

## Appendix SEA – Seattle, Washington 2003 Annual Report on Freeway Mobility and Reliability

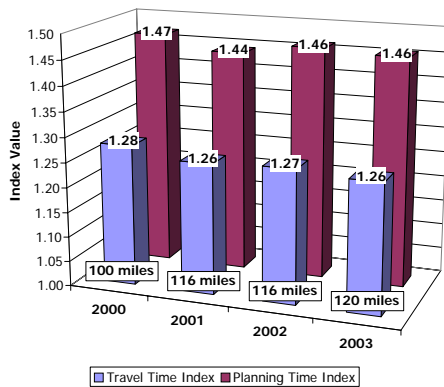
This report is a supplement to: *Monitoring Urban Freeways in 2003: Current Conditions and Trends from Archived Operations Data*. Texas Transportation Institute and Cambridge Systematics, Inc., Report No. FHWA-HOP-05-018, December 2004, available at <http://mobility.tamu.edu/mmp>.

**Exhibit SEA-1: Current Measures and Trends**

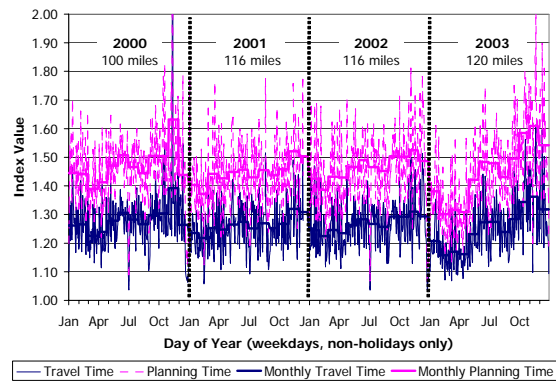
Measures	Current Year	Last Year		Two Years Ago	
	2003	2002	Change	2001	Change
<b>Performance Measures</b>					
Travel Time Index	1.26	1.27	-1% ↓	1.26	0% —
Planning Time Index	1.46	1.46	0% —	1.44	+1% ↑
Buffer Index	14%	14%	0% —	14%	0% —
% Congested Travel	61%	61%	0% —	60%	+1% ↑
Total Delay (veh-hours) per 1000 VMT	4.22	4.41	-4% ↓	4.53	-7% ↓
<b>Explanatory Measures</b>					
Peak Period VMT (000)	5,200	3,610	+44% ↑	3,780	+38% ↑
Avg. Annual DVMT (000)	17,890	14,480	+24% ↑	14,820	+21% ↑
<b>Data Quality Measures</b>					
% complete	80%	53%	+27% ↑	87%	-7% ↓
% valid	85%	98%	-13% ↓	97%	-12% ↓
% of VMT covered	58%	48%	+10% ↑	49%	+9% ↑
% of freeway miles	48%	47%	+1% ↑	48%	0% —

\* See pages 7 and 9 for maps of freeway coverage, measure definitions, and further documentation.

