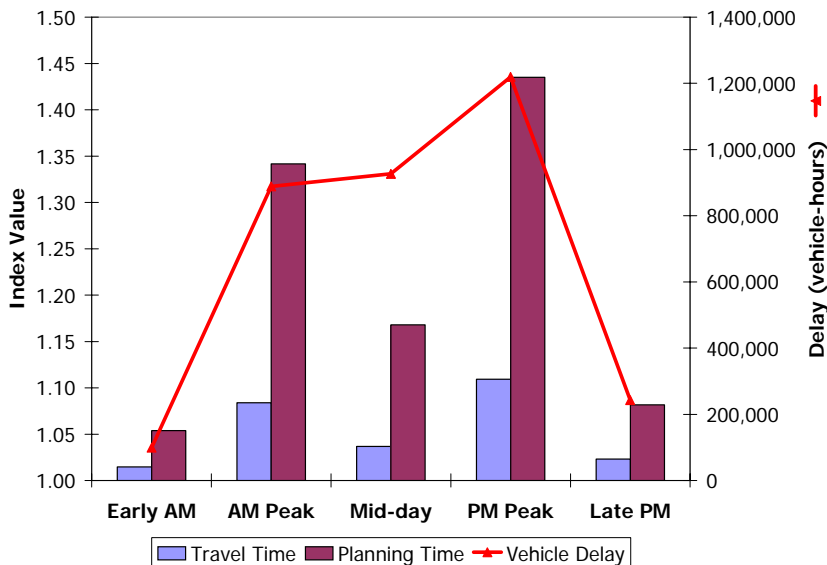
- Early AM: 12 to 6 am
- AM Peak: 6 to 9 am
- Mid-day: 9 am to 4 pm
- PM Peak: 4 to 7 pm
- Late PM: 7 pm to 12 am



Comments

- This chart shows the percent of delay that occurred during different time periods of an average weekday. Note that the AM and PM peak periods are the same duration, but that the other time periods have different lengths.
- The delay in the afternoon peak period is greater than in the morning.
- Delay during the mid-day period is comparable to that during the morning peak period.

Exhibit MKE-6: Percent of Delay by Time Period



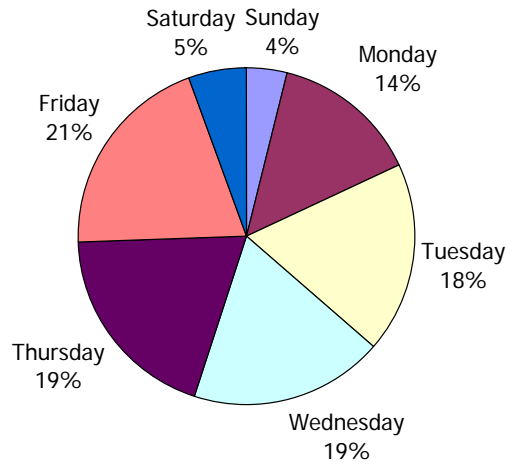
Comments

- This chart shows congestion and reliability (shown as bars) as well as delay (shown as a line) during different time periods of an average weekday.
- The trends in this chart follow closely those shown in Exhibit 6.
- The travel time index for the mid-day period is low, but the delay is relatively high because of the length of this time period (7 hours).

Exhibit MKE-7: Mobility, Reliability, and Delay by Time Period

Day of Week Patterns and Trends

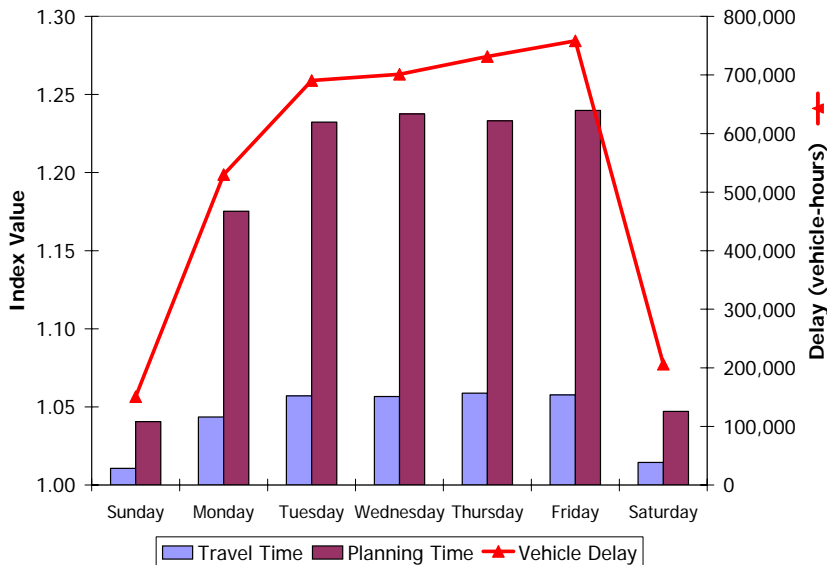
The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. Because of different peak period times and lengths on weekdays and weekends, the statistics presented on this page are 24-hour daily totals or averages.



