Estimated Cost of Freight Involved in Highway Bottlenecks

final

report

prepared for

Federal Highway Administration
Office of Transportation Policy Studies

prepared by

Cambridge Systematics, Inc.

November 12, 2008

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Technical White Paper

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Executive Summary

Objectives of This Report

There are four objectives for this study:

1. Identify the highway traffic bottlenecks in the country that delay truck freight, based on the total amount annual truck delay. Approximately 200 such locations should be identified. A sketch planning method is used to accomplish this task.
2. For the worst bottlenecks, identify the top 30 locations using a more refined methodology to derive truck annual truck delay.
3. Discuss trends in congestion related to trucks, especially with regard to the previous FHWA freight bottleneck study.[1]
4. Provide suggestions for how truck-related bottlenecks should be monitored in the future and provide options for FHWA in developing a freight bottleneck program.

The Congestion Problem in the U.S.

National estimates of how each of these sources contributes to total congestion have been made by FHWA (Figure ES.1). However, local conditions vary widely – the national estimates probably do not apply for individual facilities or areas. Studies of individual urban freeways indicate that the amount of congestion due to recurring (bottleneck) sources is higher, indicating that bottlenecks are a highly significant aspect of the congestion problem.

Highway bottlenecks affecting freight are a problem today because they delay large numbers of truck freight shipments. They will become increasingly problematic in the future as the U.S. economy grows and generates more demand for truck freight shipments. If the U.S. economy grows at a conservative annual rate of 2.5 to 3 percent over the next 20 years, domestic freight tonnage will almost double and the volume of freight moving through the largest international gateways may triple or quadruple.

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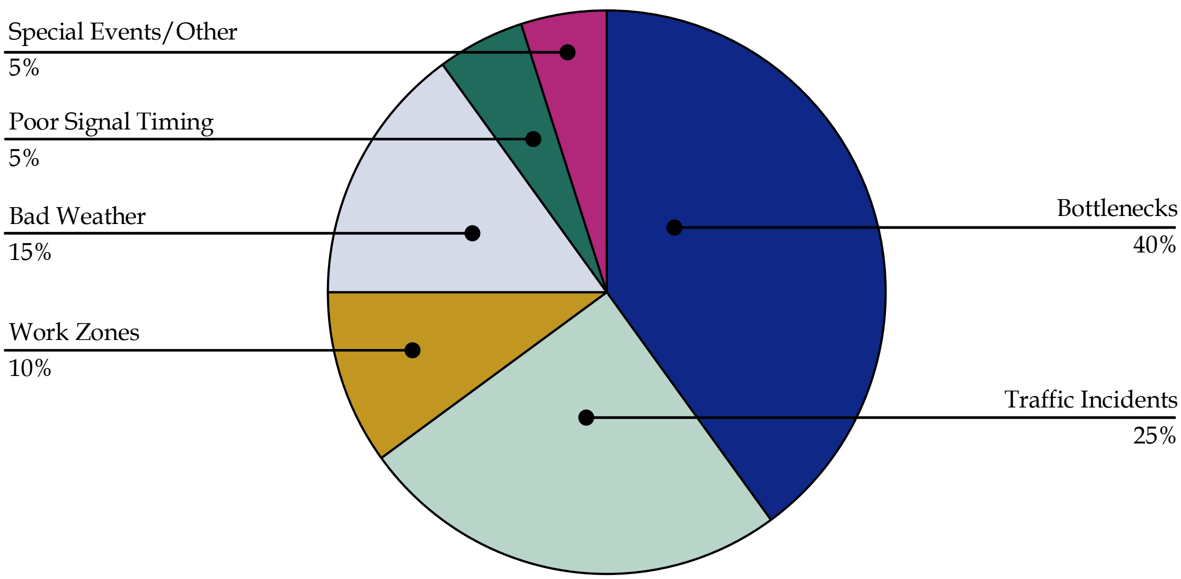
[1] Cambridge Systematics, Inc. and Battelle Memorial Institute, *An Initial Assessment of Freight Bottlenecks on Highways*, prepared for Federal Highway Administration, Office of Transportation Policy Studies, October 2005.

Figure ES.1 The Sources of Congestion
National Summary



Source: http://www.ops.fhwa.dot.gov/aboutus/opstory.htm.

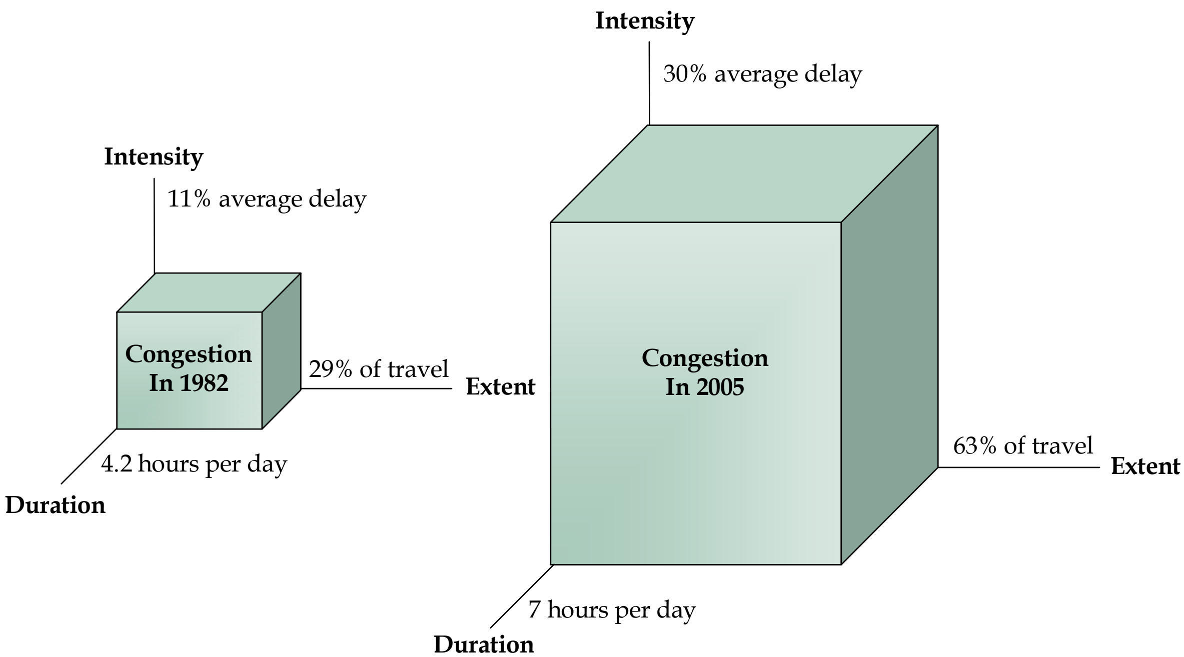
Just in the past decade, traffic demand has increased significantly. The result has been considerable congestion and delays to automobiles and truck traffic, with potentially significant impacts on air quality and the natural environment. Figure ES.2 shows how congestion has expanded since 1982 on three dimensions; not only has the average delay increased, but congestion now affects significantly more roadways (travel) and is present for more hours of the day.

The Texas Transportation Institute's (TTI) 2007 Urban Mobility Report estimates that the cost of congestion in the 437 U.S. urban areas in 2005 was $78 billion. Corresponding to that dollar loss is 4.2 billion hours of delay and 2.9 billion gallons of excess fuel consumed. However, the TTI methodology is based on analyzing mainline segments of highway rather than specific bottlenecks.

The demand for freight transportation is driven by economic growth. The United States' economy is forecast to grow at a compound annual rate of 2.8 percent over the next 30 years. This means that the gross domestic product (GDP) – a measure of the market value of all final goods and services produced in the nation – will grow by 130 percent over the same period. This rate of growth is slightly lower than the rate of growth over the last decade, which averaged 3 percent, but about the same rate of growth experienced over the last 30 years.

Figure ES.2 Growth in Congestion
1982 to 2005

Weekday Peak-Period Congestion Has Grown in Several Ways in the Past 20 Years in Our Largest Cities

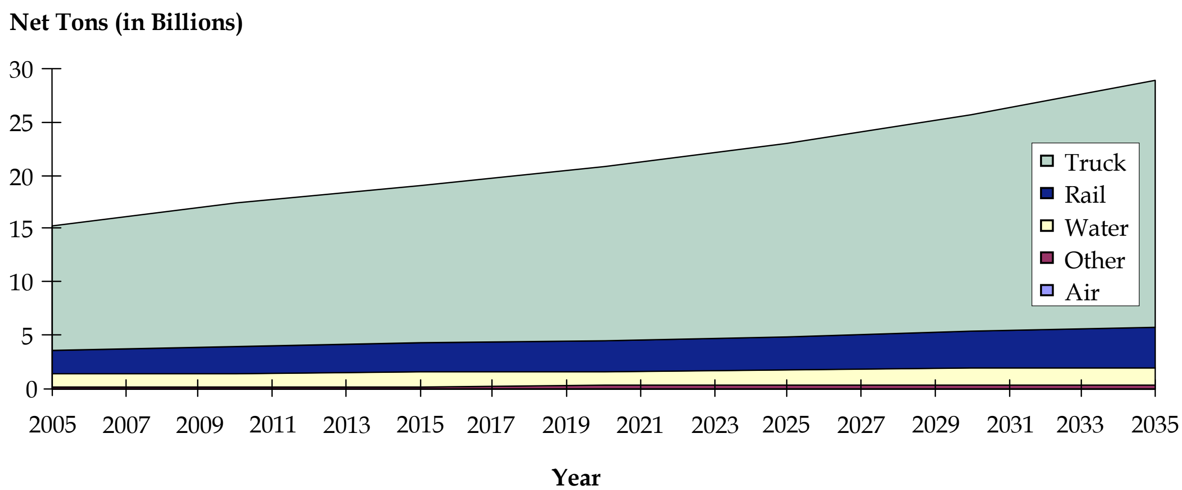


Source: Cambridge Systematics, Inc. and Texas Transportation Institute, *Traffic Congestion and Reliability Trends and Advanced Strategies for Congestion Mitigation*, September 1, 2005.

The demand for freight transportation to support this economic growth will nearly double between 2005 and 2035. Measured in tons, freight demand will grow from 15 billion tons today to 26 billion tons in 2035, an increase of 89 percent. Measured in ton-miles (a ton of freight moved a mile counts as one ton-mile), freight demand will grow from 6 trillion ton-miles today to 11 trillion ton-miles in 2035, an increase of 92 percent. Figure ES.3 shows the freight tonnage forecast by mode for 2005 through 2035; the most significant increase in demand is exhibited by trucks.

Delays to trucks are of particular concern to the nation because the national economy is highly dependent on reliable and cost-effective truck-freight transportation. Truck delays add to the cost of freight shipments, increasing the cost of doing business in the region and the cost of living. The delays come at a time when shippers and receivers are putting more pressure on motor carriers to reduce shipment costs and improve service to support fast cycle, on demand supply chains.

Figure ES.3 Freight Tonnage Forecast
By Mode – 2005 to 2035



Source: Global Insight, Inc., TRANSEARCH 2004.

The increase in freight demand and truck travel means that where today, on average, there are 10,500 trucks per day per mile on the Interstate Highway System, in 2035 there will be 22,700 trucks, with the most heavily used portions of the system seeing upwards of 50,000 trucks per day per mile.[2] The additional freight trucks will add to traffic congestion. The number of automobile and local truck trips also will grow with population and the economy. The result will be more traffic and more traffic congestion nationally.

■ Highway Bottlenecks – Background

In the past several years, transportation professionals have come to realize that highway bottlenecks – specific points on the highway system where traffic flow is restricted due to geometry, lane drops, weaving, or interchange-related merging maneuvers – demand special attention. The congestion caused by bottlenecks results from the interaction of traffic and these points of reduced capacity, and is usually referred to as "recurring congestion." In the past, recurring congestion was felt to be a systemic problem ("not enough lanes"), but the root cause of recurring congestion is in fact bottlenecks, not uniform highway segments.

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[2] Intercounty loaded and empty flows, calculated by truck miles over Interstate highway links divided by the length of the Interstate highway links used in the routes.

The American Highway Users Alliance (AHUA) published two studies of national bottlenecks in 1999 and 2004.[3] The studies ranked the worst bottlenecks and highlighted locations where successful improvements had been made. These studies received extensive media attention and helped to galvanize interest in specifically addressing bottlenecks. On freeways, the AHUA study found that the predominant type of bottleneck was freeway-to-freeway interchanges. Lane-drop bottlenecks were far less common and interchanges with surface streets produced significantly less delay than freeway-to-freeway interchanges.

FHWA undertook a study of truck-related bottlenecks in 2005.[4] The study used the same methodology as the AHUA studies but calculated truck-only delay at the bottlenecks using truck volume information from HPMS and the Freight Analysis Framework. A study performed for the Ohio Department of Transportation[5] expanded on the bottleneck analysis approach used in both the AHUA and previous FHWA studies.

