Appendix MSP – Minneapolis-St. Paul, Minnesota
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 MSP-1: Current Measures and Trends

Measures	Current Year	Last Year		Two Years Ago	
	2003	2002	Change	2001	Change
Performance Measures					
Travel Time Index	1.23	1.20	+2% ↑	1.27	-3% ↓
Planning Time Index	1.52	1.49	+2% ↑	1.61	-5% ↓
Buffer Index	20%	21%	-1% ↓	23%	-3% ↓
% Congested Travel	37%	39%	-2% ↓	50%	-13% ↓
Total Delay (veh-hours) per 1000 VMT	3.92	3.78	+4% ↑	4.86	-19% ↓
Explanatory Measures					
Peak Period VMT (000)	5,750	4,720	+22% ↑	4,560	+26% ↑
Avg. Annual DVMT (000)	19,610	16,160	+21% ↑	15,520	+26% ↑
Data Quality Measures					
% complete	79%	85%	-6% ↓	98%	-19% ↓
% valid	78%	89%	-11% ↓	92%	-14% ↓
% of VMT covered	72%	59%	+13% ↑	55%	+17% ↑
% of freeway miles	69%	60%	+9% ↑	60%	+9% ↑

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

Exhibit MSP-2: 2000 to 2003 Annual Trends

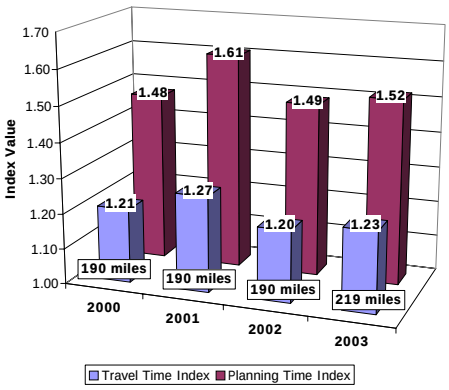
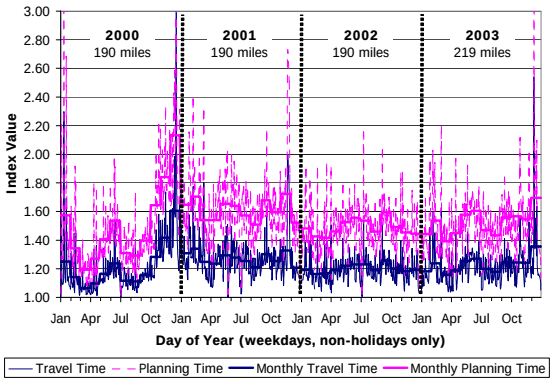


Exhibit MSP-3: Daily and Monthly Trends



Comments

- The 2003 travel time index is up slightly from 2002 levels but is still less than 2001 levels (post-ramp meter test phase). The 2003 buffer index and percent of congested travel are also less than 2001 and 2002 levels.
- The amount of vehicle travel (DVMT) being reported has increased by more than 20% each of the past 3 years.

Data Source(s): University of Minnesota-Duluth (http://tdrl1.d.umn.edu/) in cooperation with the Minnesota DOT (http://www.dot.state.mn.us/tmc/)
Includes 219 of 317 (69%) total freeway miles in Minneapolis-St. Paul; 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.