Comments

- This chart shows the percent of total daily delay that occurred during each day of the week.
- Friday has the most delay, and Monday has the least delay of all weekdays.
- Both weekend days combined have about half of the delay of a typical weekday.

Exhibit MKE-8: Percent of Daily Vehicle Delay by Day of Week



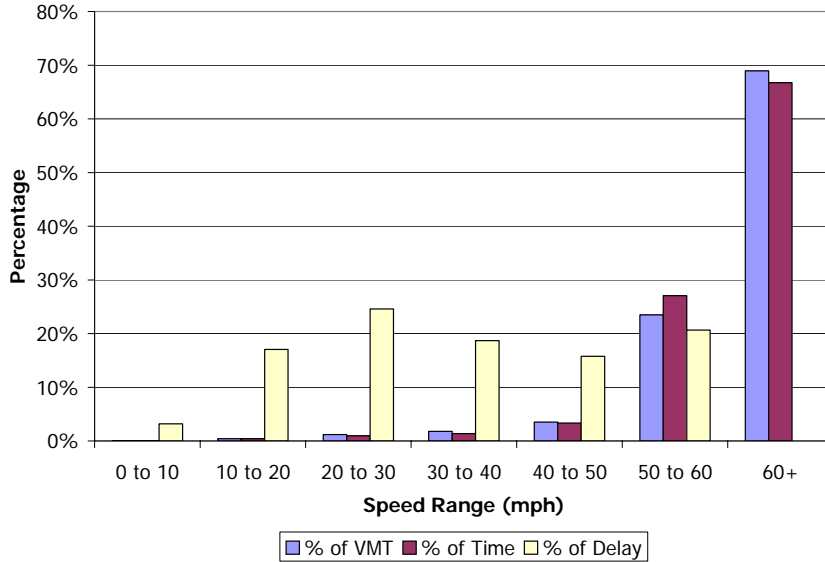
Comments

- This chart shows average daily congestion and reliability (shown as bars) as well as total daily delay (shown as a line) during each day of the week.
- The trends in this chart follow closely those shown in Exhibit 8.
- Friday has the most delay and also is the least reliable day (highest planning time index).

Exhibit MKE-9: Mobility, Reliability, and Delay by Day of Week

Other Traffic Data Patterns and Trends

The chart on this page illustrates average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors.



Comments

- This chart shows the percent of VMT, time, and delay in different speed ranges. This chart is useful to determine how much VMT and delay occurred at different congestion levels.
- About 20% of the delay is in the 50 to 60 mph range.
- Only 2% of the VMT is below 30 mph, but 45% of the delay occurred below 30 mph.

Exhibit MKE-10: Percent of VMT, Delay and Time Periods in Different Speed Ranges

Mobility and Reliability Statistics for Specific Freeway Sections

The table in this section illustrates average weekday (no holidays included) statistics from the freeway sections instrumented with operations-based traffic sensors. Where possible, the freeway sections have been defined to begin and end at major interchanges, streets, or other locations where traffic conditions are likely to change. The freeway sections are typically between 5 and 10 miles in length.