In 2006, CS applied the Ohio DOT methodology to national freight bottlenecks.[6] The I-95 Corridor Coalition has two truck-related bottleneck studies underway:

1. A regional study of bottlenecks for all states in the Coalition, which uses only the simple AHUA methodology; and

2. A subregion study of bottlenecks for the Mid-Atlantic states, which uses the methodology previously developed for FHWA in the 2005 study.

A key aspect of these studies was a survey of Coalition states to identify what they feel are their worst bottlenecks. As discovered in the original AHUA study, this local knowledge is indispensable in conducting the analysis, rather than relying blindly on HPMS or other inventory data.

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[3] American Highway Users Alliance, *Unclogging America's Arteries: Effective Relief for Highway Bottlenecks*, 2004, http://www.highways.org/pdfs/bottleneck2004.pdf.

[4] Cambridge Systematics, Inc. and Battelle Memorial Institute, *An Initial Assessment of Freight Bottlenecks on Highways*, prepared for Office of Transportation Studies, FHWA, October 2005.

[5] Maring, Gary; Margiotta, Rich; Hodge, Daniel; and Beagan, Dan, *Ohio Freight Mobility,* prepared for Ohio Department of Transportation, Office of Research and Development, December 30, 2005.

[6] Cambridge Systematics, Inc., *Application of Detailed Interchange Analysis to Top Freight Bottlenecks: Methods, Results, and Road Map for Future Research*, prepared for Office of Transportation Policy Studies, FHWA, September 1, 2006.

■ Methodology

The significant aspects of these steps are further detailed in the subsections that follow.

1. **Assemble Initial List of Bottlenecks by "Scanning" HPMS –** The AHUA methodology was used with the 2006 HPMS data to make a first ranking of truck-related bottlenecks. This method is based on identifying HPMS segments where capacity is restricted, i.e., the AADT[7]-to-capacity (AADT/C) ratio is above 12.0.

2. **Compare Initial List of Bottlenecks in Those in the I-95 Corridor –** Concurrent with this study, the I-95 Corridor Coalition is identifying truck-related bottlenecks in Coalition states. In this study, Coalition states were asked to nominate their worst truck-related bottlenecks for consideration. Any Coalition state locations not identified by the HPMS scan were added to the list of national bottlenecks were located in HPMS, and the annual truck delay was estimated.

3. **Compare Initial List to FHWA Office of Operations Bottleneck Survey –** The 2006 survey of state bottlenecks conducted by the FHWA Office of Operations was used to further refine the initial list of bottleneck locations; these also were identified in HPMS and their annual truck delay was estimated.

4. **For Final List of National Bottlenecks, Identify the HPMS Segments representing the Bottleneck –** This step was a manual process of matching the bottleneck with corresponding HPMS data.

5. **Identify Top 40 Preliminary Bottlenecks –** From the combined list of preliminary bottlenecks, identify the top 40 (in terms of total truck delay) for detailed analysis. The concept is that the scan method is imprecise, so in order to get the top 30, a greater number of locations need to be analyzed.

6. **Identify the Geometric Characteristics for Each of the Top 40 Bottlenecks –** For each location, the key merge points where traffic is moving away from the center of the interchange were identified. At each merge point, the number of entering and exiting lanes was noted. The capacity of each merge juncture was determined by the minimum of either the number of exiting lanes or the number of lanes 1,500 feet downstream.

7. **Identify HPMS Traffic Data and FAF2 Truck Volumes –** On each leg of the interchange, identify HPMS-derived AADTs. Use FAF2 truck volumes from the previous FHWA Freight Bottleneck Study where available to derive truck percents. Where these are unavailable, use HPMS truck percents.

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[7] Average Annual Daily Traffic.

8. **Develop Daily Turning Movements –** Using the balancing procedure from NCHRP Report 255, directional AADT turning movements were synthesized. This was necessary because ramp volume counts were unavailable. (See Section 2.3 for details.)

9. **Conduct Delay Analysis for Each Merge Juncture, Weaving, and Other Capacity Restrictions at the Interchanges –** The equations developed for another FHWA study[8] were used to estimate total delay at each point. Truck percents were applied to derive truck delay.

10. **Compare Truck Speeds from the American Transportation Research Institute (ATRI) at the Bottlenecks –** ATRI provided to FHWA truck travel times on the approaches to the bottlenecks identified in this study. Delay values are compared.

National Inventory of Truck Bottlenecks

We located and estimated truck hours of delay for the various types of highway truck bottlenecks. Table ES.1 lists the types of bottlenecks and the annual truck hours of delay associated with each type. The bottleneck types are sorted in descending order of truck hours of delay by constraint type and then within each group by the truck hours of delay for each bottleneck type.

Table ES.1 also shows the delay values from Reference 1. It must be noted that the 2004 and 2006 numbers are not directly comparable, because the 2004 values are based on truck volumes from the FAF while the 2006 numbers are based on truck volumes from HPMS. Further, the number of bottlenecks is not directly comparable due to additional sources being used in 2006 (inclusion of the I-95 Corridor Coalition identified locations) and changes in HPMS data.

In 2006, the bottlenecks accrued 226 million hours of delay. At a delay cost of $32.15 per hour, the conservative value used by the FHWA's Highway Economic Requirements System model for estimating national highway costs and benefits, the direct user cost of the bottlenecks is about $7.3 billion per year.[9]

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[8] Cambridge Systematics, Inc., *Sketch Methods for Estimating Incident-Related Impacts*, prepared for FHWA Office of Planning, December 1998.

[9] The FHWA Highway Economic Requirements System model uses a current value of truck time of $32.15 per hour. Other researchers have suggested higher rates, typically between $60 and $70 per hour.

Table ES.1 Truck Hours of Delay by Type of Highway Freight Bottleneck

Constraint	Highway Type	Freight Route	National Annual Truck Hours of Delay, 2006 (Estimated)	National Annual Truck Hours of Delay, 2004 (Reference 1)
Interchange and Lane Drop	Freeway	Urban Freight Corridor	151,519,000	
		Intercity Freight Corridor	36,000	
		Subtotal	**151,555,000**	**134,517,000**
Steep Grade	Arterial	Intercity Freight Corridor	15,001,000	
		Urban Freight Corridor	471,000	
	Freeway	Intercity Freight Corridor	10,697,000	
		Subtotal	**26,169,000**	**32,859,000**
Signalized Intersections	Arterial	Urban Freight Corridor	43,462,000	
		Intercity Freight Corridor	4,799,000	
		Subtotal	**48,261,000**	**43,113,000**
		Total	**225,985,000**	**210,489,000**

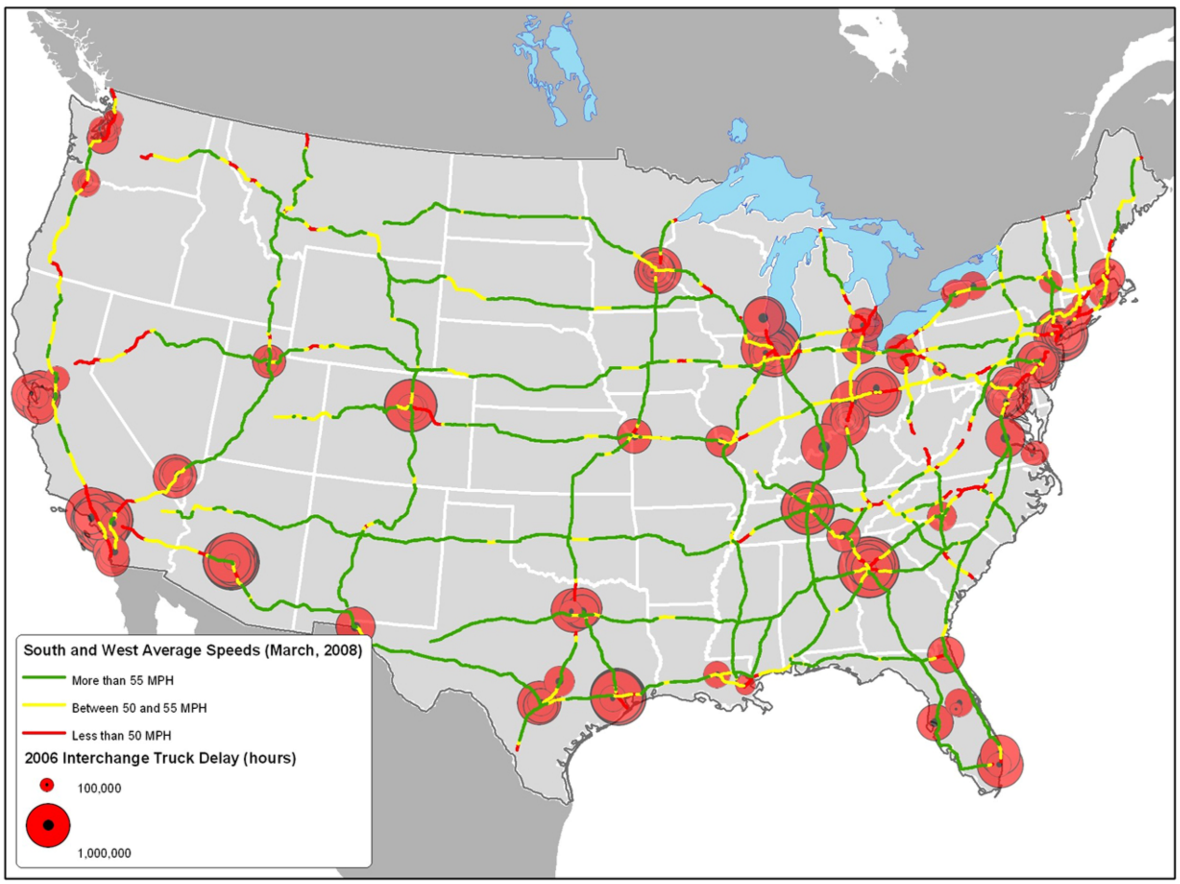
Notes:

1. **Interchange and Lane Drops –** The delay estimation methodology calculated delay resulting from queuing on the critically congested roadway of the interchange (as identified by the scan) and the immediately adjacent highway sections. Estimates of truck hours of delay are based on two-way traffic volumes. The bottleneck delay estimation methodology also did not account for the effects of weaving and merging at interchanges, which aggravates delay, but could not be calculated from the available HPMS data.
2. **Steep Grades and Signalized Intersections –** The total delay shown is the expanded delay, assuming that the HPMS Sample data used in the analysis does not cover all possible grades or signals. Unexpanded delay for steep grades and signalized intersections are 11,048,000 and 12,415,000, respectively.
3. **Steep Grades –** It is assumed that the delay is incurred only by trucks on the upgrade (one direction). The delay values in Reference 1 were computed for both directions, so they have been halved here.

■ Interchange Bottlenecks for Trucks

A total of 326 bottlenecks were identified. Figure ES.4 shows the locations of the bottlenecks overlaid on national speed data produced by the American Transportation Research Institute. Note that this shows only the South and West directions; Appendix F shows the map for the North and East directions.