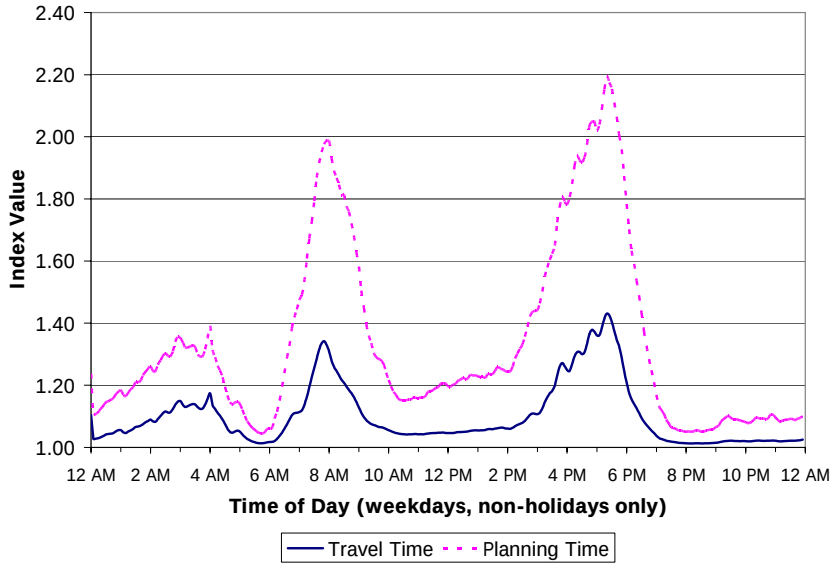


Exhibit MSP-4: Mobility and Reliability by Time of Average Weekday

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 slightly worse than in the morning.
- Travelers must add 30-50% additional buffer time during peak times to account for traffic unreliability.

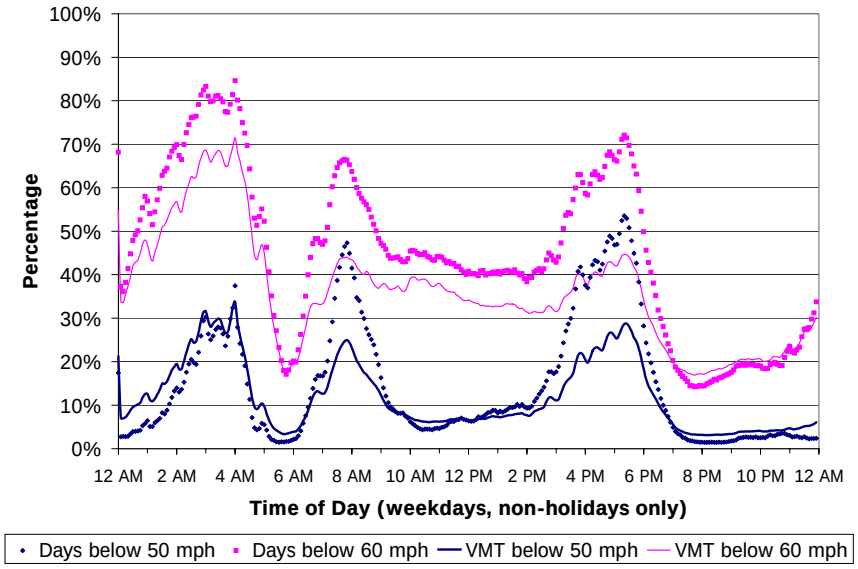


Exhibit MSP-5: Frequency and Percentage of Congested Travel by Time of Average Weekday

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.
- Slow speeds (even less than 50 mph) are being recorded during the early morning.
- There appear to be significant differences between using a 50 mph threshold and a 60 mph threshold.

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

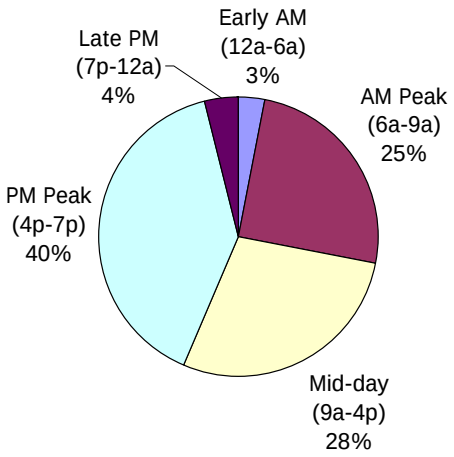


Exhibit MSP-6: Percent of Delay by Time Period

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 slightly greater than during the morning peak period. This is due to the longer mid-day time period.

