# Appendix BAL – Baltimore, Maryland
# 2003 Annual Report on Freeway Mobility and Reliability

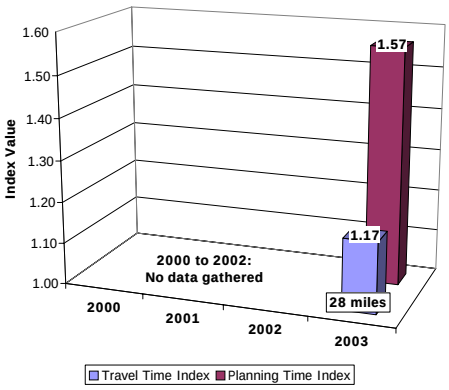
This report is a supplement to: *Monitoring Urban Freeways in 2003: Current Conditions and Trends from Archived Operations Data*. Texas Transportation Institute and Cambridge Systematics, Inc., Report No. FHWA-HOP-05-018, December 2004, available at http://mobility.tamu.edu/mmp.

## Exhibit BAL-1: Current Measures and Trends

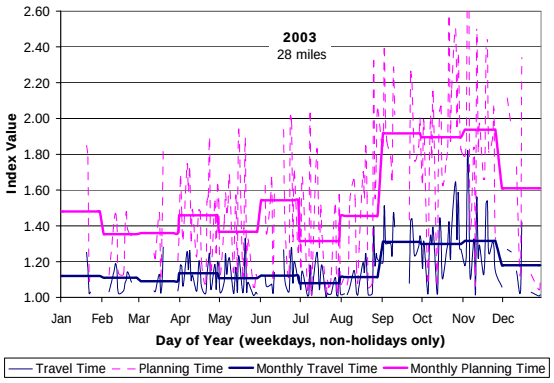
| Measures | Current Year | Last Year | | Two Years Ago | |
|---|---|---|---|---|---|
| | 2003 | 2002 | Change | 2001 | Change |
| **Performance Measures** | | | | | |
| Travel Time Index | 1.17 | n.a. | n.a. — | n.a. | n.a. — |
| Planning Time Index | 1.57 | n.a. | n.a. — | n.a. | n.a. — |
| Buffer Index | 23% | n.a. | n.a. — | n.a. | n.a. — |
| % Congested Travel | 28% | n.a. | n.a. — | n.a. | n.a. — |
| Total Delay (veh-hours) per 1000 VMT | 2.96 | n.a. | n.a. — | n.a. | n.a. — |
| **Explanatory Measures** | | | | | |
| Peak Period VMT (000) | 400 | n.a. | n.a. — | n.a. | n.a. — |
| Avg. Annual DVMT (000) | 1,910 | n.a. | n.a. — | n.a. | n.a. — |
| **Data Quality Measures** | | | | | |
| % complete | 57% | n.a. | n.a. — | n.a. | n.a. — |
| % valid | 73% | n.a. | n.a. — | n.a. | n.a. — |
| % of VMT covered | 7% | n.a. | n.a. — | n.a. | n.a. — |
| % of freeway miles | 10% | n.a. | n.a. — | n.a. | n.a. — |

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

## Exhibit BAL-2: 2000 to 2003 Annual Trends




## Exhibit BAL-3: Daily and Monthly Trends




## Comments

- This is the first year for Baltimore to be included in the Mobility Monitoring Program; therefore, trend information is not available yet. However, the last several months of 2003 showed declines in congestion and reliability over the spring of 2003.
- The data collection system in Baltimore accounts for only 10% of the freeway miles and 7% of the vehicle travel.

**Data Source(s):** University of Maryland (http://www.cattlab.umd.edu) in cooperation with CHART, Maryland State Highway Administration (http://www.chart.state.md.us)
Includes 28 of 290 (10%) total freeway miles in Baltimore; collected using microwave radar 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.