**Exhibit SEA-2: 2000 to 2003 Annual Trends**



**Exhibit SEA-3: Daily and Monthly Trends**



### Comments

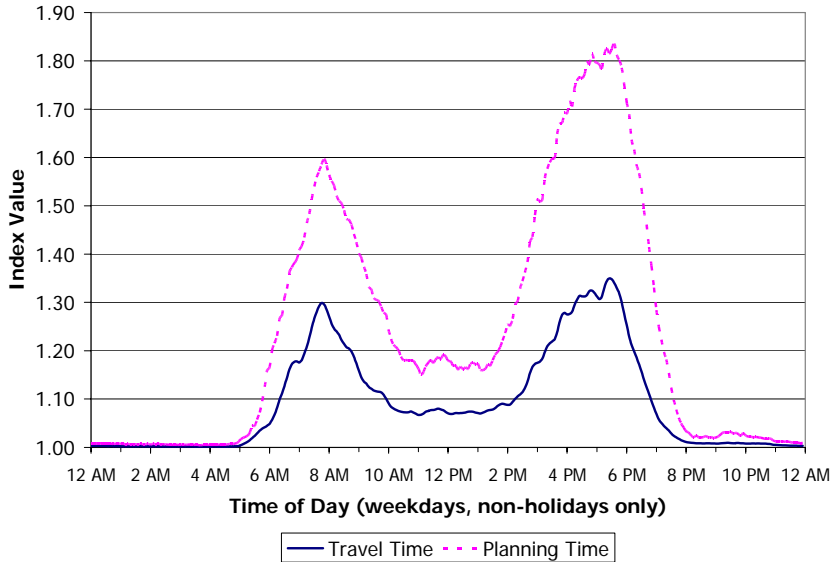
- All 2003 congestion and reliability measures remained stable as compared to 2002 and 2001 levels. Delay in 2003 shows a 4-7% improvement over 2002 and 2001 levels, respectively.
- The data indicate that peak period and daily vehicle travel has significantly increased – the cause of this increase is not known.

**Data Source(s):** Washington Department of Transportation (<http://www.wsdot.wa.gov/PugetSoundTraffic/>)  
Includes 120 of 249 (48%) total freeway miles in Seattle; collected using loop detectors; see page 7 for additional information on the data source

**Data Analysis:** Cambridge Systematics, Inc., analysis completed October 2004

### Time of Day Patterns and Trends

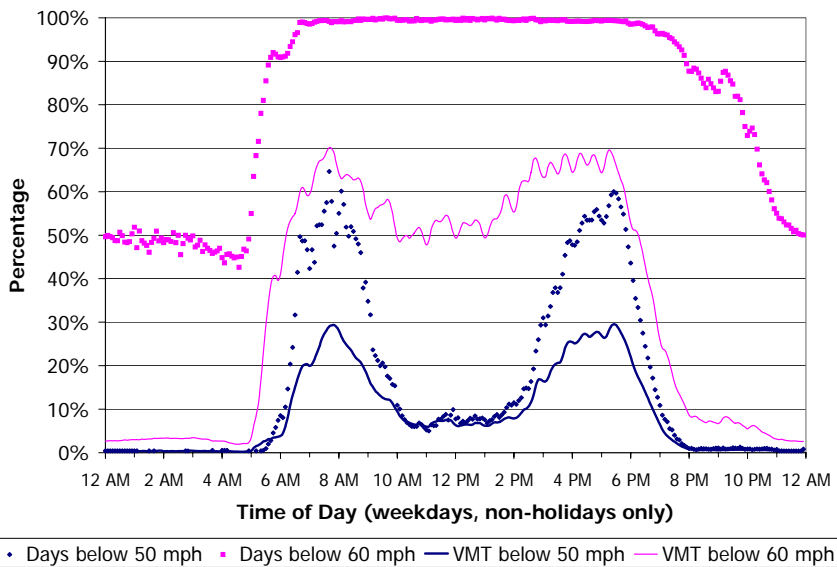
The charts on this page illustrate average weekday (no holidays included) traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors.



#### 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 is slightly higher and longer than in the morning.
- Travelers must add 25-35% additional buffer time during peak times to account for traffic unreliability.

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



#### Comments

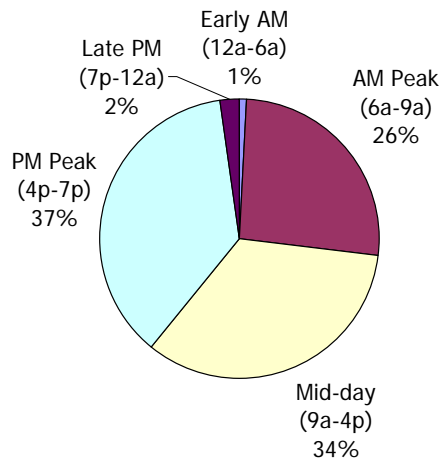
- This chart illustrates the difference in using two different speed thresholds (50 and 60 mph) to compute the percent of congested days as well as the percent of congested travel.
- Nearly all mid-day speeds appear to be in the 50 to 60 mph range, as indicated by the odd line shape for the 60 mph threshold.
- Peak period trends are more evident when using 50 mph as the congestion threshold.