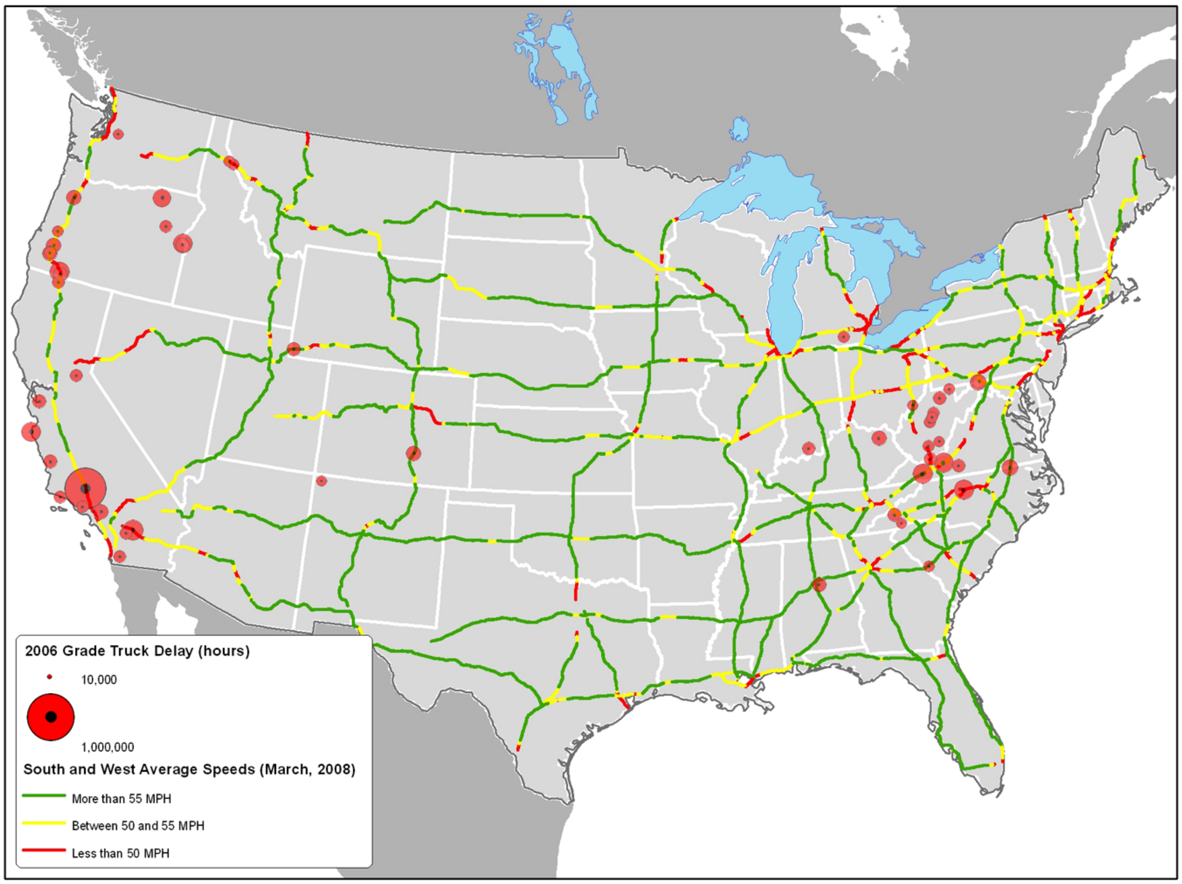
Figure ES.4 Interchange Bottlenecks Identified with the HPMS Scan Method and National Truck Speeds
2006 (South and West Directions)



■ Steep-Grade Bottlenecks for Trucks

We located 818 bottlenecks created by steep grades on freeways and arterials. These bottlenecks were located by scanning the HPMS Sample database for roadway sections with grades greater than 4.5 percent and more than a mile long. These bottlenecks represent a partial inventory of this type of bottleneck. Using HPMS expansion factors, we estimate that the total delay associated nationally with this type of bottleneck in 2006 was about 26 million truck hours or 12 percent of the total truck hours of delay. At a delay cost of $32.15 per hour, the direct user cost of the bottlenecks is about $836 million per year. Figure ES.5 shows the location of the steep-grade bottlenecks. Note that this shows only the South and West directions; Appendix F shows the map for the North and East directions.

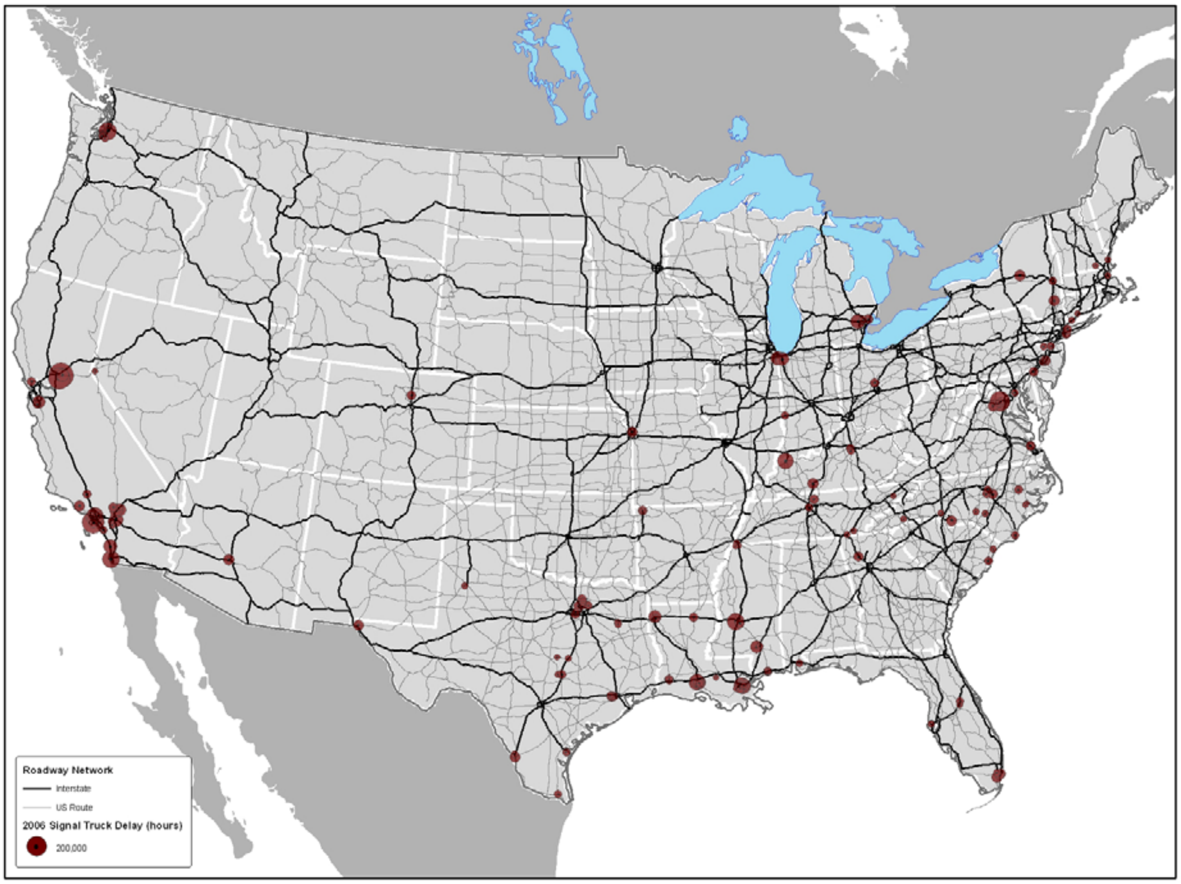
Figure ES.5 Grade Bottlenecks Identified with HPMS Scan Method and National Truck Speeds
2006 (South and West Directions)



■ Signalized Intersection Bottlenecks for Trucks

We located 559 truck-related bottlenecks caused by signalized intersections on arterials. These bottlenecks were located by scanning the HPMS Sample database for signalized roadway sections with a volume-to-capacity ratio greater than 0.925. These bottlenecks also represent a partial inventory of this type of bottleneck. Expanding the sample, we estimate that the total delay associated nationally with this type of bottleneck in 2006 was about 48 million truck hours of delay. At a delay cost of $32.15 per hour, the direct user cost of the bottlenecks is about $1.5 billion per year. The truck volumes and highway capacity calculations were based on the HPMS Sample statistics. Figure ES.6 shows the location of the signalized intersection truck bottleneck locations.

Figure ES.6 Signal Bottlenecks Identified with the HPMS Scan Method
2006



■ Detailed Delay Analysis of the Top Bottlenecks

The national scan of bottlenecks produced a "short list" for more detailed examination. The main criterion for developing this short list was to look at locations with the highest truck delays. This resulted in considering freeway bottlenecks for the next level of analysis, because truck volumes are higher (i.e., more trucks are exposed to congestion on freeways). The bottleneck delay results from the ramp-based delay methodology are shown in Table ES.2. The bottlenecks are listed in order from the highest to the lowest based on the current delay estimates. The delay values for the previous FHWA study also are presented.

Table ES.2 Annual Delays, Based on Detailed Delay Method, at Major Truck Bottlenecks
2006

No.	Bottleneck Name	County/State	Annual Truck Delay (Hours) 2006[a]	Annual Truck Delay (Hours) 2004[a]	ATRI-Derived Truck Delay[b]	Number of ATRI Trucks Measured[b]	Caltrans HICOMP Congestion[c]
1	I-710 at I-105 Interchange	Los Angeles, California	1,550,000	425,200	1,240,000	27,488	4 of 4 legs
2	I-17 (Black Canyon Freeway): I-10 Interchange (the "Stack") to Cactus	Maricopa, Arizona	1,492,100	493,200	728,100	42,395	
3	I-285 at I-85 Interchange ("Spaghetti Junction")	De Kalb, Georgia	1,415,500	1,815,100	2,063,000	71,865	
4	I-20 at I-75/I-85 Interchange	Fulton, Georgia	1,336,500	285,100	1,446,000	27,537	
5	I-80 at I-94 split in Chicago, Illinois	Cook, Illinois	1,300,000	1,365,300	1,368,400	227,578	
6	SR 60 at SR 57 Interchange	Los Angeles, California	1,259,700	*1,029,700*	705,000	52,140	2 of 3 legs
7	I-80 at I-580/I-880 in Oakland, California	Alameda, California	1,240,000	1,838,700	2,703,000	10,347	
8	I-405 (San Diego Freeway) at I-605 Interchange	Orange, California	1,221,500	2,662,600	273,500	4,426	4 of 4 legs
9	I-90 at I-94 Interchange ("Edens Interchange")	Cook, Illinois	1,185,700	1,600,300	1,266,800	49,923	
10	I-40 at I-65 Interchange (east)	Davidson, Tennessee	1,099,700	Not included	682,100	51,313	
11	I-290 at I-355 Interchange	DuPage, Illinois	1,039,400	263,600	117,000	49,546	
12	I-75 at I-85 Interchange	Fulton, Georgia	920,800	272,600	1,372,500	18,270	
13	I-95 at SR 9A (Westside Highway; George Washington Bridge approach)	New York, New York	919,200	*445,200*	3,095,050[a]	21,896	
14	I-71 at I-70 Interchange	Franklin, Ohio	905,900	*968,800*	354,000	40,718	
15	I-880 at I-238	Alameda, California	883,900	1,200,300	812,987	13,550	3 of 3 legs
16	I-110 at I-105 Interchange	Los Angeles, California	860,000	*910,000*	1,080,600		2 of 4 legs

[a] 2006 delay numbers based on the ramp-based method. 2004 delay numbers in italics indicate that the "scan" method was used; other values were estimated using the ramp-based method.

[b] ATRI data covers both sides of the George Washington Bridge, including SR 4 in New Jersey and the Westside Highway interchanges; ATRI data for individual locations may be found in Appendix F.

[c] The Caltrans HICOMP report (*State Highway Congestion Monitoring Program, Annual Data Compilation*, November 2007) maybe found at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/pdfs/2006HICOMP.pdf.

Table ES.2 Annual Delays, Based on Detailed Delay Method, at Major Truck Bottlenecks (continued)
2006

No.	Bottleneck Name	County/State	Annual Truck Delay (Hours) 2006[a]	Annual Truck Delay (Hours) 2004[a]	ATRI-Derived Truck Delay[b]	Number of ATRI Trucks Measured[b]	Caltrans HICOMP Congestion[c]
17	SR 91 at SR 55 Interchange	Orange, California	816,700	(946,900)	458,356	8,163	Not congested
18	I-285 at I-75 Interchange	Cobb, Georgia	772,200	1,815,000	1,253,476	8,532	
19	I-695/I-70 and I-95 exit 11	Baltimore, Maryland	748,900	(616,800)	270,000	59,523	
20	I-95 at SR 4 (GW Bridge approach)	Bergen, New Jersey	734,600	Not included	(Note[a])	51,257	
21	I-10 at I-110/U.S.-54 Interchange	El Paso, Texas	664,700	(241,800)	105,900	49,672	
22	I-45 (Gulf Freeway) at U.S. 59 Interchange	Harris, Texas	644,700	(386,900)	778,223	32,627	
23	SR 134 at SR 2 Interchange	Los Angeles, California	598,700	267,600	109,000	4,603	1 of 4 legs
24	I-10 at SR 51/SR 202 Interchange ("Ministack")	Maricopa, Arizona	521,600	(982,600)	872,300	8,322	
25	I-10 at I-15 Interchange	San Bernardino, California	513,600	1,308,000	1,037,400	56,102	2 of 4 legs
26	I-95/I-495	Prince Georges, Maryland	475,400	(1,020,100)	685,100	36,540	
27	I-45 at I-610 Interchange	Harris, Texas	450,600	(452,300)	378,300	46,856	
28	I-10 at I-410 Loop North Interchange	Bexar, Texas	450,200	(418,300)	346,600	15,243	
29	I-75 at I-275 Interchange	Kenton, Kentucky	435,600	(662,900)			
30	I-64 atI-65/I-71 Interchange	Jefferson, Kentucky	432,400	(375,900)			
31	I-94 (Dan Ryan Expressway) at I-90 Skyway	Cook, Illinois	292,300	584,500			
32	I-20 at I-285 Interchange	De Kalb, Georgia	215,600	(1,359,400)			
33	I-35E at I-94 Interchange ("Spaghetti Bowl") – East section	Ramsey, Minnesota	210,300	(230,300)			
34	I-95 at I-476 Interchange	Delaware, Pennsylvania	179,600	(437,300)			
35	I-75 at I-74 Interchange	Hamilton, Ohio	124,800	305,800		6,370	

[a] 2006 delay numbers based on the ramp-based method. 2004 delay numbers in parentheses indicate that the "scan" method was used; other values were estimated using the ramp-based method.

