

Appendix SLC – Salt Lake City, Utah 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 SLC-1: Current Measures and Trends

Measures	Current Year	Last Year		Two Years Ago	
	2003	2002	Change	2001	Change
Performance Measures					
Travel Time Index	1.05	1.01	+4% ↑	n.a.	n.a. —
Planning Time Index	1.18	1.02	+16% ↑	n.a.	n.a. —
Buffer Index	11%	1%	+10% ↑	n.a.	n.a. —
% Congested Travel	15%	12%	+3% ↑	n.a.	n.a. —
Total Delay (veh-hours) per 1000 VMT	0.89	0.41	+114% ↑	n.a.	n.a. —
Explanatory Measures					
Peak Period VMT (000)	1,670	360	+364% ↑	n.a.	n.a. —
Avg. Annual DVMT (000)	7,430	1,450	+412% ↑	n.a.	n.a. —
Data Quality Measures					
% complete	38%	19%	+19% ↑	n.a.	n.a. —
% valid	53%	60%	-7% ↓	n.a.	n.a. —
% of VMT covered	83%	17%	+66% ↑	n.a.	n.a. —
% of freeway miles	113%	116%	-3% ↓	n.a.	n.a. —

* See pages 8 and 9 for maps of freeway coverage, measure definitions, and further documentation.

Exhibit SLC-2: 2000 to 2003 Annual Trends

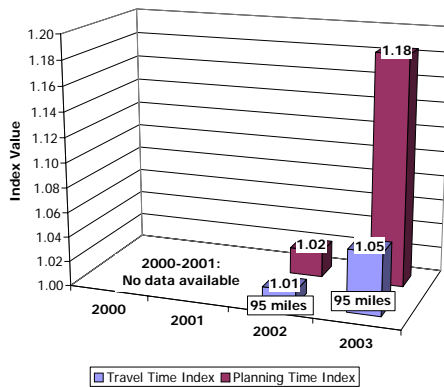
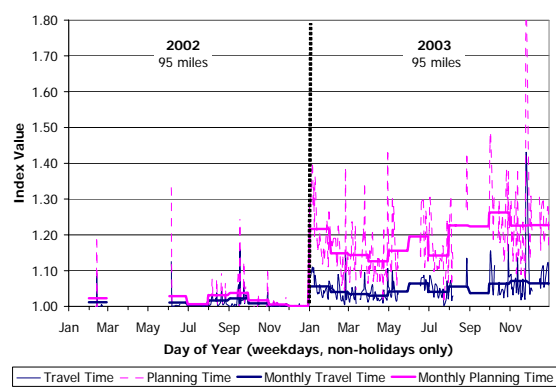


Exhibit SLC-3: Daily and Monthly Trends



Comments

- Nearly all 2003 congestion and reliability measures show large increases over 2002 levels; however, data quality in 2002 was poor and thus the 2002 statistics are suspect.
- The 2003 vehicle travel increased significantly over 2002 levels. This was likely due to changes in the data archiving system and improving data quality.

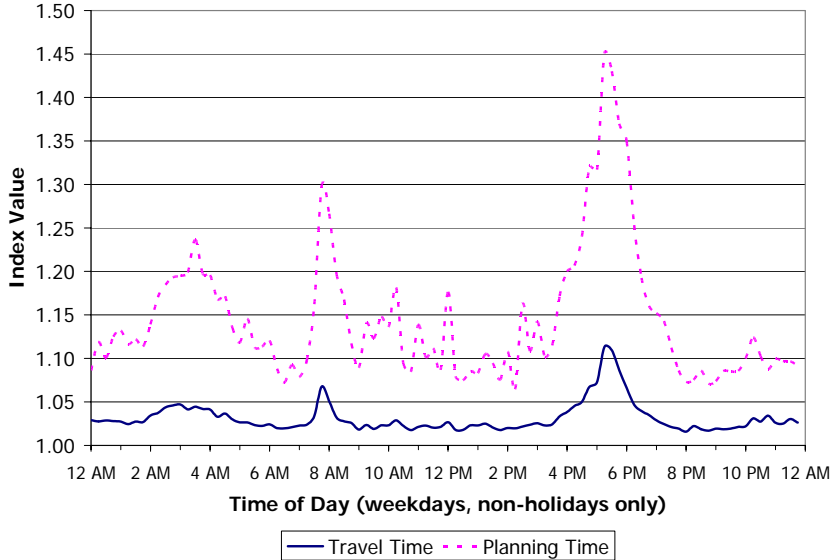
Data Source(s): Utah Department of Transportation (<http://www.utahcommuterlink.com>)