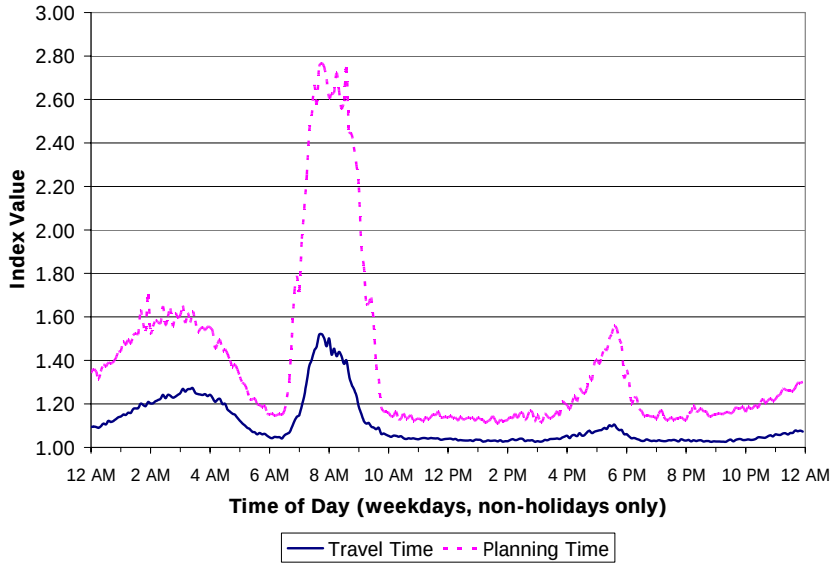



**Exhibit BAL-4: Mobility and Reliability by Time of Average Weekday**

**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 morning congestion level appears to be much worse than in the evening.
- Travelers must add 50-70% additional buffer time during peak times to account for traffic unreliability.

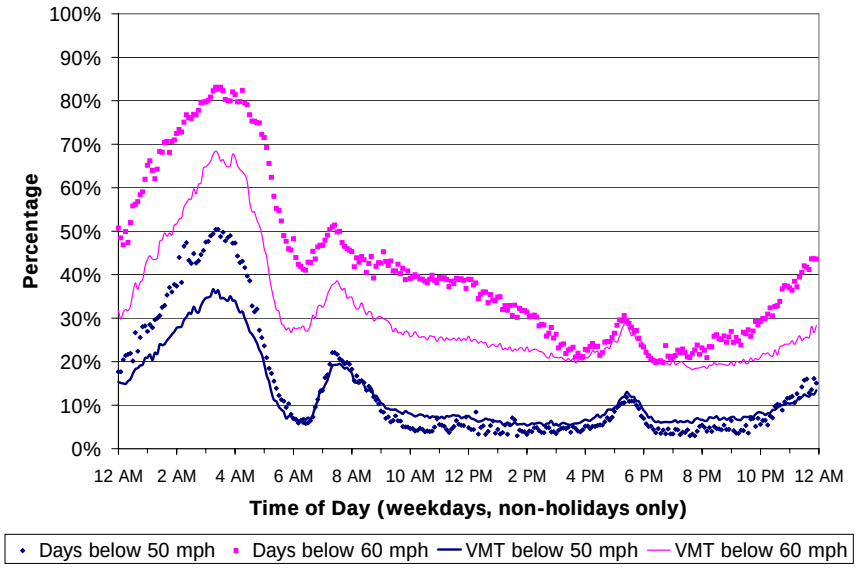



**Exhibit BAL-5: Frequency and Percentage of Congested Travel by Time of Average Weekday**

**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.
- This chart and Exhibit 4 indicate that slow speeds are being reported in the early morning hours. This could be an actual travel anomaly or it could be a measurement or data archiving error.

## 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

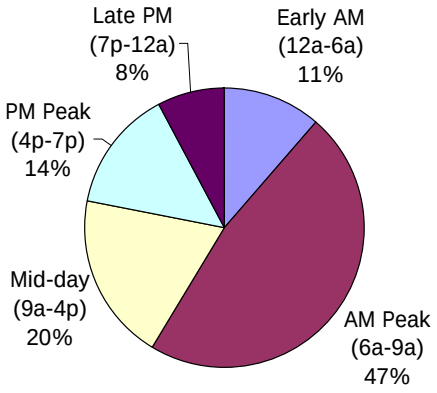



**Exhibit BAL-6: Percent of Delay by Time Period**

**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 morning peak period is more than 3 times greater than during the evening peak period.
- Delay during the overnight hours is significant, but could be due to the problems described in Exhibit 5.