[b] ATRI data covers both sides of the George Washington Bridge, including SR 4 in New Jersey and the Westside Highway interchanges; ATRI data for individual locations may be found in Appendix F.

[c] The Caltrans HICOMP report (*State Highway Congestion Monitoring Program, Annual Data Compilation*, November 2007) maybe found at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/pdfs/2006HICOMP.pdf.

Some 2006 bottlenecks were not identified in 2004, and the delay estimates for common bottlenecks vary widely. A number of reasons exist for this discrepancy, which makes the development of trend information impossible from these data:

- The previous study used FAF truck volumes while the current study uses HPMS truck volumes.
- The two studies used different national scans to get the short list, so some bottlenecks were inevitably left out.
- The HPMS data and satellite imagery used to derive the turning movements and geometric characteristics may have changed between the two studies. More importantly, the process of identifying bottleneck locations in HPMS and coding geometric features from satellite imagery is a manual and somewhat subjective process. Many interchange locations are extremely complex and require substantial judgment on how to assign turning movements and code merge areas.

A number of observations regarding the results obtained with the detailed delay analysis can be made:

- As with the previous FHWA freight bottleneck study, the delay estimates change when the ramp-based method is used. The ramp-based method provides a more detailed picture of capacity restrictions at the interchanges. Also, as in the previous study, it was found that truck bottlenecks (in terms of total delay) occur at urban commuter bottlenecks.
- The list of the highest delay bottlenecks in Table ES.2 is thought to be more accurate than the ones identified in the previous study. This is because the initial pool of locations has been expanded by using state-identified bottlenecks from the I-95 Corridor Coalition (CC) and FHWA's bottleneck survey. Also, more recent HPMS and geometric information has been used here.
- As before, there is a much sharper drop off in delay as one proceeds down the list than the list produced by the simple scanning method. The reason for this is that in the original methodology, a single AADT/C value was used for the entire interchange. This value is based on HPMS data and the value tended to be very similar for the high-delay interchanges. In the current methodology, there is much more distinction between both the AADT/C values for the individual merge junctures and the volumes of trucks using them.
- The worst bottleneck is the I-710/I-105 interchange in Los Angeles. I-710 is the major connector to the Port of Long Beach.
- The area around the George Washington Bridge in New York and New Jersey requires special discussion. This is an extremely complex area from a geometric standpoint, with multiple highways merging just prior to the Bridge (eastbound, on the New Jersey side; Bottleneck number 19) and a major bottleneck on the eastern end (Bottleneck number 13). For all practical purposes, this probably should be considered

a single bottleneck. Truck travel-time data from the American Transportation Research Institute being used in the I-95 CC bottleneck study indicates that annual truck delay on the approaches to the George Washington Bridge is 1,848,000 hours. If Bottleneck numbers 13 and 19 are added together, total delay is 1,654,000 hours, a close agreement.

- Los Angeles has five of the top truck bottlenecks, Atlanta has four, and Chicago has three. This is roughly commensurate with the number of commuter bottlenecks found in the AHUA study.

- The ATRI estimates are sometimes close to the ramp-based method and sometimes much different. For those locations where differences are present:

  - The ATRI estimates for I-80 at I-580/I-880 in Oakland, California and I-95 at SR 4 in New Jersey are much higher than those of the ramp-based method. Both of these are in the immediate vicinity of a major bridge crossing (Bay Bridge and George Washington Bridge, respectively). The ramp-based method does not detect delay caused by the bridge and associated toll plazas, so the higher delay measured by the ATRI trucks is to be expected.

  - Several other discrepancies – Bottleneck numbers 8, 22, and 23 – may be occurring because the number of ATRI trucks in the sample is low. Other locations that show a high ramp-based method delay and low ATRI-based delay are Bottleneck numbers 11, 14, and 18.

  - Other discrepancies are difficult to explain without more detailed local knowledge. Several of these discrepancies are in the Los Angeles area (Bottleneck numbers 6, 8, 22, and 24). Of these, only number 24 has a higher ATRI-based estimate. A separate data source is available for the California bottlenecks; Caltrans publishes annual congestion statistics in their HICOMP report.[10] Caltrans uses a combination of floating car measurements (limited sample vehicle probe) and roadway detector measurements to estimate congestion, which is defined as speeds 35 mph or lower. The results are published as a series of maps showing congested roadway sections. From these maps the rightmost column in Table 3.5 was derived. Comparing HICOMP to the ramp-based and ATRI methods:

    - **I-710 at I-105 –** HICOMP verifies the high delay predicted by both methods.

    - **SR 60 at SR 57 –** HICOMP shows this section as being moderately to heavily congested, which would tend to verify the ramp-based method.

    - **I-80 at I-580/I-880 (Bay Bridge approach) –** HICOMP indicates that the high delay values shown by ATRI are justified.

[10] Caltrans, State Highway Congestion Monitoring Program (HICOMP), Annual Data Compilation, November 2007.

- **I-405 at I-605 –** HICOMP shows this location as heavily congested verifying the ramp-based method; the low number of trucks measured by ATRI is probably producing an underestimate of delay.
- **I-880 at I-238 –** HICOMP verifies that this location has high delay as predicted by the two methods.
- **SR 91 at SR 55 –** HICOMP indicates that the lower delay derived from the ATRI method is probably correct.
- **SR 134 at SR 2 –** HICOMP shows a low level of congestion, which is probably between the ramp-based and ATRI methods.
- **I-10 at I-15 –** HICOMP shows a moderate level of congestion, which is probably between the ramp-based and ATRI methods.
- **I-100 at I-105 –** HICOMP shows a moderate level of congestion, which is indicated by both methods.

Recommendations for Future Bottleneck Monitoring (Freight and Nonfreight)

The study demonstrates that the basic information to monitor the performance of bottlenecks – interchange configuration/geometrics and traffic – can be cost effectively obtained from existing sources. However, a few improvements in the process are recommended. More refined traffic data may be obtained directly from state DOTs. This would include primarily directional AADTs on each of the approaches of the interchanges. If temporal traffic distributions could be obtained, then instead of applying the default delay equations (which are based on fixed temporal distributions) the queuing procedures used in the Ohio study could be applied directly to each merge juncture. Finally, data on the temporal distributions of trucks – ideally site-specific – would improve the estimates of truck delay.

The process used to determine the lane configurations and geometrics at merge areas (visual inspection of satellite imagery) is somewhat subjective, and becomes more so as the complexity of the ramp layouts become more complex. Many of these complex locations also are major bottlenecks. Verification of interchange configurations with local data – at least for bottlenecks thought to be of high value – should be undertaken.

Additional types of traffic flow restrictions at interchanges should be considered. The study focused on the worst delay bottlenecks, which tend to be major freeway-to-freeway interchanges. There may be some merit in examining simpler geometric bottlenecks, because they are more amenable to low-cost improvements. This study assumed that the "chokepoints" of the intersection are where two or more freeway ramps merge with each other or the mainline. Given the nature of the interchanges studied, nearly all of which are fully directional or mostly so, this assumption was adequate for our purposes.

However, if the method is to be applied more universally, other types of restrictions need to be added, such as:

- Restricted diverge areas;
- Limited acceleration lanes; and
- Other types of limited geometry (short radius loops).

For all of these, the way the method will assess them is through the estimate of capacity (to determine if queuing is occurring).

Along these same lines, coordination with FHWA's Office of Operations Bottleneck Initiative should be undertaken. The Bottleneck Initiative is focusing on low-cost improvements which will be beneficial to improving truck flows in the near term.

The HPMS scanning method (based on the original AHUA methodology) should only be used as a screening tool. It has proven to be an effective first cut at bottleneck delay estimation and ranking, but as this study has shown, interchanges are too unique in geometrics and traffic patterns for that method to produce operations-level rankings.

The restructured HPMS data set (i.e., once states start submitting in the new format) can be used directly by the methods developed here. The restructured HPMS will have ramp AADT, presumably directly measured, which will render the synthetic turning movement calculations unnecessary. However, the detail on the lane configurations at interchange merge points will not be collected by HPMS and will still require manual inspection of satellite photos.

The analytic procedures developed here should be considered for inclusion within the HERS model. Specifically, interchange deficiency analysis should be added to HERS as a companion to its current general capacity deficiency analysis (i.e., number of lanes on mainline, noninterchange-influenced segments). The interchange deficiency analysis would be based on the methodology used here. This inclusion will be particularly valuable when HERS migrates to a network-based (rather than sample section-based) framework. Since it is clear that interchanges and there immediate influence areas are the physical items that control congestion on urban freeways, performing delay analysis based on them will provide a much more realistic assessment of capacity deficiencies and needs.

The HERS delay equations should be reviewed. The data on which they were developed are now 15 years old. In particular, the assumptions about traffic variability need to be checked, particularly for congested highways. Some level of field validation also is probably in order.

Comparison of this study with past bottleneck studies reveals inconsistencies in the results, due to use of different data sources, updates to common data sources, additional locations identified by state personnel for the "pool" of candidate sites (e.g., the I-95 Corridor Coalition states), and the subjective nature of some of the analysis steps. These problems frustrate trends analysis, which could be very informative for policy development. Therefore, it is recommended that FHWA consider undertaking a formal program of bottleneck monitoring that would provide this valuable trend information. The Bottleneck Monitoring Program could span FHWA program areas (e.g., Offices of Policy, Operations, and Planning), especially considering the major overlap between commuter and freight bottlenecks. This program would identify a fixed set of bottlenecks to be analyzed every year, perhaps upward of 50. A selected few bottlenecks may be added from year-to-year. The initial list could be based on those bottlenecks identified here, adjusted to accommodate some from the commuter-only realm. With a finite number of locations to start with, the effort could be concentrated on obtaining the detailed data directly from the states, rather than relying on secondary sources. Where freeway surveillance data are available from FHWA's Mobility Monitoring Program, these could be used instead of the modeling approach discussed in this report. Annual trends in both total and truck-only delay (and travel-time reliability where freeway surveillance data are available) would be an excellent way to "take a pulse" of the system in terms of congestion and its impacts.

Probe-based travel time data – such as those from the ATRI project as well as those data available from other private vendors – represent a very valuable resource for congestion monitoring and bottleneck analysis. For example, vehicle probe data from Inrix is now being provided to several I-95 Corridor Coalition states, primarily as a real-time resource. However, the Coalition plans to use these data for monitoring the performance of long-distance trips and for bottleneck identification. Probe-based travel time data could be used in the Bottleneck Monitoring Program outlined above cost-effectively if the number of locations can be restricted. (Some firms will price the data on a coverage basis.)

1.0 Introduction

1.1 Objectives of This Report

There are four objectives for this study:

1. Identify the highway traffic bottlenecks in the country that delay truck freight, based on the total amount annual truck delay. Approximately 200 such locations should be identified. A sketch planning method is used to accomplish this task.

2. For the worst bottlenecks, identify the top 30 locations using a more refined methodology to derive truck annual truck delay.

3. Discuss trends in congestion related to trucks, especially with regard to the previous FHWA freight bottleneck study.[1]

4. Provide suggestions for how truck-related bottlenecks should be monitored in the future and provide options for FHWA in developing a freight bottleneck program.

1.2 The Congestion Problem in the U.S.

The Nature of Congestion

Congestion is defined by an excess of vehicles – sometimes influenced by outside events – on a portion of roadway at a particular time resulting in speeds that are slower – sometimes much slower – than normal or "free flow" speeds. Congestion often means stopped or stop-and-go traffic. Previous work has shown that congestion is the result of seven root causes, often interacting with one another.[2]

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[1] Cambridge Systematics, Inc. and Battelle Memorial Institute, An *Initial Assessment of Freight Bottlenecks on Highways,* prepared for Federal Highway Administration, Office of Transportation Policy Studies, October 2005.

[2] Cambridge Systematics, Inc. et al., *Providing a Highway System with Reliable Travel Times,* F-SHRP Web Document 3, September 2003, http://onlinepubs.trb.org/onlinepubs/f-shrp/f-shrp_webdoc_3.pdf.

- **Physical Bottlenecks ("Capacity") –** Capacity is the maximum amount of traffic capable of being handled by a given highway section. Capacity is determined by a number of factors: the number and width of lanes and shoulders; merge areas at interchanges; and roadway alignment (grades and curves).

- **Traffic Incidents –** Are events that disrupt the normal flow of traffic, usually by physical impedance in the travel lanes. Events such as vehicular crashes, breakdowns, and debris in travel lanes are the most common form of incidents.

- **Work Zones –** Are construction activities on the roadway that result in physical changes to the highway environment. These changes may include a reduction in the number or width of travel lanes, lane "shifts," lane diversions, reduction, or elimination of shoulders, and even temporary roadway closures.