Includes 95 of 84 (100+%) total freeway miles in Salt Lake City (11 miles are outside the urban area); collected using loop detectors; see page 8 for additional information on the data source

Data Analysis: Texas Transportation Institute, analysis completed September 2004

Time of Day Patterns and Trends

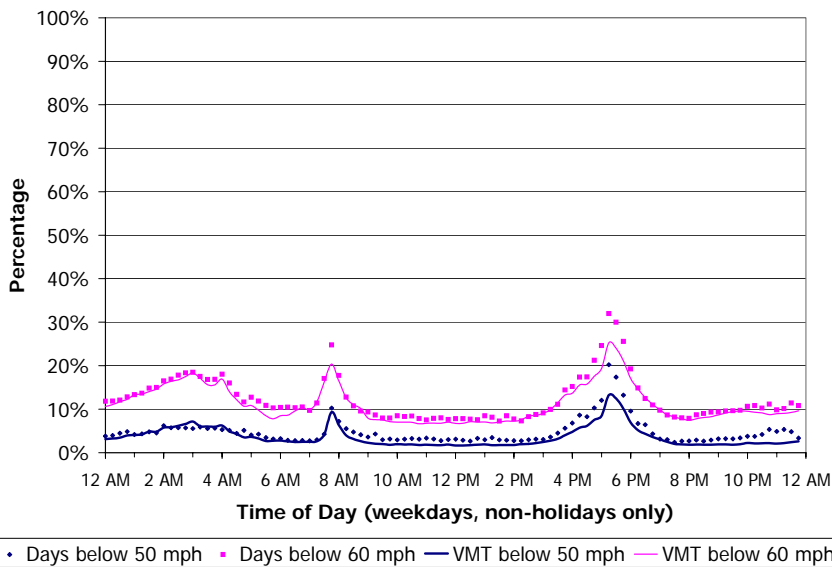
The charts on this page illustrate average weekday (no holidays included) traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors.



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 evening congestion level is worse than the morning congestion level.
- The reliability (planning time index) is unstable during the mid-day period.

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



Comments

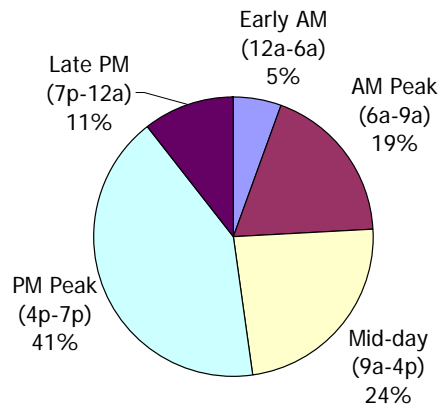
- This chart illustrates the difference in using two different speed thresholds (50 and 60 mph) to compute the percent of congested days as well as the percent of congested travel.
- Because of low congestion levels, there does not appear to be a significant difference between using a 50 mph or 60 mph threshold in Salt Lake City.

Exhibit SLC-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:

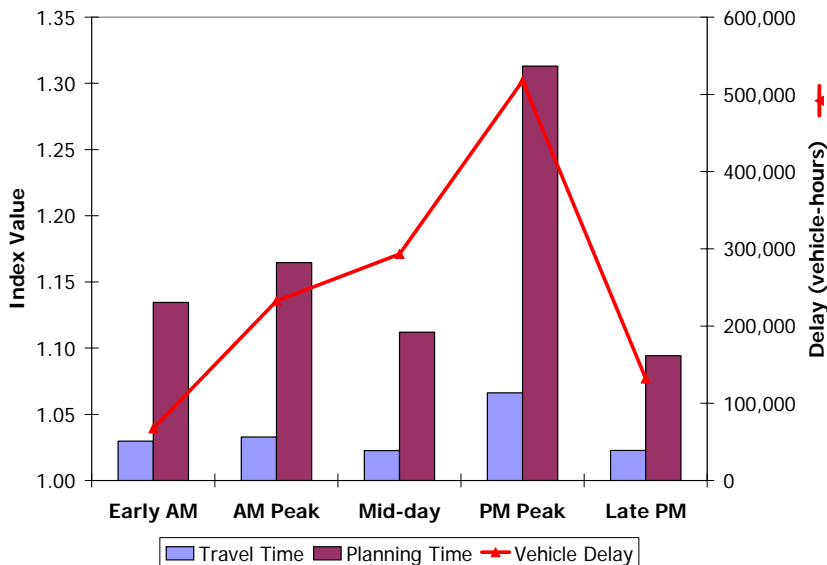
- Early AM: 12 to 6 am
- AM Peak: 6 to 9 am
- Mid-day: 9 am to 4 pm
- PM Peak: 4 to 7 pm
- Late PM: 7 pm to 12 am