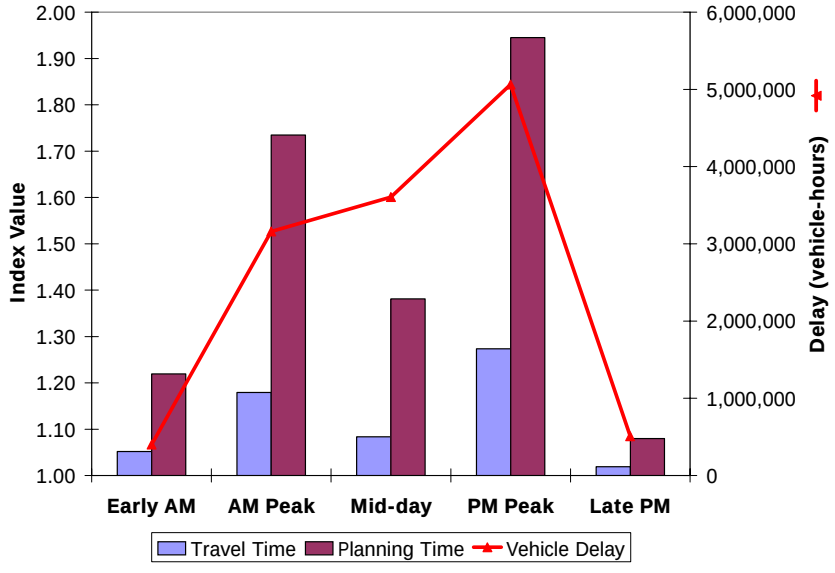


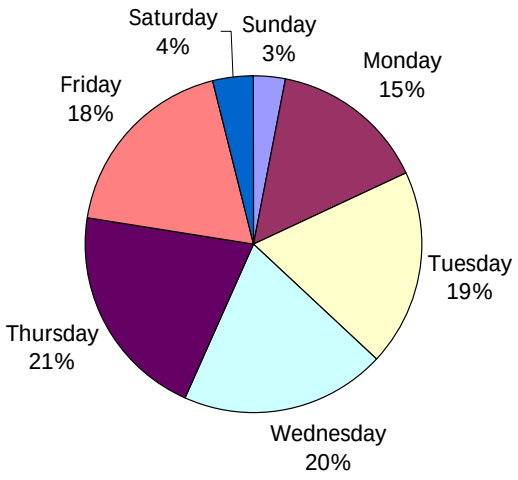
Exhibit MSP-7: Mobility, Reliability, and Delay by Time Period

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).

Day of Week Patterns and Trends

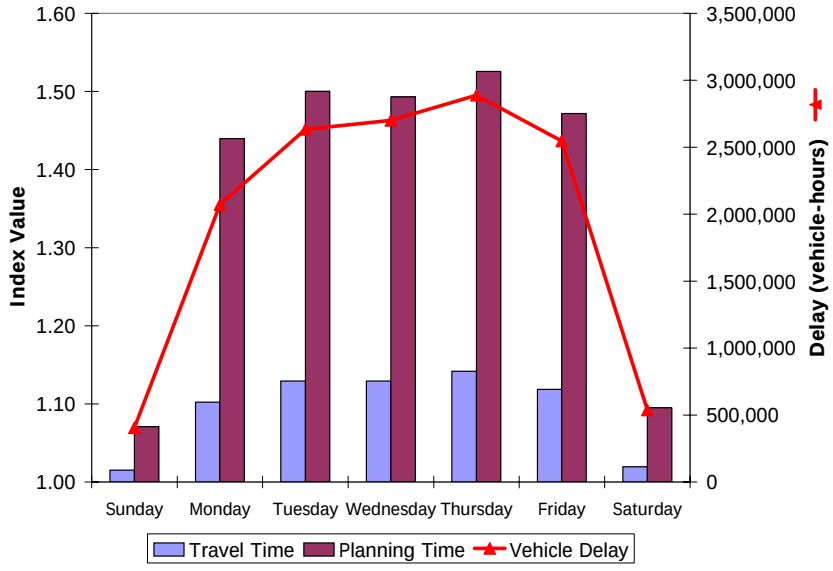
The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. Because of different peak period times and lengths on weekdays and weekends, the statistics presented on this page are 24-hour daily totals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



Comments

- This chart shows the percent of total daily delay that occurred during each day of the week.
- Thursday has the most delay, and Monday has the least delay of all weekdays.
- Both weekend days combined have 35-50% of the delay of a typical weekday.