**Exhibit SEA-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:

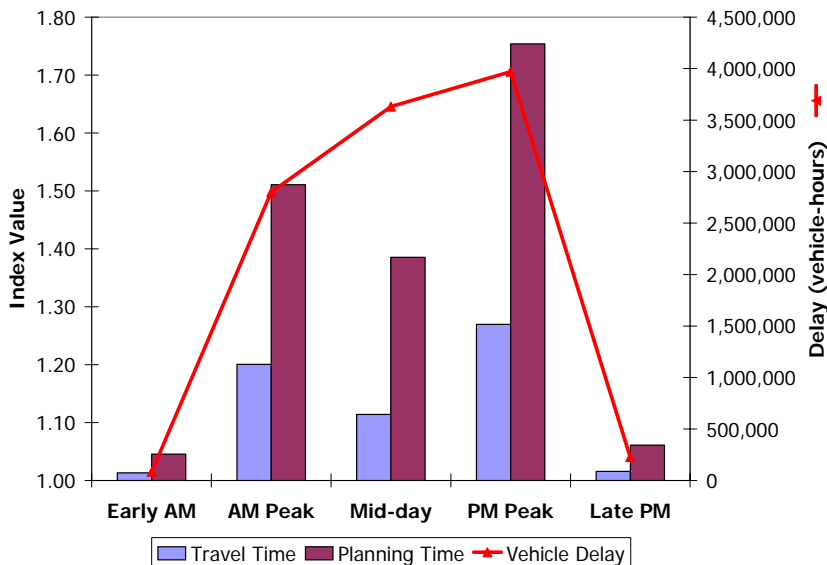
- Early AM: 12 to 6 am
- AM Peak: 6 to 9 am
- Mid-day: 9 am to 4 pm
- PM Peak: 4 to 7 pm
- Late PM: 7 pm to 12 am



#### 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.
- Delay in the evening peak period is greater than during the morning peak period.
- These results are affected by mid-day speeds during the mid-day period and the use of a 60 mph congestion threshold (see Exhibit 5).

Exhibit SEA-6: Percent of Delay by Time Period



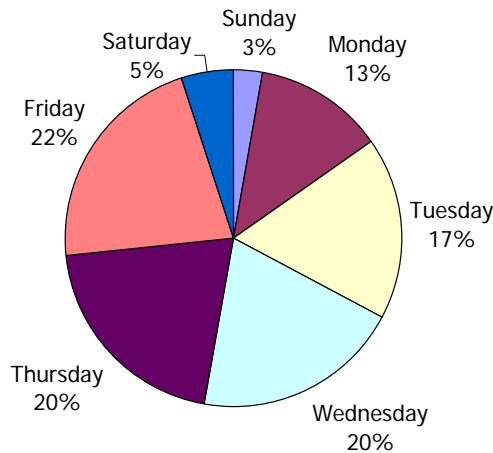
#### Comments

- 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.
- These results are affected by mid-day speeds during the mid-day period and the use of a 60 mph congestion threshold (see Exhibit 5).