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 significantly greater than during the morning peak period.
- Delay during the mid-day period is greater than delay during the morning peak period.

Exhibit SLC-6: Percent of Delay by Time Period



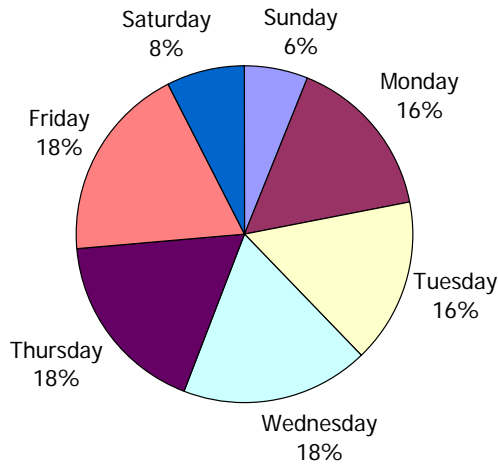
Comments

- 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 SLC-7: Mobility, Reliability, and Delay by Time Period

Day of Week Patterns and Trends

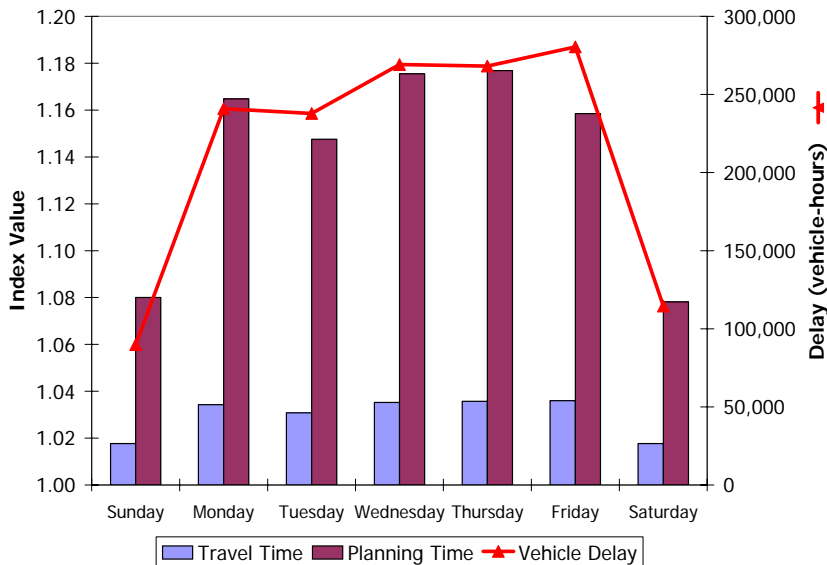
The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. Because of different peak period times and lengths on weekdays and weekends, the statistics presented on this page are 24-hour daily totals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



Comments

- This chart shows the percent of total daily delay that occurred during each day of the week.
- The delay from all weekdays is comparable, accounting for 16-18% each day.
- The weekend days have about half of the normal weekday delay.