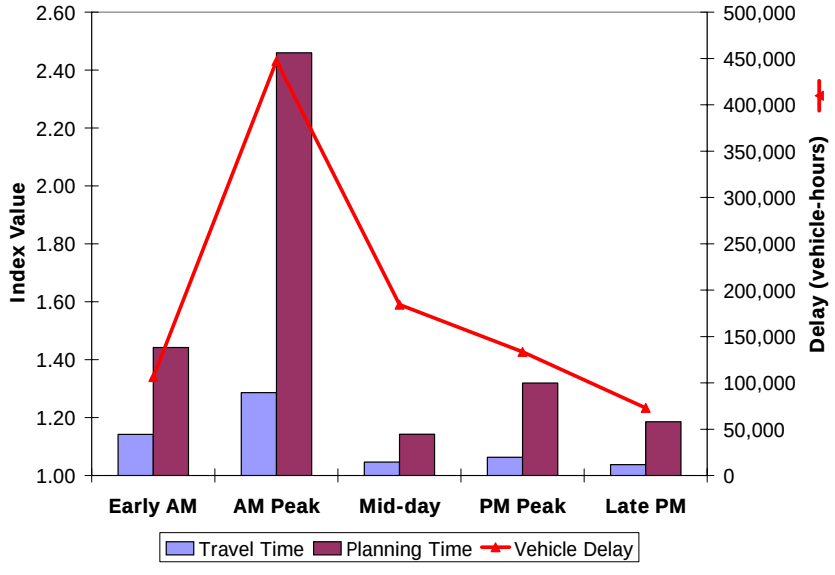


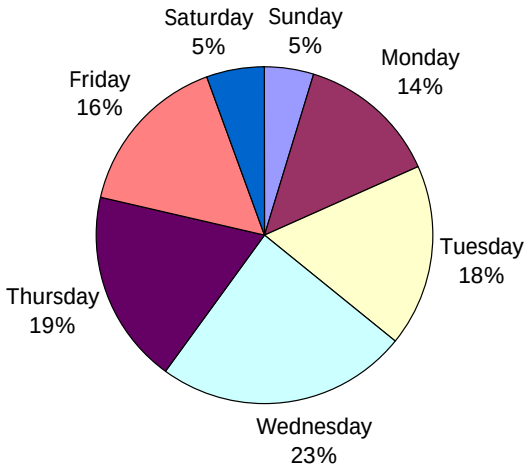

**Exhibit BAL-7: Mobility, Reliability, and Delay by Time Period**

**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

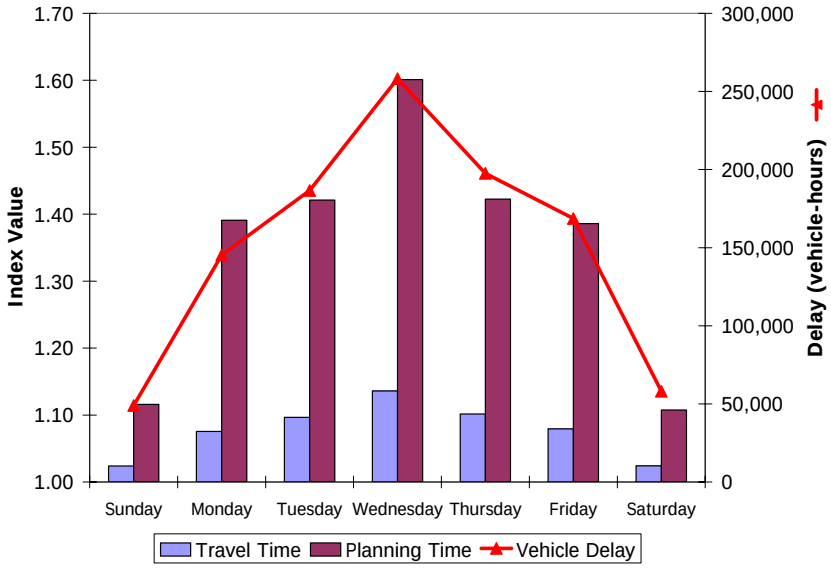
The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. Because of different peak period times and lengths on weekdays and weekends, the statistics presented on this page are 24-hour daily totals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




**Comments**

- This chart shows the percent of total daily delay that occurred during each day of the week.
- The delay for Wednesday is greater than other weekdays.
- Both weekend days combined have about half of the normal weekday delay.

**Exhibit BAL-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.
- Wednesday has the most delay and is the least reliable day (highest planning time index).