Exhibit MSP-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.
- Thursday has the most delay and also is the least reliable day (highest planning time index).

Exhibit MSP-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.

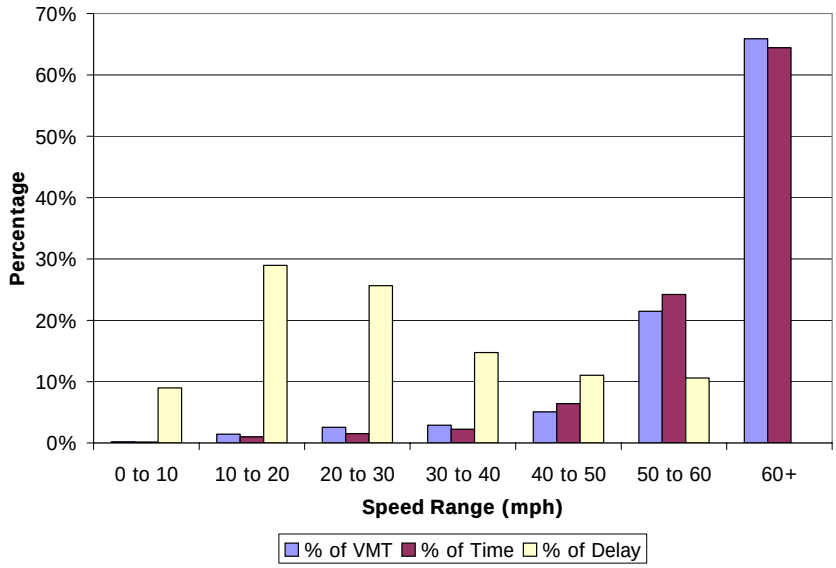


Exhibit MSP-10: Percent of VMT, Delay and Time Periods in Different Speed Ranges

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 65% of the delay is at speeds less than 30 mph.
- Slightly more than 10% of the delay is in the 50 to 60 mph range.