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



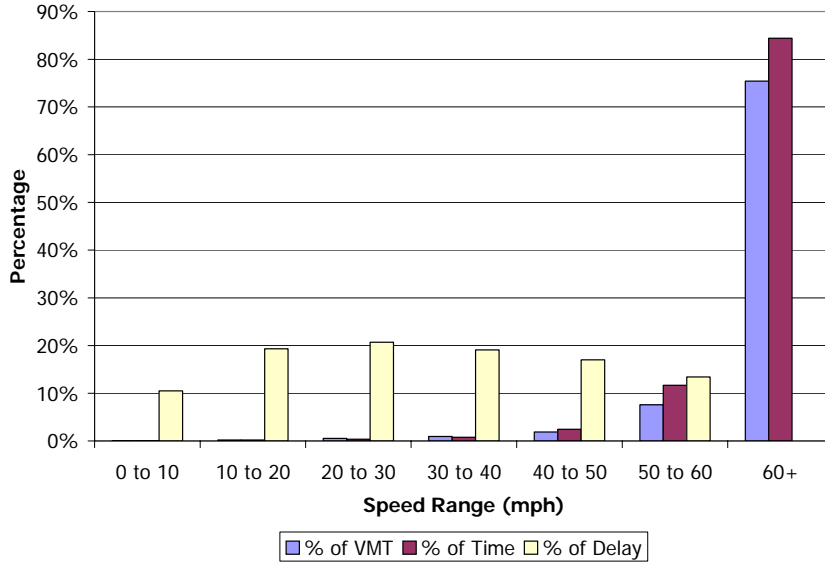
Comments

- 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 but Thursday is the least reliable day (highest planning time index).

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

Other Traffic Data 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.



Comments

- This chart shows the percent of VMT, time, and delay in different speed ranges. This chart is useful in determining how much VMT and delay is occurring at different congestion levels.
- The delay is about evenly spread among all speed ranges less than 60 mph.

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

Mobility and Reliability Statistics for Specific Freeway Sections

The table and charts in this section illustrate 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 SLC-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-15 HOV NB: 5800 South to 2700 South	4.85	1.31	1.12	1.16	1.24	102%	58%	87%	95%
I-15 NB: 550 North to 2600 South	6.45	1.06	1.06	1.32	1.24	32%	32%	73%	60%
I-15 SB: 10700 South to 14800 South	6.33	1.01	1.04	1.27	1.16	0%	24%	55%	33%
I-15 SB: I-215 North to 10500 South	5.80	1.00	1.01	1.16	1.10	0%	0%	68%	42%
I-15 SB: 2700 South to 5800 South	4.85	1.06	1.08	1.10	1.09	13%	29%	44%	33%
I-215 CW: I-80 to 900 West	6.00	1.00	1.01	1.13	1.09	0%	0%	81%	52%
I-215 CW: 2300 East to 600 West	5.00	1.09	1.04	1.07	1.08	37%	24%	29%	32%
I-15 HOV NB: 2400 South to North Temple	4.75	1.08	1.11	1.07	1.08	23%	12%	20%	22%
I-15 NB: 2400 South to North Temple	4.75	1.07	1.09	1.07	1.07	31%	48%	35%	33%
SR 201 WB: 850 West to 7000 West	9.25	1.01	1.01	1.10	1.06	3%	0%	37%	23%
I-80 EB: 400 West to I-215E	6.55	1.01	1.01	1.08	1.06	2%	0%	27%	18%
SR 201 EB: 7000 West to 850 West	8.50	1.08	1.01	1.02	1.05	30%	4%	7%	19%
I-15 NB: 14800 South to 10700 South	6.33	1.06	1.02	1.03	1.04	29%	0%	10%	20%
I-15 HOV SB: I-215 North to 10500 South	5.80	1.03	1.01	1.04	1.04	15%	4%	13%	14%
I-15 NB: 5800 South to 2700 South	4.85	1.04	1.03	1.02	1.03	20%	7%	6%	14%
I-80 EB: West of Quarry to Lamb	9.35	1.04	1.03	1.03	1.03	8%	7%	6%	7%
I-15 HOV NB: 10500 South to I-215	5.80	1.04	1.01	1.02	1.03	12%	0%	0%	6%
I-80 WB: Silvercreek to Parley's Summit	9.18	1.03	1.02	1.03	1.03	13%	7%	12%	12%
I-15 HOV SB: 2700 South to 5800 South	4.85	1.02	1.01	1.03	1.03	9%	3%	11%	11%
I-15 NB: 10500 South to I-215	5.80	1.04	1.00	1.00	1.03	22%	0%	0%	12%
I-80 EB: Parley's Summit to Silvercreek	8.40	1.03	1.03	1.02	1.02	7%	0%	0%	3%
I-80 WB: I-215E to Main	6.05	1.04	1.00	1.00	1.02	20%	0%	0%	11%
I-15 SB: 2600 South to 550 North	6.45	1.02	1.01	1.01	1.01	9%	5%	5%	7%
I-80 WB: Lamb to West of Quarry	8.35	1.02	1.01	1.01	1.01	4%	2%	2%	3%
I-15 SB: North Temple to 2400 South	4.75	1.01	1.01	1.02	1.01	0%	0%	0%	0%
I-215 CCW: I-80 West to 3550 South	5.70	1.00	1.00	1.02	1.01	0%	0%	0%	0%
I-215 CW: I-15 to 4200 South	6.70	1.02	1.00	1.00	1.01	0%	0%	0%	0%
I-215 CCW: 6200 South to Foothill	6.30	1.02	1.00	1.00	1.01	0%	0%	0%	0%
I-215 CCW: 3900 South to 700 West	5.55	1.00	1.00	1.01	1.01	0%	0%	4%	3%
I-15 HOV SB: North Temple to 2400 South	4.75	1.01	1.00	1.01	1.01	6%	0%	0%	2%