- **Weather –** Environmental conditions can lead to changes in driver behavior that affect traffic flow.

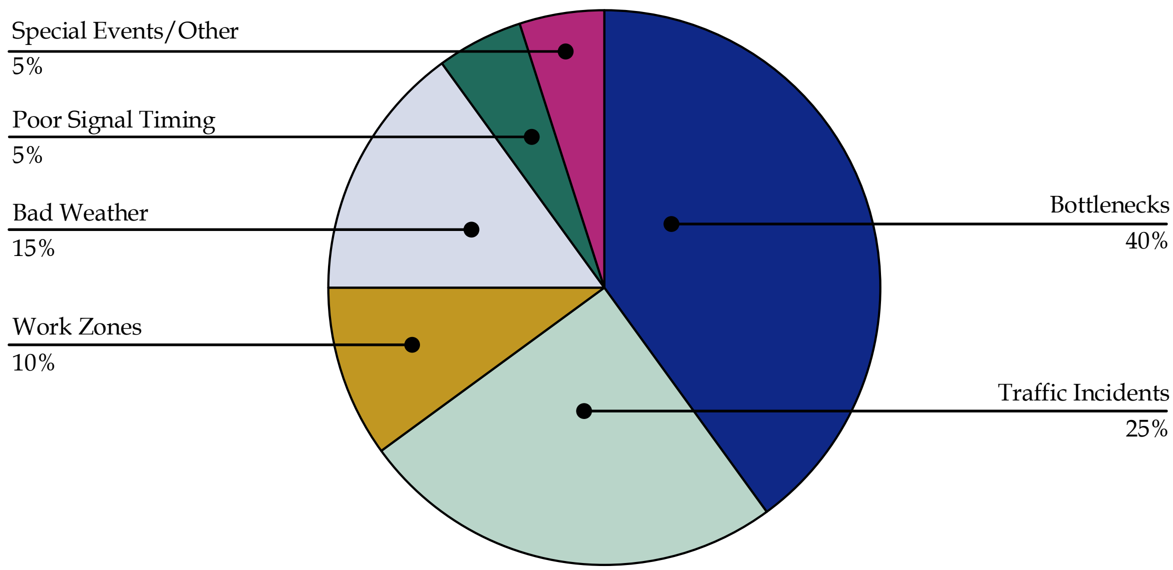
- **Traffic Control Devices –** Intermittent disruption of traffic flow by control devices such as railroad grade crossings and poorly timed signals also contribute to congestion and travel-time variability.

- **Special Events –** Are a special case of demand fluctuations whereby traffic flow in the vicinity of the event will be radically different from "typical" patterns. Special events occasionally cause "surges" in traffic demand that overwhelm the system.

- **Fluctuations in Normal Traffic –** Day-to-day variability in demand leads to some days with higher traffic volumes than others. Varying demand volumes superimposed on a system with fixed capacity also results in variable (i.e., unreliable) travel times.

National estimates of how each of these sources contributes to total congestion have been made by FHWA (Figure 1.1). However, local conditions vary widely – the national estimates probably do not apply for individual facilities or areas. Studies of individual urban freeways indicate that the amount of congestion due to recurring (bottleneck) sources is higher, indicating that bottlenecks are a highly significant aspect of the congestion problem (Table 1.1).

Figure 1.1 The Sources of Congestion
National Summary



Source: http://www.ops.fhwa.dot.gov/aboutus/opstory.htm.

Table 1.1 Results from Previous Studies Identifying Congestion by Source

Statistics	Study: Dowling	NCHRP 3-68	Kwon *et al.*	CDTC
Metro Area	Los Angeles	Seattle	San Francisco	Albany
Routes	I-10	I-405, I-90, SR 520	I-880	I-87, I-90
Freeway Miles	10 miles	42 miles	45 miles	15 miles
Amount of Data	7 days	4 months	6 months	1 year
Total Delay	–	–	–	–
Recurring Delay	69%	71%	80%	72%
Nonrecurring Delay	31%	29%	20%	28%[b]
Nonrecurring Sources	–	–	–	–
Percent Incident	31%	16%	13%	28%

Table 1.1 Results from Previous Studies Identifying Congestion by Source (continued)

	Study			
Statistics	**Dowling**	**NCHRP 3-68**	**Kwon *et al.***	**CDTC**
Percent Work Zone	Not studied	Not studied	Not studied	Not studied
Percent Weather	0%	9%	2%	Not studied
Percent Special Events	0%	Not studied	5%	Not studied
Percent High Volume	Not studied	4%	Not studied	Not studied

Sources: Cambridge Systematics, Inc., Guide to Effective Freeway Performance Measurement, NCHRP Project 3-68, Web-Only Document 97, August 2006, http://trb.org/news/blurb_detail.asp?id=7477.

Kwon, J., M. Mauch, and P. Varaiya, *The Components of Congestion: Delay from Incidents, Special Events, Lane Closures, Potential Ramp Metering Gain, and Excess Demand*, presented at 85th Annual Meeting Transportation Research Board, January 2006.

Capital District Planning Commission, *New Visions Regional Transportation Plan Update: Working Group B Draft Report – Expressway System Options*, August 2005.

Dowling Associates, Berkeley Transportation Systems, and Systems Metrics Group, *Measuring Nonrecurring Traffic Congestion*, Contract No. 65A0120, prepared for California Department of Transportation, December 11, 2002.

Several caveats must be made about these studies:

- All of these studies represent the first step in developing congestion by source and none can be considered to be definitive.
- It should be noted with care what sources of nonrecurring congestion are included in each study. No study was able to incorporate all the potential sources.
- The freeways studied have operations strategies deployed, especially formal incident management programs. These programs provide the data required to do the analyses, but also reduce the share of incident delay from what it would be with no formal programs. However, even accounting for the effectiveness of incident management, it is clear that the contribution of bottlenecks to congestion is much greater than 40 percent.

- All of the studies used data from freeways that experience a significant amount of bottleneck-related (recurring) congestion. As bottleneck conditions worsen, they will tend to dominate delay from a percentage viewpoint. The increased "baseline" congestion also will cause an increase in nonrecurring congestion, all other things equal, but since recurring congestion happens more of the time, on a percentage basis it will be higher.

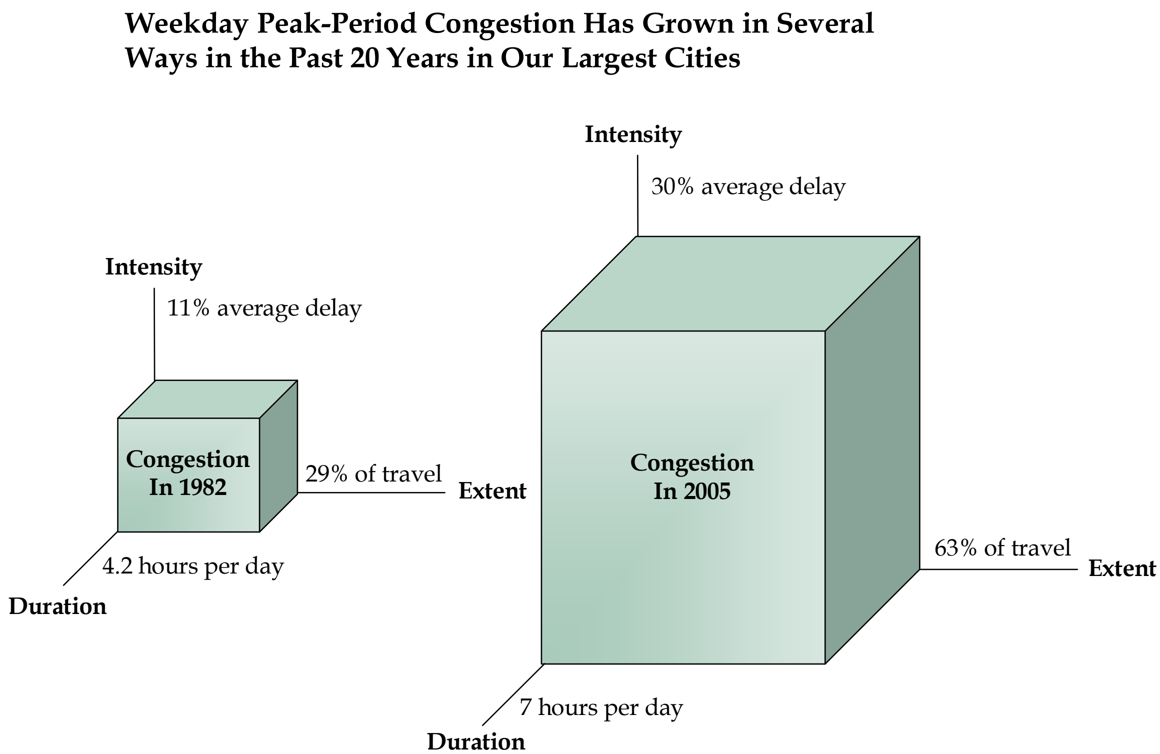
- The occurrence of work zones during the relatively brief study periods is mostly nonexistent.

Congestion Trends

Highway bottlenecks affecting freight are a problem today because they delay large numbers of truck freight shipments. They will become increasingly problematic in the future as the U.S. economy grows and generates more demand for truck freight shipments. If the U.S. economy grows at a conservative annual rate of 2.5 to 3 percent over the next 20 years, domestic freight tonnage will almost double and the volume of freight moving through the largest international gateways may triple or quadruple.

Just in the past decade, traffic demand has increased significantly. The result has been considerable congestion and delays to automobiles and truck traffic, with potentially significant impacts on the region's air quality and nature environment. Figure 1.2 shows how congestion has expanded since 1982 on three dimensions; not only has the average delay increased, but congestion now affects significantly more roadways (travel) and is present for more hours of the day.

Figure 1.2 Growth in Congestion
1982 to 2005



Source: Cambridge Systematics, Inc. and Texas Transportation Institute, *Traffic Congestion and Reliability Trends and Advanced Strategies for Congestion Mitigation*, September 1, 2005.

Delays to trucks are of particular concern to the Nation because the national economy is highly dependent on reliable and cost-effective truck-freight transportation. Truck delays add to the cost of freight shipments, increasing the cost of doing business in the region and the cost of living. The delays come at a time when shippers and receivers are putting more pressure on motor carriers to reduce shipment costs and improve service to support fast-cycle, on demand supply chains.

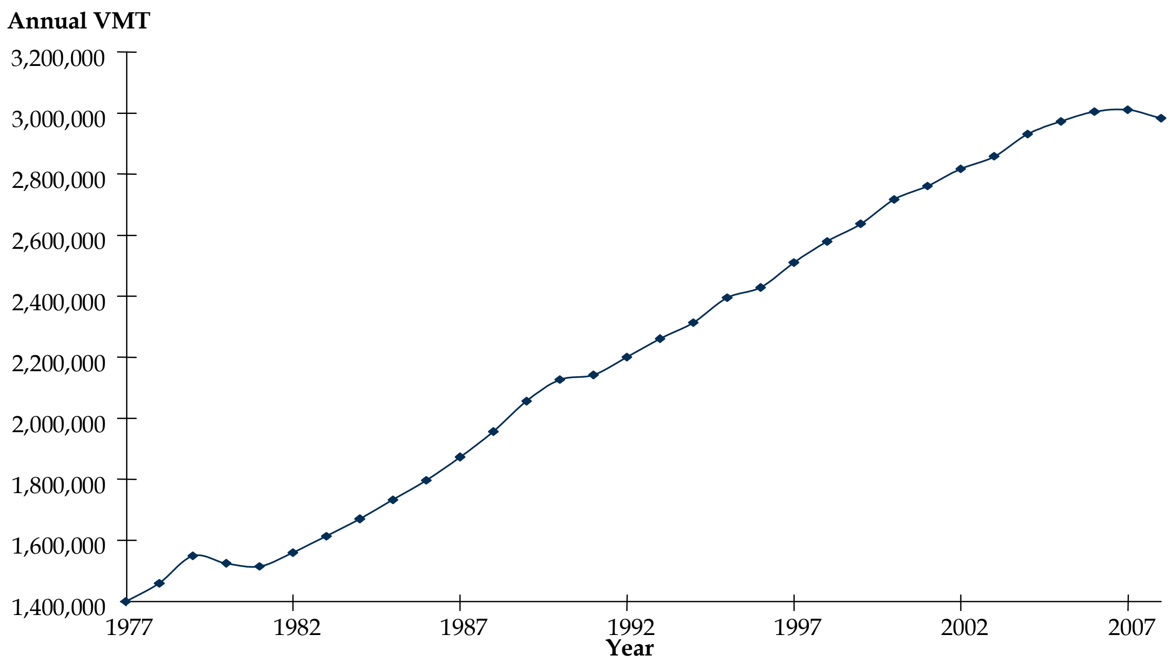
The Texas Transportation Institute's (TTI) 2007 Urban Mobility Report estimates that the cost of congestion in the 437 U.S. urban areas in 2005 was $78 billion. Corresponding to that dollar loss is 4.2 billion hours of delay and 2.9 billion gallons of excess fuel consumed. However, the TTI methodology is based on analyzing mainline segments of highway rather than specific bottlenecks.