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 MSP-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
MN 62 EB: I-494 to I-35W	7.50	1.34	1.30	1.88	1.61	56%	65%	74%	65%
US 100 NB: I-494 to Duluth St	10.46	1.25	1.09	1.62	1.45	56%	46%	79%	69%
I-494 WB: TH 5 to I-35W	4.96	1.46	1.16	1.39	1.43	94%	71%	113%	103%
I-35W NB: I-494 to I-94	8.34	1.39	1.15	1.44	1.41	65%	52%	52%	58%
MN 62 WB: I-35W to I-494	6.93	1.31	1.27	1.51	1.41	68%	74%	84%	76%
I-494 WB: I-35W to I-394	14.14	1.10	1.18	1.63	1.37	24%	46%	98%	62%
I-94 WB: I-35E/MN 52 to I-394	12.35	1.29	1.19	1.45	1.36	60%	40%	54%	57%
I-35E NB: I-494 to I-94	7.14	1.29	1.18	1.43	1.36	51%	41%	76%	63%
I-94 EB: I-394 to I-35E/MN 52	12.64	1.09	1.15	1.57	1.35	21%	40%	65%	45%
US 169 NB: I-494 to I-394	8.45	1.12	1.12	1.59	1.35	40%	41%	101%	70%
I-35E NB: I-94 to Hwy 36	5.50	1.02	1.12	1.52	1.31	5%	50%	85%	53%
I-35W SB: I-94 to I-494	8.17	1.15	1.19	1.46	1.31	43%	49%	49%	46%
US 100 SB: Duluth St to I-494	10.69	1.27	1.06	1.34	1.30	61%	23%	46%	54%
US 169 SB: 77th Ave/I-94 to I-394	8.66	1.47	1.03	1.06	1.29	111%	3%	24%	73%
MN 62 WB: TH 5 to I-35W	4.86	1.36	1.11	1.23	1.29	79%	46%	66%	72%
I-35E SB: Hwy 36 to I-94	5.68	1.40	1.05	1.08	1.26	74%	24%	36%	57%
I-394 WB: I-94 to I-494/Central Ave	11.79	1.02	1.04	1.42	1.25	7%	20%	61%	37%
I-94 WB: TH 252/I-694 to I-494	8.87	1.07	1.15	1.36	1.24	62%	57%	69%	67%
I-494 EB: I-94 to I-394	9.07	1.38	1.03	1.04	1.24	89%	0%	21%	62%
I-35W SB: Hwy 36 to I-94	6.24	1.18	1.12	1.27	1.22	45%	42%	61%	52%
I-35W NB: I-35 split to I-494	8.91	1.35	1.02	1.04	1.22	91%	2%	21%	61%
I-35W NB: I-94 to Hwy 36	5.76	1.04	1.12	1.32	1.22	9%	34%	93%	62%
MN 62 EB: I-35W to TH 5	4.38	1.22	1.11	1.20	1.21	42%	27%	26%	34%
I-35E SB: I-94 to I-494	8.33	1.06	1.07	1.32	1.20	11%	10%	78%	46%
I-35W SB: Lexington to Hwy 36	11.36	1.31	1.01	1.00	1.20	78%	0%	0%	50%
MN 36 EB: TH 280 to Hwy 61	7.19	1.01	1.03	1.29	1.20	2%	12%	72%	49%
US 169 SB: I-394 to I-494	8.26	1.13	1.12	1.27	1.19	37%	28%	57%	46%
I-394 EB: Central Ave/I-494 to I-94	11.68	1.18	1.07	1.19	1.18	48%	31%	49%	48%
I-694 EB: I-94/TH 252 to Rice St/I-35E	10.04	1.10	1.04	1.26	1.18	32%	22%	71%	53%
US 169 NB: I-394 to 77th Ave/I-94	8.66	1.01	1.07	1.29	1.18	0%	33%	38%	23%
MN 36 WB: Hwy 61 to I-35W	6.76	1.29	1.03	1.02	1.18	68%	6%	11%	44%
I-494 EB: I-394 to I-35W	13.64	1.08	1.06	1.28	1.17	34%	26%	52%	42%
I-35W NB: Hwy 36 to Lexington	11.29	1.00	1.03	1.24	1.17	0%	20%	55%	39%
I-94 EB: I-494 to TH 252/I-694	8.51	1.25	1.05	1.05	1.17	76%	20%	15%	51%
MN 77 NB: County Rd 38 to TH 62	10.43	1.19	1.01	1.01	1.13	70%	0%	7%	48%
I-94 EB: TH 252/I-694 to I-394	6.44	1.17	1.03	1.02	1.12	36%	10%	7%	27%
I-694 WB: Rice St/I-35E to I-94/TH 252	9.38	1.12	1.04	1.10	1.11	43%	10%	37%	40%
I-494 WB: I-394 to I-94	8.21	1.00	1.04	1.15	1.10	0%	23%	39%	26%
I-35W SB: I-494 to I-35 split	8.88	1.00	1.01	1.14	1.09	0%	0%	37%	24%
MN 10 WB: I-35W to US 169	12.01	1.01	1.03	1.10	1.07	0%	18%	34%	22%
MN 77 SB: TH 62 to County Rd 38	10.38	1.00	1.01	1.09	1.07	2%	1%	51%	39%
MN 10 EB: US 169 to I-35W	11.98	1.10	1.00	1.00	1.06	45%	0%	0%	27%
US 212 NB: I-494 to US 169	2.92	1.07	1.02	1.04	1.06	35%	6%	5%	22%
I-494 EB: I-35W to TH 5	4.43	1.00	1.01	1.08	1.05	0%	1%	25%	14%
I-94 WB: I-394 to TH 252/I-694	6.56	1.01	1.02	1.06	1.05	4%	5%	30%	22%