Exhibit MKE-11. Mobility and Reliability by Section and Time Period

Freeway Section (sorted from most congested to least congested sections)	Length (mi)	Travel Time Index				Buffer Index			
		Morning Peak (6a-9a)	Midday (9a-4p)	Evening Peak (4p-7p)	Average peak period	Morning Peak (6a-9a)	Midday (9a-4p)	Evening Peak (4p-7p)	Average peak period
I-94 EB: Zoo to Marquette	5.70	1.50	1.10	1.26	1.38	57%	28%	51%	54%
I-94 WB: Marquette to Zoo	5.81	1.14	1.18	1.58	1.36	45%	57%	80%	63%
I-894 WB: Hale to Zoo	5.77	1.34	1.08	1.12	1.24	62%	33%	48%	56%
I-43 SB/I-94 EB: Marquette to Mitchell	5.43	1.01	1.06	1.36	1.23	4%	25%	86%	56%
I-43 SB: STH 100 to Marquette	11.52	1.21	1.11	1.18	1.20	58%	38%	46%	52%
I-794 WB: Layton to Marquette	5.90	1.10	1.11	1.23	1.16	24%	28%	40%	32%
I-894 EB: Zoo to Hale	4.84	1.03	1.06	1.23	1.14	11%	27%	42%	29%
I-43 NB/I-94 WB: Mitchell to Marquette	5.77	1.19	1.06	1.06	1.13	49%	20%	24%	39%
US 41/45 SB: N. of County Line to Zoo	14.74	1.05	1.04	1.20	1.12	22%	20%	50%	34%
I-43 SB/I-894 WB: Mitchell to Hale	5.11	1.08	1.07	1.14	1.12	33%	24%	29%	31%
I-43 NB/I-894 EB: Hale to Mitchell	5.86	1.13	1.04	1.08	1.10	52%	16%	33%	43%
I-794 EB: Marquette to Layton	5.90	1.13	1.03	1.06	1.10	24%	5%	7%	15%
I-94 EB: CTH SS to Zoo	13.83	1.09	1.01	1.10	1.10	39%	0%	38%	39%
I-43 NB: Marquette to STH 100	11.52	1.00	1.02	1.11	1.06	1%	7%	38%	22%
I-94 WB: Zoo to CTH SS	14.02	1.01	1.01	1.07	1.04	3%	0%	33%	20%
I-94 NB: Oakwood to Mitchell	9.28	1.03	1.02	1.03	1.03	13%	3%	8%	11%
I-43 SB: STH 60 to STH 100	9.79	1.03	1.01	1.00	1.02	15%	0%	0%	9%
I-43 NB: STH 164 to Hale	12.61	1.02	1.00	1.01	1.01	8%	0%	0%	5%
US 41/45 NB: Zoo to N. of County Line	17.29	1.00	1.00	1.02	1.01	0%	0%	7%	4%
I-94 SB: Mitchell to Oakwood	8.90	1.00	1.00	1.01	1.01	0%	0%	0%	0%
I-94 SB: Oakwood to STH 11	11.85	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-94 NB: State Line to STH 11	11.86	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-43 NB: STH 100 to STH 60	9.78	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-43 SB: Hale to STH 164	11.77	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-94 NB: STH 11 to Oakwood	11.86	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-94 SB: STH 11 to State Line	11.85	1.00	1.00	1.00	1.00	0%	0%	0%	0%
Average for all Sections		1.08	1.04	1.11	1.10	22%	12%	27%	24%

Comments

- This table shows average weekday congestion (travel time index) and reliability (buffer index) for specific routes for different time periods of the day.
- There are several freeway sections at the bottom of the table that have little or no congestion and very good reliability.

Source and Coverage of Data

This report was produced using data collected and archived by the Wisconsin Department of Transportation (<http://www.dot.state.wi.us/> and <http://www.gcmtravel.com>). A map of the freeway routes on which traffic data was collected is shown below.

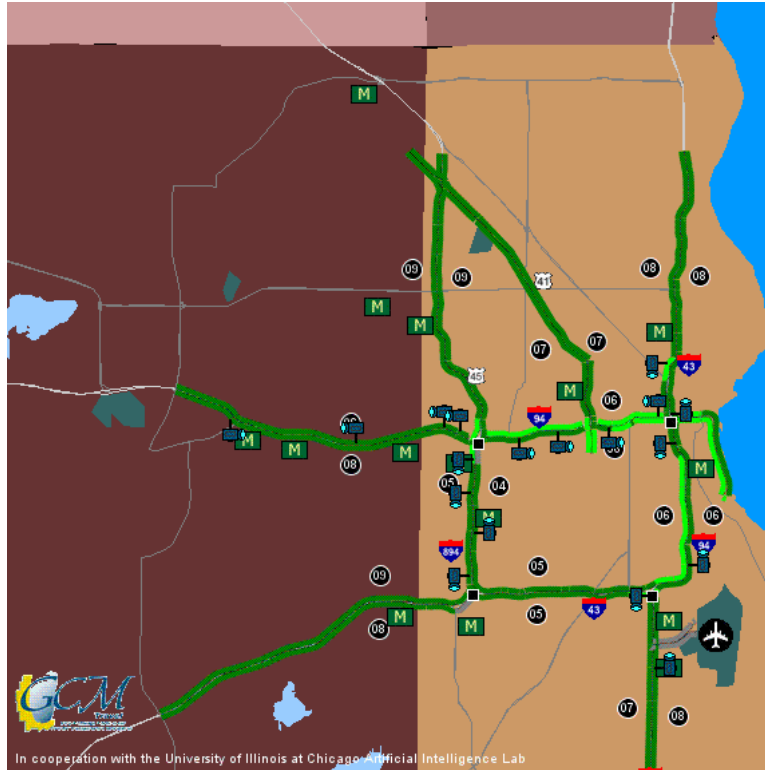


Exhibit MKE-12: Freeway Routes with Traffic Sensors in Milwaukee

(Source of graphic: GCM Travel, <http://www.gcmtravel.com>)