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

### Day of Week Patterns and Trends

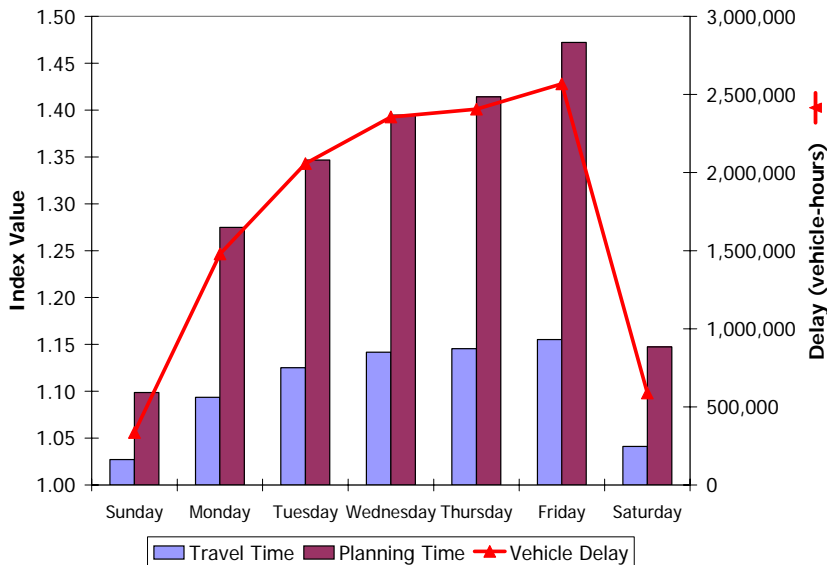
The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. Because of different peak period times and lengths on weekdays and weekends, the statistics presented on this page are 24-hour daily totals 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.
- Both weekend days combined have less than one-half of the normal weekday delay.

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



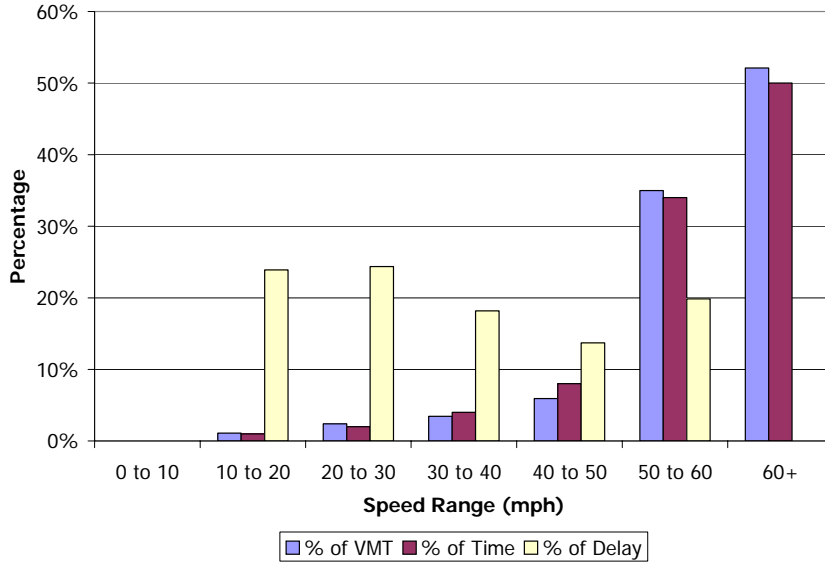
#### Comments

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

**Exhibit SEA-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.
- A large amount of VMT is in the 50 to 60 mph speed range (as indicated by Exhibit 5).
- Nearly half of the delay is in the 10 to 30 mph ranges, but only 3% of the VMT is in these same speed ranges.