**Exhibit BAL-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.

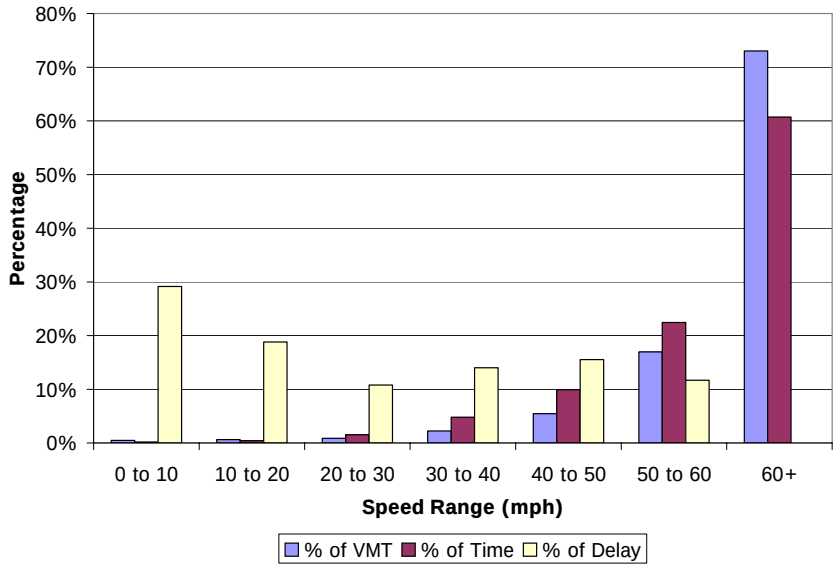



**Exhibit BAL-10: Percent of VMT, Delay and Time Periods in Different Speed Ranges**

**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.
- Only 12% of the delay is in the 50 to 60 mph range.
- Nearly 50% of the delay is below 20 mph, but only 1% of the VMT is in this same speed 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 BAL-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-695 WB: US 1 to Joppa Rd | 5.58 | 2.14 | 1.06 | 1.11 | 1.59 | 210% | 0% | 43% | 122% |
| I-795 SB: MD 140 to Church Rd | 4.10 | 1.20 | 1.11 | 1.08 | 1.17 | 26% | 15% | 18% | 23% |
| I-83 SB: MD 137 to Padonia rd | 11.43 | 1.12 | 1.10 | 1.10 | 1.11 | 63% | 30% | 40% | 55% |
| I-95 SB: MD 175 to Brooklyn Bridge rd | 6.91 | 1.13 | 1.03 | 1.02 | 1.08 | 58% | 6% | 3% | 34% |
| I-95 NB: Brooklyn Bridge rd to MD 175 | 6.91 | 1.03 | 1.03 | 1.08 | 1.06 | 10% | 10% | 30% | 21% |
| I-83 NB: Padonia rd to MD 137 | 11.33 | 1.06 | 1.06 | 1.04 | 1.05 | 14% | 14% | 19% | 17% |
| I-795 NB: Church Rd to MD 140 | 4.10 | 1.06 | 1.03 | 1.03 | 1.04 | 23% | 11% | 12% | 17% |
| Average for all Sections | | 1.29 | 1.05 | 1.06 | 1.17 | 70% | 9% | 24% | 46% |

**Comments**

- This table shows average weekday congestion (travel time index) and reliability (buffer index) for specific routes for different time periods of the day.
- I-695 Westbound is, by far, the most congested and least reliable instrumented freeway section.

## Source and Coverage of Data

This report was produced using data collected by the CHART program of the Maryland State Highway Administration (http://www.chart.state.md.us) and archived by the University of Maryland (http://www.cattlab.umd.edu ). A map of the freeway routes on which traffic data was collected is shown below (symbols indicate sensor locations).


**Exhibit BAL-12: Freeway Routes with Traffic Sensors in Baltimore**
(Note that I-270 in the left side of the figure is included in the Washington, DC report)
(Source of graphic: Maryland State Highway Administration, http://www.chart.state.md.us)

**Exhibit BAL-13: Instrumented Freeway Coverage in Baltimore**

| Coverage Measures | Year | Instrumented Freeway Routes | Total Freeway System[1] | Percent Coverage |
|---|---|---|---|---|
| Lane-miles | 2000 | n.a. | 1,475 | n.a. |
| | 2001 | n.a. | 1,480 | n.a. |
| | 2002 | n.a. | 1,520 | n.a. |
| | 2003 | 167 | 1,543 | 11% |
| Centerline-miles | 2000 | n.a. | 278 | n.a. |
| | 2001 | n.a. | 278 | n.a. |
| | 2002 | n.a. | 286 | n.a. |
| | 2003 | 28 | 290 | 10% |
| Average annual daily vehicle-miles of travel (DVMT) (1000) | 2000 | n.a. | 22,660 | n.a. |
| | 2001 | n.a. | 23,555 | n.a. |
| | 2002 | n.a. | 25,430 | n.a. |
| | 2003 | 1,910 | 26,815 | 7% |

[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.