Exhibit SLC-11 (Continued). 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-215 CW: 3900 South to I-80	5.85	1.01	1.00	1.00	1.01	1%	0%	0%	0%
I-215 CW: Foothill to 6220 South	6.55	1.01	1.00	1.00	1.00	0%	0%	0%	0%
I-215 CCW: 300 West to 2300 East	4.70	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-80 EB: 4800 West to 1300 West	5.20	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-215 CCW: 900 West to 100 North	5.95	1.00	1.00	1.00	1.00	0%	0%	0%	0%
I-80 WB: 1300 West to 4800 West	4.60	1.00	1.00	1.00	1.00	0%	0%	0%	0%
Average for all Sections		1.03	1.02	1.07	1.05	12%	8%	21%	17%

Comments

- This table shows average weekday congestion (travel time index) and reliability (buffer index) for specific routes for different time periods of the day.
- All freeway sections have travel time index values less than 1.25, which indicates low overall congestion levels.
- The most congested freeway sections are on I-15.

Source and Coverage of Data

This report was produced using data collected by the Utah DOT (<http://www.utahcommuterlink.com>). A map of the freeway routes on which traffic data was collected is shown below.

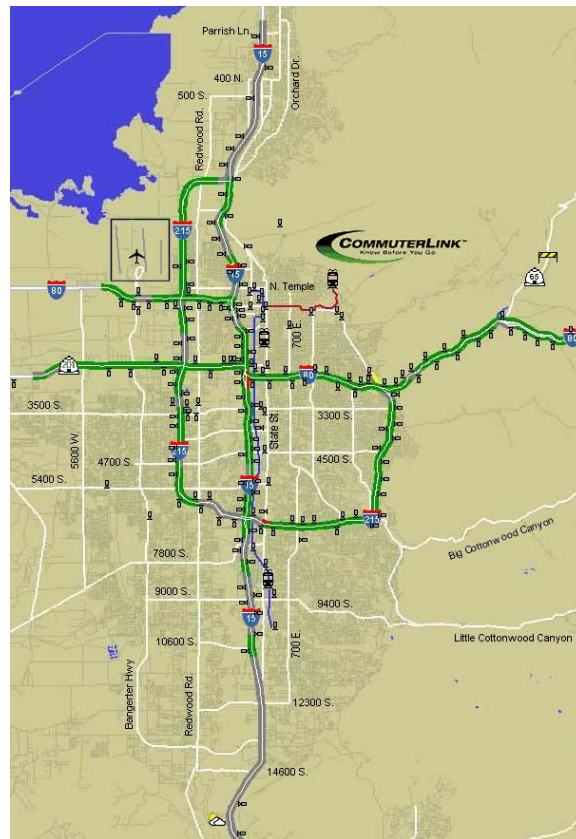


Exhibit SLC-12: Freeway Routes with Traffic Sensors in Salt Lake City
 (Source of graphic: Utah DOT CommuterLink, <http://www.utahcommuterlink.com>)

Exhibit SLC-13: Instrumented Freeway Coverage in Salt Lake City

Coverage Measures	Year	Instrumented Freeway Routes	Total Freeway System ¹	Percent Coverage
Lane-miles	2000	n.a.	500	n.a.
	2001	n.a.	525	n.a.
	2002	656	530	124%
	2003	656	545	120%
Centerline-miles	2000	n.a.	79	n.a.
	2001	n.a.	79	n.a.
	2002	95	82	116%
	2003	95	84	113%
Average annual daily vehicle-miles of travel (DVMT) (1000)	2000	n.a.	7,000	n.a.
	2001	n.a.	7,800	n.a.
	2002	1,450	8,295	17%
	2003	7,430	8,943	83%

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.