1.3 What the Future Holds for Congestion

Future congestion levels will be a function of the demand for travel and the ability to meet that demand through physical improvements and operating policies. Beginning in late 2007, FHWA's monitoring of monthly VMT began to show a flattening of VMT and then a downturn in early 2008. Rising oil prices coupled with a slowdown of economic activity have been cited as the factors behind this trend. This is not the first time such a phenomenon has been observed. As shown in Figure 1.3, the period from 1978 to 1980, the previous serious disruption in oil supply and prices, showed a corresponding downturn in VMT, followed by an increase with the ensuing up-tick with the economic activities of the 1980s. Also note the flattening of VMT briefly in 1990 to 1991 that accompanied a slowdown in the economy, but no oil disruptions. It is very difficult to say whether the current downturn can be followed by a period of VMT growth. Previous VMT downturns were followed by "corrections" in oil price and supply. If this happens again – or if alternative sources can reduce (or stop the growth in) energy prices, then the historical pattern will repeat. If not, and oil prices remain high and if alternative sources do not provide a significant part of transportation energy, then it likely that VMT will be suppressed, not only directly because of price pressures but indirectly because of their effect on the economy as a whole. Figure 1.4 shows that combination truck VMT follows the same basic pattern, but the 1978-1980 period is more flat rather than a downturn. Also, combination VMT increased 2.6 times as compared to 2.0 times for all vehicles over the period.

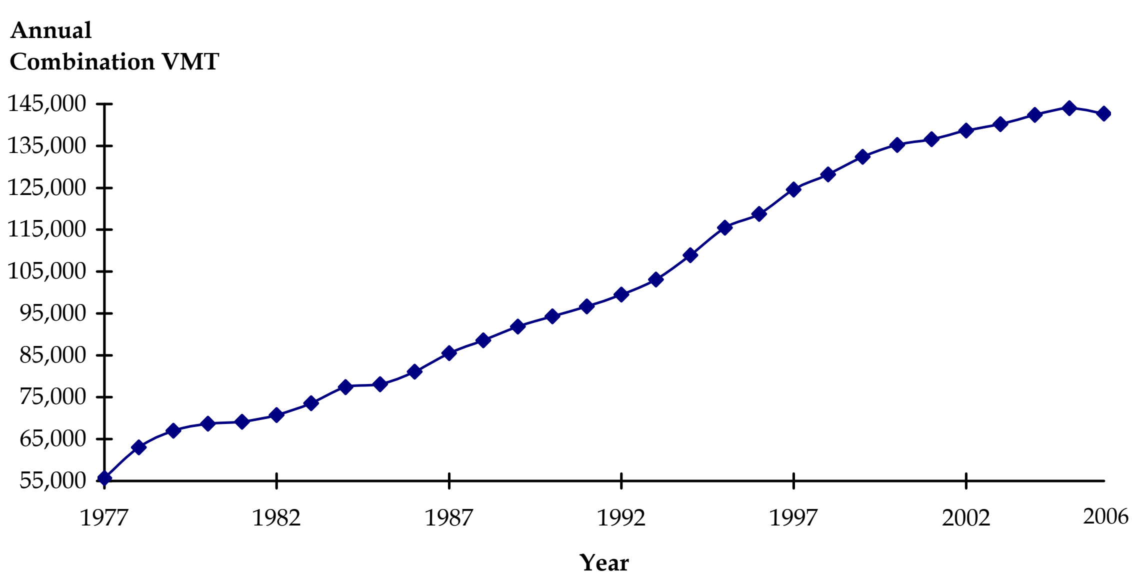
Some have postulated that even if economic activity blossoms, structural changes in lifestyle and business practice affected by the current period of high energy costs will lead to reduced demand for travel. The argument goes that people and businesses will tend to centralize their activities, negating the need for extensive travel, at least in the current weekday/peak-period/commuter pattern to which we have grown accustomed. The changes would manifest themselves as increased telecommuting, electronic shopping, centralization of residential and business locations, and decreased reliance on automobile travel as alternate modes are used. Simultaneously, there will be increasing legislative pressure to reduce carbon-based emissions as part of the effort to control global climate change, which will have an impact on oil-based transportation.

Figure 1.3 Annual VMT Trends
1977 to 2008



Source: FHWA. VMT based on 12-month rolling average for April of each year; VMT in millions.

Figure 1.4 Combination Truck VMT Trends

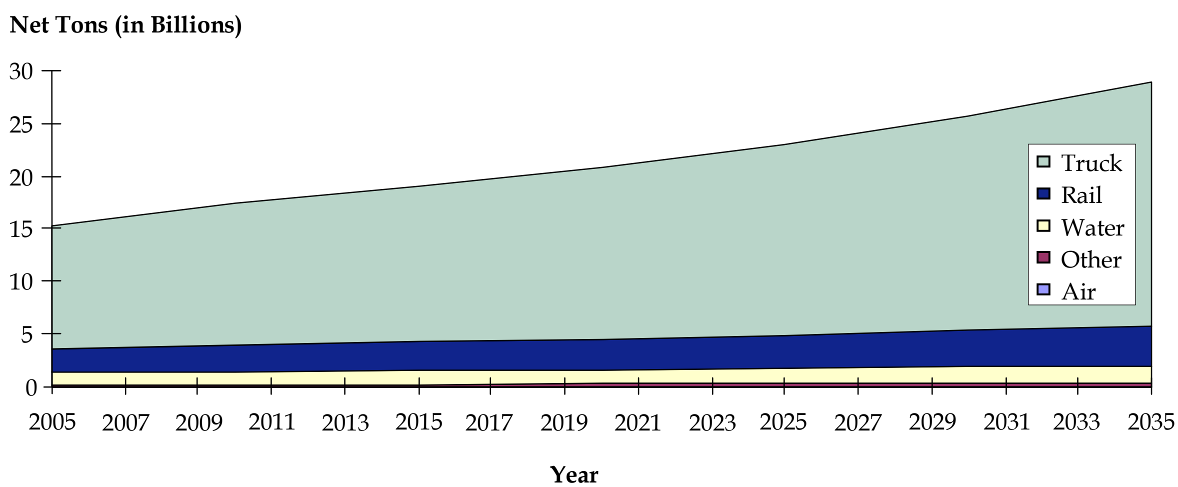


Even if these trends materialize, their effect on VMT will not be completely negative. Increased telecommuting may lead to longer distance (though less frequent) commutes as the need for employees to stay connected to their business environment does not vanish with remote work. More on-line shopping means increased use of delivery services. Increased economic activity will require more use of trucks to deliver goods, especially high value, time-sensitive ones. So, even if personal lifestyles, mode choice, and land use changes drive VMT down, other forces may drive it in the other direction, particularly for freight.

The demand for freight transportation is driven by economic growth. The United States' economy is forecast to grow at a compound annual rate of 2.8 percent over the next 30 years. This means that the gross domestic product (GDP) – a measure of the market value of all final goods and services produced in the nation – will grow by 130 percent over the same period. This rate of growth is slightly lower than the rate of growth over the last decade, which averaged 3 percent, but about the same rate of growth experienced over the last 30 years.

The demand for freight transportation to support this economic growth will nearly double between 2005 and 2035. Measured in tons, freight demand will grow from 15 billion tons today to 26 billion tons in 2035, an increase of 89 percent. Measured in ton-miles (a ton of freight moved a mile counts as one ton-mile), freight demand will grow from 6 trillion ton-miles today to 11 trillion ton-miles in 2035, an increase of 92 percent. Figure 1.5 shows the freight tonnage forecast by mode for 2005 through 2035; the most significant increase in demand is exhibited by trucks.

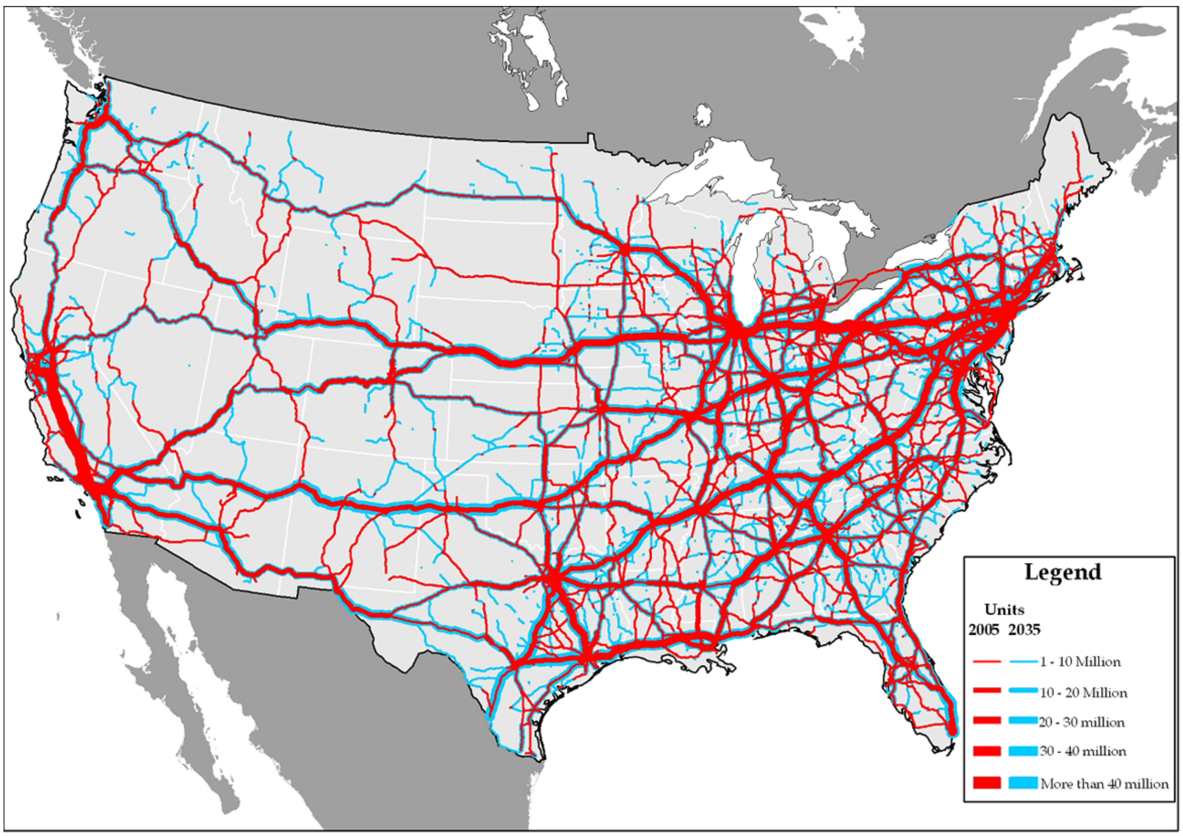
Figure 1.5 Freight Tonnage Forecast
By Mode – 2005 to 2035



Source: Global Insight, Inc., TRANSEARCH 2004.

The growth in freight demand and the increase in tonnage and ton-miles carried by trucks will add truck traffic to the entire highway system. Figure 1.6 compares truck traffic on the National Highway System roads in 2005 with the anticipated density of truck traffic in 2035. The map shows the estimated number of large freight trucks (i.e., five-axle tractor semi-trailers) on the highways; it does not account for smaller trucks such as local delivery trucks, some construction trucks, service vans, etc.

Figure 1.6 Comparison of Truck Freight Flows Trucks per Year
2005 and 2035



The increase in freight demand and truck travel means that where today, on average, there are 10,500 trucks per day per mile on the Interstate Highway System, in 2035 there will be 22,700 trucks; with the most heavily used portions of the system seeing upwards of 50,000 trucks per day per mile.[3]

[3] Intercounty loaded and empty flows, calculated by truck miles over Interstate Highway links divided by the length of the Interstate Highway links used in the routes.

The additional freight trucks will add to traffic congestion. The number of automobile and local truck trips also will grow with population and the economy. The result will be more traffic and more traffic congestion nationally.

1.4 Highway Bottlenecks

Overview

In the past several years, transportation professionals have come to realize that highway bottlenecks – specific points on the highway system where traffic flow is restricted due to geometry, lane drops, weaving, or interchange-related merging maneuvers – demand special attention. The congestion caused by bottlenecks results from the interaction of traffic and these points of reduced capacity, and is usually referred to as "recurring congestion." In the past, recurring congestion was felt to be a systemic problem ("not enough lanes"), but the root cause of recurring congestion is in fact bottlenecks, not uniform highway segments.