Exhibit MSP-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
MN 5 EB: I-494 to TH 55	2.09	1.02	1.02	1.03	1.02	6%	5%	5%	5%
I-35E NB: I-35 split to I-494	12.00	1.03	1.00	1.00	1.02	8%	0%	0%	5%
I-35E SB: I-494 to I-35 split	11.05	1.00	1.00	1.03	1.02	0%	0%	9%	6%
US 212 SB: US 169 to I-494	2.62	1.01	1.00	1.02	1.01	0%	0%	10%	6%
MN 5 WB: TH 55 to I-494	1.93	1.01	1.01	1.01	1.01	1%	2%	2%	2%
I-94 EB: I-35E/MN 52 to Manning Ave	9.97	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
I-94 WB: Manning Ave to I-35E/MN 52	9.98	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Average for all Sections		1.18	1.08	1.27	1.23	44%	26%	49%	47%

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 but one freeway section had travel time index values less than 1.50.
- The last two freeway sections in the table (I-94 EB and I-94 WB) had no data available in 2003.

Source and Coverage of Data

This report was produced using data collected by the Minnesota Department of Transportation (http://www.dot.state.mn.us/tmc/) and archived by the University of Minnesota-Duluth (http://tdrl1.d.umn.edu/). A map of the freeway routes on which traffic data was collected is shown below.

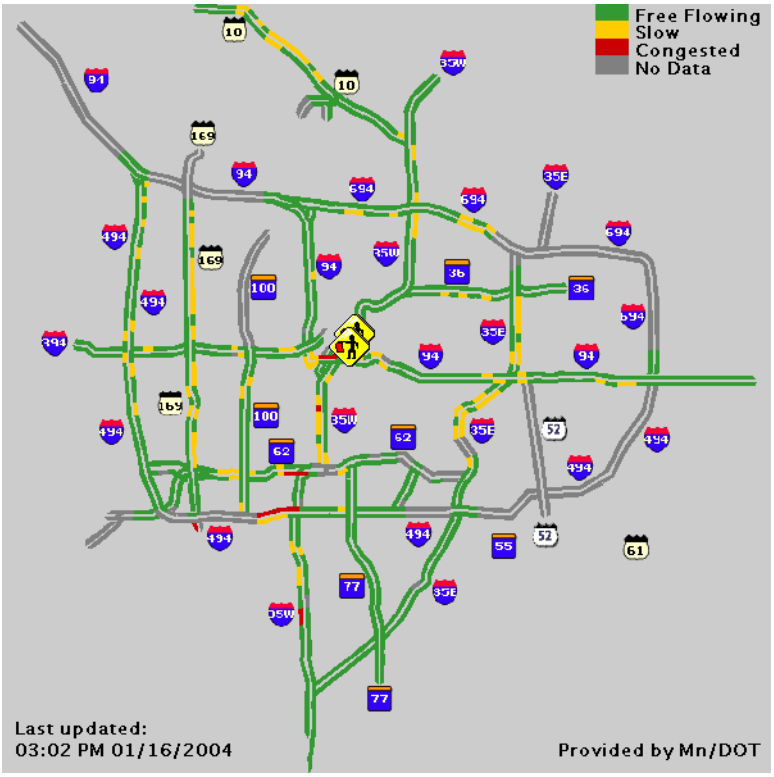


Exhibit MSP-12: Freeway Routes with Traffic Sensors in Minneapolis-St. Paul
(Source of graphic: Minnesota DOT, http://www.dot.state.mn.us/tmc/)

Exhibit MSP-13: Instrumented Freeway Coverage in Minneapolis-St. Paul

Coverage Measures	Year	Instrumented Freeway Routes	Total Freeway System[1]	Percent Coverage
Lane-miles	2000	990	1,580	63%
	2001	990	1,600	62%
	2002	999	1,590	63%
	2003	1194	1,595	75%
Centerline-miles	2000	190	316	60%
	2001	190	317	60%
	2002	190	317	60%
	2003	219	317	69%
Average annual daily vehicle-miles of travel (DVMT) (1000)	2000	16,240	27,095	60%
	2001	15,520	28,185	55%
	2002	16,160	27,300	59%
	2003	19,615	27,403	72%

[1]Source 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: buffer index = (95^{th} percentile travel time – average travel time) / 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.