**Exhibit SEA-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 SEA-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-5B NB: I-90 to SR 520	2.69	1.34	1.30	1.73	1.54	73%	65%	83%	78%
SR-520 EB: 10th Avenue E to Redmond Way	12.30	1.33	1.17	1.52	1.43	31%	43%	38%	35%
I-5C SB: SR-526 to SR-520	21.39	1.46	1.19	1.24	1.36	49%	30%	37%	43%
I-5C NB: SR-520 to SR-526	21.39	1.02	1.13	1.49	1.31	2%	44%	52%	33%
I-405A NB: I-5 S to I-90	9.01	1.34	1.13	1.18	1.26	28%	23%	20%	24%
SR-520 WB: Redmond Way to 11th Avenue	12.30	1.12	1.08	1.39	1.25	19%	21%	44%	31%
I-405A SB: I-90 to I-5 S	9.01	1.13	1.18	1.32	1.23	17%	24%	24%	21%
I-5B SB: SR 520 to I-90	2.69	1.10	1.17	1.35	1.23	21%	32%	29%	25%
I-5A NB: I-405 to I-90	11.13	1.32	1.09	1.09	1.22	37%	20%	21%	30%
I-405B SB: I-5 N to I-90	15.44	1.25	1.09	1.18	1.22	29%	15%	19%	24%
I-5A SB: I-90 to I-405	11.13	1.03	1.10	1.27	1.17	2%	23%	56%	35%
I-405B NB: I-90 to I-5 N	15.44	1.04	1.08	1.25	1.17	4%	13%	24%	16%
SR-167 SB: S. 23rd St. to 16th Street NW-NB	9.80	1.02	1.11	1.22	1.14	3%	20%	44%	28%
SR-167 NB: 15th Street NW-NB to S. 23rd St.	9.80	1.19	1.09	1.05	1.13	19%	12%	15%	17%
I-90 WB: Front Street to 12th Avenue	14.32	1.10	1.02	1.16	1.13	22%	4%	41%	30%
I-90 EB: S. Norman Street to Front Street	14.06	1.06	1.02	1.16	1.12	17%	2%	40%	31%
SR-599 NB: Pacific Hwy South to MetroBus base	2.30	1.02	1.00	1.00	1.02	7%	0%	0%	5%
SR-599 SB: MetroBus Base to Pacific Hwy South	2.30	1.00	1.02	1.02	1.01	0%	7%	6%	4%
SR-525 NB: Ash Way to SR-99	2.68	1.00	1.00	1.00	1.00	0%	0%	0%	0%
SR-525 SB: SR-99 to Ash Way	2.68	1.00	1.00	1.00	1.00	0%	0%	0%	0%
<b>Average for all Sections</b>		<b>1.20</b>	<b>1.11</b>	<b>1.27</b>	<b>1.24</b>	<b>24%</b>	<b>24%</b>	<b>37%</b>	<b>31%</b>

### Comments

- This table shows average weekday congestion (travel time index) and reliability (buffer index) for specific routes for different time periods of the day.
- Only one freeway section had a travel time index value greater than 1.50.

### Source and Coverage of Data

This report was produced using data collected and archived by the Washington Department of Transportation (<http://www.wsdot.wa.gov/PugetSoundTraffic/>). A map of the freeway routes on which traffic data was collected is shown below.



**Exhibit SEA-12: Freeway Routes with Traffic Sensors in Seattle**  
(Source of graphic: Washington State DOT, <http://www.wsdot.wa.gov/PugetSoundTraffic/>)

**Exhibit SEA-13: Instrumented Freeway Coverage in Seattle**

<b>Coverage Measures</b>	<b>Year</b>	<b>Instrumented Freeway Routes</b>	<b>Total Freeway System<sup>1</sup></b>	<b>Percent Coverage</b>
Lane-miles	2000	745	1,695	44%
	2001	602	1,715	35%
	2002	820	1,740	47%
	2003	889	1,763	50%
Centerline-miles	2000	100	241	41%
	2001	116	241	48%
	2002	116	246	47%
	2003	120	249	48%
Average annual daily vehicle-miles of travel (DVMT) (1000)	2000	13,700	29,315	47%
	2001	14,820	29,955	49%
	2002	14,480	30,465	48%
	2003	17,890	31,040	58%
<sup>1</sup> Source is FHWA's Highway Performance Monitoring System and the Texas Transportation Institute's Urban Mobility Study ( <a href="http://mobility/tamu.edu/ums">http://mobility/tamu.edu/ums</a> ).				



## 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.