Bottlenecks also resonate with public officials and travelers, and making improvements to them can provide good publicity for transportation agencies. Major bottlenecks are well known to both travelers and the media who give them colorful nicknames, such as:

- **"Spaghetti Bowl"** in Las Vegas;
- **"Hillside Strangler"** in Chicago; and
- **"Mixmaster"** in Dallas.

What Is a Bottleneck?

Many different combinations of traffic, physical, and event conditions that can interact to cause traffic flow to become restricted. Table 1.2 discusses the various ways in which this can happen.

In the forthcoming report for NCHRP Project 3-83, a definition of physical bottlenecks is presented.[4] In this detailed view, bottlenecks are specific highway locations where:

- A queue is present upstream of the bottleneck location;
- "Free-flow" conditions exist downstream;
- Activation times and location are reproducible over typical weekdays; and
- Traffic flow is disrupted by drops in physical capacity, surges in demand, or a combination of both.

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[4] Based on presentations made by the NCHRP 3-83 team, unpublished.

Table 1.2 What Causes Breakdowns in Traffic Flow?

What causes traffic flow to break down to stop-and-go conditions? The layman's definition of congestion as "too many cars trying to use a highway at the same time" is essentially correct. Transportation engineers formalize this idea as capacity – the ability to move vehicles past a point over a given span of time. When the capacity of a highway section is exceeded, traffic flow breaks down, speeds drop, and vehicles crowd together. These actions cause traffic to back up behind the disruption. So, what situations would cause the overload that leads to traffic backups?

Basically, there are three types of traffic flow behavior that will cause traffic flow to break down:

1. ***"Bunching" of vehicles as a result of reduced speed.*** As vehicles are forced to get closer and closer together, abrupt speed changes can cause shock waves to form in the traffic stream, rippling backward and causing even more vehicles to slow down. Several things can cause vehicles to slow down while traveling in their intended lanes:
   - Visual Effects on Drivers. Driver behavior is a very important part of traffic flow. When traffic volume is high and vehicles are moving at relatively high speeds, it may take only the sudden slowing down of one driver to disrupt traffic flow. Driver behavior in this case is influenced by some sort of a visual cue and can include:
     - Roadside distractions – unusual or atypical events that cause drivers to become distracted from driving.
     - Limited lateral clearance – drivers will usually slow down in areas where barriers get too close to travel lanes or if a vehicle has broken down on the shoulder.
     - Traffic incident "rubbernecking" – call it morbid curiosity, but most drivers will slow down just to get a glimpse of a crash scene, even when the crash has occurred in the opposite direction of travel or there is plenty of clearance with the travel lane.
     - Inclement weather – poor visibility and slippery road surfaces cause drivers to slow down.
   - Abrupt Changes in Highway Alignment. Sharp curves and hills can cause drivers to slow down either because of safety concerns or because their vehicles cannot maintain speed on upgrades. Another example of this type of bottleneck is in work zones where lanes may be redirected or "shifted" during construction.
2. ***Intended Interruption to Traffic Flow.*** "Bottlenecks on purpose" are sometimes necessary in order to manage flow. Traffic signals, freeway ramp meters, and tollbooths are all examples of this type of bottleneck.
3. ***Vehicle Merging Maneuvers***. This form of traffic disruption has the most severe effect on traffic flow, with the exception of really bad weather (snow, ice, and dense fog). These disruptions in traffic flow are caused by some sort of physical restriction or blockage of the road, which in turn causes vehicles to merge into other lanes of traffic. How severely this type of disruption influences traffic flow is related to *how many vehicles must merge in a given space over a given time*. These disruptions include:
   - Areas where one or more traffic lanes are lost – a "lane drop" which sometimes occurs at bridge crossings and in work zones.
   - Lane-blocking traffic incidents.
   - Areas where traffic must merge across several lanes to access entry and exit points (called "weaving areas").
   - Freeway on-ramps – merging areas where traffic from local streets can join a freeway.
   - Freeway-to-freeway interchanges – a special case of on-ramps where flow from one freeway is directed to another. These are typically the most severe form of physical bottlenecks because of the high traffic volumes involved.

Source: Cambridge Systematics, Inc. and Texas Transportation Institute, *Traffic Congestion and Reliability Trends and Advanced Strategies for Congestion Mitigation*, September 1, 2005.

1.5 Previous and Current Studies of Highway Bottlenecks

The American Highway Users Alliance (AHUA) published two studies of national bottlenecks in 1999 and 2004.[5] The studies ranked the worst bottlenecks and highlighted locations where successful improvements had been made. These studies received extensive media attention and helped to galvanize interest in specifically addressing bottlenecks. The studies employed a simplified method for calculating bottleneck delay; using Highway Performance Monitoring System (HPMS) data, a "critical intersecting route" of the interchange was defined, and all the delay was assigned to that route. Delay was calculated using the relationships from FHWA's Highway Economic Requirements System.

FHWA undertook a study of truck-related bottlenecks in 2005. The study used the same methodology as the AHUA studies but calculated truck-only delay at the bottlenecks using truck volume information from HPMS and the Freight Analysis Framework. One of the major results of this study verified previous notions about truck bottlenecks – that urban interchanges heavily used by weekday commuters represent the overwhelming source of delay for trucks. However, the methodology used to estimate delay and perform the rankings is a very simple scanning level of analysis. It was clear that a more detailed form of analysis was needed.

A study performed for the Ohio Department of Transportation[6] expanded on the bottleneck analysis approach used in both the AHUA and previous FHWA studies. On freeways, the AHUA study found that the predominant type of bottleneck was freeway-to-freeway interchanges. Lane-drop bottlenecks were far less common and interchanges with surface streets produced significantly less delay than freeway-to-freeway interchanges. The AHUA methodology (also used in the previous FHWA bottleneck study) is based on identifying the "critical leg" of a freeway-to-freeway interchange (i.e., one of the two intersecting highways for the interchange) and assumes that all interchange delay is attributable to that leg. (Lane-drop and freeway-to-surface-street bottlenecks do not need this assumption since there is only one freeway "leg" present. In the AHUA approach, delay is estimated using a set of equations developed from a queuing-based model; these are the same equations that are in the HERS model. This provides a good first cut for identifying bottlenecks but delay is highly dependent on the actual interchange configurations (roadway geometry) at each location. For the Ohio work, the methodology was extended by:

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[5] American Highway Users Alliance, *Unclogging America's Arteries: Effective Relief for Highway Bottlenecks,* 2004, http://www.highways.org/pdfs/bottleneck2004.pdf.

[6] Maring, Gary; Margiotta, Rich; Hodge, Daniel; and Beagan, Dan, *Ohio Freight Mobility,* prepared for Ohio Department of Transportation, Office of Research and Development, December 30, 2005.

- Applying the actual queuing procedure (rather than default equations) on a ramp-by-ramp basis at each bottleneck. Detailed interchange configurations were available from ODOT's straight line diagrams.

- Estimating truck delay from actual truck counts at the bottlenecks (rather than aggregate AADT and truck percentage values).

The Ohio methodology is therefore more closely aligned with an operational-level analysis similar to those in the Highway Capacity Manual. It identifies specific merge points within each interchange that are the causes of delay (usually, not all merge points are problems) rather than using the planning-level notion of a "critical intersecting route."

In 2006, CS applied the Ohio DOT methodology to national freight bottlenecks.[7] Interchange configurations and geometrics were obtained using the satellite-based photos available from GoogleEarth.[8] For each interchange, the key merge points where traffic is moving away from the center of the interchange were identified. At each merge point, the number of entering and exiting lanes was noted. If there was a change in the number of exiting lanes within 1,500 feet of the interchange, this too was noted. The capacity of each merge juncture was determined by the minimum of either the number of exiting lanes or the number of lanes 1,500 feet downstream. The interchange configuration information used in this study is therefore as detailed as that used in the Ohio study.

The I-95 Corridor Coalition has two truck-related bottleneck studies underway:

- A regional study of bottlenecks for all states in the Coalition, which uses only the simple AHUA methodology; and

- A subregion study of bottlenecks for the Mid-Atlantic States, which uses the methodology previously developed for FHWA in Reference 7.

A key aspect of these studies was a survey of Coalition states to identify what they feel are their worst bottlenecks. As discovered in the original AHUA study, this local knowledge is indispensable in conducting the analysis, rather than relying blindly on HPMS or other inventory data.

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[7] Cambridge Systematics, Inc., *Application of Detailed Interchange Analysis to Top Freight Bottlenecks: Methods, Results, and Road Map for Future Research*, prepared for Office of Transportation Policy Studies, FHWA, September 1, 2006.

[8] http://earth.google.com/.

2.0 Methodology

2.1 Highway Truck Bottleneck Typology

A typology of truck bottlenecks was developed in Reference 1 to categorize bottlenecks clearly and consistently (Table 2.1).

Table 2.1 Truck Bottleneck Typology from Reference 1

Constraint Type	Roadway Type	Freight Route Type
Lane Drop	Freeway	Intercity Truck Corridor
Interchange	Arterial	Urban Truck Corridor
Intersection/Signal	Collectors/Local Roads	Intermodal Connector
Roadway Geometry		Truck Access Route
Rail Grade Crossing		
Regulatory Barrier		

Many of the classifications used in that typology are subjective and/or no formal data exists on them. It was therefore decided to simplify the typology using only HPMS data items:

1. Freeway interchanges and lane drops (usually in urban areas);
2. Steep grades (all highway types together; usually in rural areas); and
3. Signalized highways (usually in urban areas).

These three types of bottlenecks are consistent with the definitions presented in Section 1.0. The simplified categories are by no means exhaustive, but previous experience indicates that, excepting heavily used border crossings, these are the most severe types of truck bottlenecks. Regulatory barriers, especially border crossings, can have significant delay associated with them, but the data used for the rest of the bottlenecks is incompatible with border crossings.

2.2 Overview of Methodology

This study uses the same methodology as was used in Reference 7, with updated data and information gleaned from the I-95 Corridor Coalition studies. The following process was used to develop delay estimates for the key freight bottlenecks. The significant aspects of these steps are further detailed in the subsections that follow.

1. **Assemble Initial List of Bottlenecks by "Scanning" HPMS** – The AHUA methodology was used with the 2006 HPMS data to make a first ranking of truck-related bottlenecks. This method is based on identifying HPMS segments where capacity is restricted, i.e., the AADT[9]-to-capacity (AADT/C) ratio is above 12.0.

2. **Compare Initial List to Bottlenecks in Those in the I-95 Corridor** – Concurrent with this study, CS also is working with the I-95 Corridor Coalition to identify truck-related bottlenecks in Coalition states. In this study, Coalition states were asked to nominate their worst truck-related bottlenecks for consideration. Previous bottleneck work for AHUA indicates that this type of local knowledge is very valuable as it allows easy identification of locations in the HPMS data. Any Coalition state locations not identified by the HPMS scan were added to the list of national bottlenecks were located in HPMS, and the annual truck delay was estimated.

3. **Compare Initial List to FHWA Office of Operations Bottleneck Survey** – The 2006 survey of state bottlenecks conducted by the FHWA Office of Operations was used to further refine the initial list of bottleneck locations; these also were identified in HPMS and their annual truck delay was estimated.

4. **For Final List of National Bottlenecks, Identify the HPMS Segments Representing the Bottleneck** – This step was a manual process of matching the bottleneck with corresponding HPMS data.

5. **Identify Top 40 Preliminary Bottlenecks** – From the combined list of preliminary bottlenecks, identify the top 40 (in terms of total truck delay) for detailed analysis. The concept is that the scan method is imprecise, so in order to get the top 30, a greater number of locations need to be analyzed.

6. **Identify the Geometric Characteristics for Each of the Top 40 Bottlenecks** – For each location, the key merge points where traffic is moving away from the center of the interchange were identified. At each merge point, the number of entering and exiting lanes was noted. If there was a change in the number of exiting lanes within 1,500 feet of the interchange, this too was noted. The capacity of each merge juncture was determined by the minimum of either the number of exiting lanes or the number of lanes 1,500 feet downstream. (See Section 2.2 for details.)

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[9] Average Annual Daily Traffic.

7. **Identify HPMS Traffic Data and FAF2 Truck Volumes** – On each leg of the interchange, identify HPMS-derived AADTs. Use FAF2 truck volumes from the previous FHWA Freight Bottleneck Study where available to derive truck percents. Where these are unavailable, use HPMS truck percents.

8. **Develop Daily Turning Movements** – Using the balancing procedure from NCHRP Report 255, directional AADT turning movements were synthesized. This was necessary because ramp volume counts were unavailable. (See Section 2.3 for details.)

9. **Conduct Delay Analysis for Each Merge Juncture, Weaving, and Other Capacity Restrictions at the Interchanges** – The equations developed for another FHWA study[10] were used to estimate total delay at each point. Truck percents were applied to derive truck delay. (See Section 2.4 for details.)