Exhibit MKE-13: Instrumented Freeway Coverage in Milwaukee

Coverage Measures	Year	Instrumented Freeway Routes	Total Freeway System ¹	Percent Coverage
Lane-miles	2000	n.a.	605	n.a.
	2001	695	605	115%
	2002	695	605	115%
	2003	698	605	115%
Centerline-miles	2000	n.a.	111	n.a.
	2001	122	111	110%
	2002	122	111	110%
	2003	118	111	106%
Average annual daily vehicle-miles of travel (DVMT) (1000)	2000	n.a.	9,700	n.a.
	2001	7,900	9,545	83%
	2002	8,600	9,305	92%
	2003	10,950	9,108	120%

¹Source is FHWA's Highway Performance Monitoring System and the Texas Transportation Institute's Urban Mobility Study (<http://mobility.tamu.edu/ums>).

Documentation and Definitions

Performance Measures

- **Travel Time Index:** ratio of the average peak period travel time to an off-peak travel time. For example, a value of 1.20 means that average peak travel times are 20% longer than off-peak travel times. In this report, the morning peak period is from 6 to 9 a.m. and the evening peak period is from 4 to 7 p.m. The off-peak travel time is calculated by assuming a free-flow speed of 60 mph.
- **Planning Time Index:** statistically defined as the 95th percentile Travel Time Index, this measure also represents the extra time most travelers include when planning peak period trips. For example, a value of 1.60 means that travelers plan for an additional 60% travel time above the off-peak travel times to ensure 95% on-time arrival.
- **Buffer Index:** the extra time (or buffer) needed to ensure on-time arrival for most trips. For example, a value of 40% means that a traveler should budget an additional 8 minute buffer for a 20-minute average peak trip time to ensure 95% on-time arrival. In this report, the buffer index is a VMT-weighted average of the buffer index for each route for the morning and evening peak period. The buffer index is calculated for each route and time period as follows: $\text{buffer index} = (95^{\text{th}} \text{ percentile travel time} - \text{average travel time}) / \text{average travel time}$.
- **% Congested Travel:** the congested peak period vehicle-miles of travel (VMT) divided by total VMT in the peak period. This is a relative measure of the amount of peak period travel affected by congestion.
- **Total Delay per 1000 VMT:** the total vehicle delay (in vehicle-hours) divided by the amount of VMT. This is a relative measure of the total delay and will not be as affected by changes in the level of sensor instrumentation for a particular city.
- **Vehicle Delay:** the delay (in vehicle-hours) experienced by vehicles traveling less than free-flow speeds (assumed to be 60 mph in this report).

Explanatory Measures

- **Peak Period VMT:** the average amount of VMT within the defined peak periods (weekdays from 6 to 9 a.m. and 4 to 7 p.m.) for the year. Peak period VMT is reported by 1000s.
- **Average Annual DVMT (000):** the average annual amount of daily VMT (DVMT) for all days and times for the year. Average annual DVMT is reported by 1000s.

Data Quality Measures

- **% complete:** the number of valid reported data values divided by the number of total expected data values (given the number of active sensors and time periods). In this report, % complete is reported as the lowest value of either traffic volume or speed data.
- **% valid:** the number of reported data values that passed defined acceptance criteria divided by the total number of reported data values. In this report, % valid is reported as the lowest value of either traffic volume or speed data.
- **% of DVMT covered:** the amount of average annual DVMT reported by sensors divided by the areawide average annual DVMT as estimated in FHWA's Highway Performance Monitoring System and TTI's Urban Mobility Study. This measure characterizes the relative amount of areawide travel that has the performance indicated in this report.
- **% coverage of freeway mileage:** the amount of freeway lane-miles containing sensors divided by the areawide freeway lane-miles as estimated in FHWA's Highway Performance Monitoring System and TTI's Urban Mobility Study. This measure characterizes the relative amount of areawide freeways that has the performance indicated in this report.