10. **Compare Truck Speeds from the American Transportation Research Institute (ATRI) at the Bottlenecks –** ATRI provided to FHWA truck travel times on the approaches to the bottlenecks identified in this study. Delay values are compared.

2.3 Physical Characteristics of Interchanges for Detailed Delay Analysis

Interchange configurations and geometrics were obtained using the satellite-based photos available from GoogleEarth.[11] Figure 2.1 shows an example of the photos available; Appendix A shows the photos for all the interchanges studied. Figure 2.1 is still at a relatively low-resolution rate – more detailed resolutions are available that allow determining the number of lanes at specific points. (Indeed, even individual vehicles can be ascertained, even down to telling if they are a car, truck, or large truck!)

For each interchange, the key merge points where traffic is moving away from the center of the interchange were identified. At each merge point, the number of entering and exiting lanes was noted. If there was a change in the number of exiting lanes within 1,500 feet of the interchange, this too was noted. The capacity of each merge juncture was determined by the minimum of either the number of exiting lanes or the number of lanes 1,500 feet downstream. Table 2.2 shows the basic information used at each merge juncture. The interchange configuration information used in this study is therefore as detailed as that used in the Ohio study. Table 2.2 also indicates where there is overlap with the bottlenecks identified in the Office of Operations survey of FHWA Division Offices. Note

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[10] Cambridge Systematics, Inc., *Sketch Methods for Estimating Incident-Related Impacts*, prepared for FHWA Office of Planning, December 1998.

[11] http://earth.google.com/.

that not all states are represented in this survey. Also, the respondents sometimes identified congested segments rather then specific interchanges and lane-drops.

Figure 2.1 I-20 and I-75/I-85 Interchange, Atlanta, Georgia

As shown in Figure 2.1 and Appendix A, the design (ramp configuration) of many of the interchanges is extremely complex. For that reason, some of the interchanges exhibit multiple ramp merges for a particular "exit" (i.e., travel direction away from the interchange).

Table 2.2 Basic Characteristics of Interchanges Used in the Detailed Delay Analysis

Bottleneck Name	County/State	Exiting Leg	Percent Trucks	Merge 1 Number of Lanes	Merge 1 Dir AADT	Merge 2 Number of Lanes	Merge 2 Dir AADT
I-10 at SR 51/SR 202 Interchange ("Ministack")	Maricopa, Arizona	EB	0.10	1	11,448	3	58,150
		SB	0.10	2	29,134	4	73,750
		WB	0.10	3	100,721	5	145,350
		NB	0.10	2	60,255	4	84,207
I-17 (Black Canyon Freeway): I-10 Interchange (the "Stack") to Cactus	Maricopa, Arizona	EB	0.10	2	60,302	5	140,345
		SB	0.10	2	31,894	4	61,000
		WB	0.10	2	45,986	5	126,028
		NB	0.10	4	71,313	5	103,500
I-880 at I-238	Alameda, California	EB	0.09	3	66,500		66,500
		SB	0.09	4	134,000		134,000
		NB	0.09	5	121,500		121,500
SR 60 at SR 57 Interchange	Los Angeles, California	EB	0.10	7	171,500		171,500
		SB	0.10	5	109,500		109,500
		WB	0.10	4	108,000		108,000
SR 91 at SR 55 Interchange	Orange, California	EB	0.09	6	111,000		111,000
		SB	0.09	4	105,500		105,500
		WB	0.09	4	126,000		126,000
I-285 at I-75 Interchange	Cobb, Georgia	EB	0.14	5	79,600	7	92,280
		SB	0.14	3	21,771	5	92,640
		WB	0.14	4	64,718	4	73,810
		NB	0.14	4	90,338	7	161,219
I-20 at I-285 Interchange	DeKalb, Georgia	EB	0.13	3	56,156	5	93,560
		SB	0.13	1	36,818	4	78,110
		WB	0.13	4	49,635	4	65,339
		NB	0.13	4	47,273	6	88,565
I-285 at I-85 Interchange ("Spaghetti Junction")	DeKalb, Georgia	EB	0.10	5	83,181	6	120,875
		WB	0.10	5	86,209	6	109,466
		NB	0.10	5	101,394	6	132,555

Notes: Yellow highlight means the bottleneck also appeared in the Office of Operations survey of FHWA District Office. Green highlight means the Division Office did not respond to the survey. (33 states are represented in the survey). Some interchanges only have one merge area on the exiting legs, thus some do not have lanes reported for both.

Table 2.2 Basic Characteristics of Interchanges Used in the Detailed Delay Analysis (continued)

				Merge 1		Merge 2	
Bottleneck Name	**County/State**	**Exiting Leg**	**Percent Trucks**	**Number of Lanes**	**Dir AADT**	**Number of Lanes**	**Dir AADT**
I-20 at I-75/I-85 Interchange	Fulton, Georgia	EB	0.14	2	61,024	5	101,835
		SB	0.14	2	31,957	5	94,585
		WB	0.14	1	51,494	4	92,306
		NB	0.14	2	80,561	6	143,190
I-75 at I-85 Interchange	Fulton, Georgia	EB	0.13	5	103,145		103,145
		SB	0.13	7	139,665		139,665
		NB	0.13	5	123,165		123,165
I-90 at I-94 Interchange (“Edens Interchange”)	Cook, Illinois	EB	0.08	5	147,373	5	147,373
		SB	0.08				
		WB	0.08	3	71,023	3	71,023
		NB	0.08	3	75,569	3	75,569
I-94 (Dan Ryan Expressway) at I-90 Skyway Split (Southside)	Cook, Illinois	NB	0.10	3	118,750		118,750
		SB	0.10	3	101,000		
I-290 at I-355 Interchange	DuPage, Illinois	EB	0.13	4	74,738		74,738
		SB	0.13	3	83,194		83,194
		NB	0.13	5	102,453		102,453
I-64 at I-65/I-71 Interchange (“Spaghetti Junction”)	Jefferson, Kentucky	EB	0.14	2	19,520	5	43,994
		SB	0.14	2	48,054	4	77,427
		WB	0.14	2	46,491	4	70,965
		NB	0.14	2	17,957	4	47,330
I-75 at I-275 Interchange	Kenton, Kentucky	EB	0.19	2	34,621	4	56,255
		SB	0.19	2	37,932	5	89,820
		WB	0.19	2	32,923	3	54,557
		NB	0.19	2	29,612	4	81,500
		SB	0.10	4	68,277	4	88,113
		WB	0.10	2	45,902	4	92,327
		NB	0.10	2	53,708	5	100,950

Notes: Yellow highlight means the bottleneck also appeared in the Office of Operations survey of FHWA District Office. Green highlight means the Division Office did not respond to the survey. (33 states are represented in the survey). Some interchanges only have one merge area on the exiting legs, thus some do not have lanes reported for both.

Table 2.2 Basic Characteristics of Interchanges Used in the Detailed Delay Analysis (continued)

				Merge 1		Merge 2	
Bottleneck Name	**County/State**	**Exiting Leg**	**Percent Trucks**	**Number of Lanes**	**Dir AADT**	**Number of Lanes**	**Dir AADT**
I-95/I-495	Prince Georges, Maryland	EB	0.09	4	95,805		95,805
		WB	0.09	6	108,095		108,095
		NB	0.09	4	93,955		93,955
I-35E at I-94 Interchange ("Spaghetti Bowl") – East Section	Ramsey, Minnesota	EB	0.07	3	64,375		64,375
		WB	0.07	5	101,000		101,000
		NB	0.07	3	89,862		89,862
I-95 at SR 4	Bergen, New Jersey	EB	0.11	3	156,296		156,296
I-95 at SR 9A (Westside Highway)	New York, New York	EB	0.13		0		
		SB	0.13	2	50,621	2	60,507
		WB	0.13	5	98,865	4	74,335
		NB	0.13	2	50,621	3	24,081
		EB	0.13	5	98,865	3	30,133
		WB	0.13	5	98,865	4	74,335
I-71 at I-70 Interchange	Franklin, Ohio	EB	0.18	3	56,123	4	62,415
		SB	0.18	2	52,425	4	74,720
		WB	0.18	3	61,141	4	68,764
		NB	0.18	2	29,918	3	36,210
I-95 at I-476 Interchange	Delaware, Pennsylvania	SB	0.08	3	60,348		60,348
		WB	0.08	3	58,689		58,689
		NB	0.08	4	86,832		86,832
I-40 at I-65 Interchange (east)	Davidson, Tennessee	EB	0.14	3	83,525		83,525
		SB	0.14	3	54,390		54,390
I-10 at I-410 Loop North Interchange	Bexar, Texas	EB	0.09	4	57,589	6	86,000
		SB	0.09	2	33,698	3	82,000
		WB	0.09	3	59,213	5	90,500
		NB	0.09	3	59,698	6	108,000

Notes: Yellow highlight means the bottleneck also appeared in the Office of Operations survey of FHWA District Office. Green highlight means the Division Office did not respond to the survey. (33 states are represented in the survey). Some interchanges only have one merge area on the exiting legs, thus some do not have lanes reported for both.

Table 2.2 Basic Characteristics of Interchanges Used in the Detailed Delay Analysis (continued)

Bottleneck Name	County/State	Exiting Leg	Percent Trucks	Merge 1 Number of Lanes	Merge 1 Dir AADT	Merge 2 Number of Lanes	Merge 2 Dir AADT
I-45 at I-610 Interchange	Harris, Texas	EB	0.06	3	46,404	5	74,840
		SB	0.06	4	98,093	5	129,168
		WB	0.06	2	43,767	4	74,843
		NB	0.06	4	82,344	4	97,675
I-45 (Gulf Freeway) at U.S. 59 Interchange	Harris, Texas	EB	0.06	3	79,887	4	109,090
		SB	0.06	4	58,180		58,180
		WB	0.06	2	74,168	3	101,231
		NB	0.06	2	54,601	5	119,421
I-10 at I-110/U.S. 54 Interchange	El Paso, Texas	EB	0.09	2	37,331	4	110,715
		SB	0.09	2	17,665		17,665
		WB	0.09	4	78,751	6	89,917
		NB	0.09	4	32,530	5	43,700
I-405 (San Diego Freeway) at I-605 Interchange	Orange, California	SB	0.10	5	150,000		150,000
		WB	0.10	4	129,500		129,500
		NB	0.10	4	94,000		94,000
SR 134 at SR 2 Interchange	Los Angeles, California	EB	0.08	4	84,921	4	105,001
		SB	0.08	5	56,920	5	77,000
		WB	0.08	4	99,921	5	123,000
		NB	0.08	2	38,376	6	65,000
I-10 at I-15 Interchange	San Bernardino, California	EB	0.11	5	92,649	5	113,000
		SB	0.11	5	73,983	5	102,500
		WB	0.11	5	87,399	6	120,000
		NB	0.11	4	61,733	6	85,000
		SB	0.10	3	55,666	6	115,500
		WB	0.10	3	84,207	4	115,000
		NB	0.10	2	57,166	5	117,000
I-75 at I-74 Interchange	Hamilton, Ohio	SB	0.09	4	70,535		70,535
		WB	0.09	3	57,113		57,113
		NB	0.09	4	79,919		79,919

Notes: Yellow highlight means the bottleneck also appeared in the Office of Operations survey of FHWA District Office. Green highlight means the Division Office did not respond to the survey. (33 states are represented in the survey). Some interchanges only have one merge area on the exiting legs, thus some do not have lanes reported for both.

2.4 Traffic Volumes at Interchanges

Detailed ramp traffic data were not available for this study. The scope of this study did not allow for the contact of other DOTs and assembly of the data. Further, it is not known if other DOTs maintain counts, especially vehicle classification counts, on freeway-to-freeway ramps. Therefore, a simpler method was used. AADTs for all the approaches of the interchanges were identified from the HPMS Universe data using the LRS Beginning and Ending Points. Because the HPMS Universe data provides continuous coverage of highway segments, there were no gaps the highway segments used for this analysis. Identifying which HPMS segments were located immediately prior to the interchange involved some judgment, with the LRS information being used to get close to the interchange, then looking for large changes in AADTs indicating that merging and diverging traffic flow was occurring.

Once AADTs (two-way) for each approach were identified, it was assumed that the directional AADT was half of the total AADT. Turning movements were then synthetically derived using the balancing procedure first identified in NCHRP 255 and in widespread use among travel demand modelers.[12] Turning movements were then assigned to each ramp.

Truck percents were obtained from the HPMS Sample data. The more recent FAF data was too aggregated for segment-level analysis.

2.5 Delay Estimation

Background

This study uses the delay equations developed in a previous FHWA study[13] and subsequently adapted for use in the HERS model. A series of these equations were developed specifically to estimate the delay due to recurring bottlenecks. A brief history of the development of this methodology follows.

The equations were developed by using a simple queuing-based model. The procedure works as shown in Figure 2.2:

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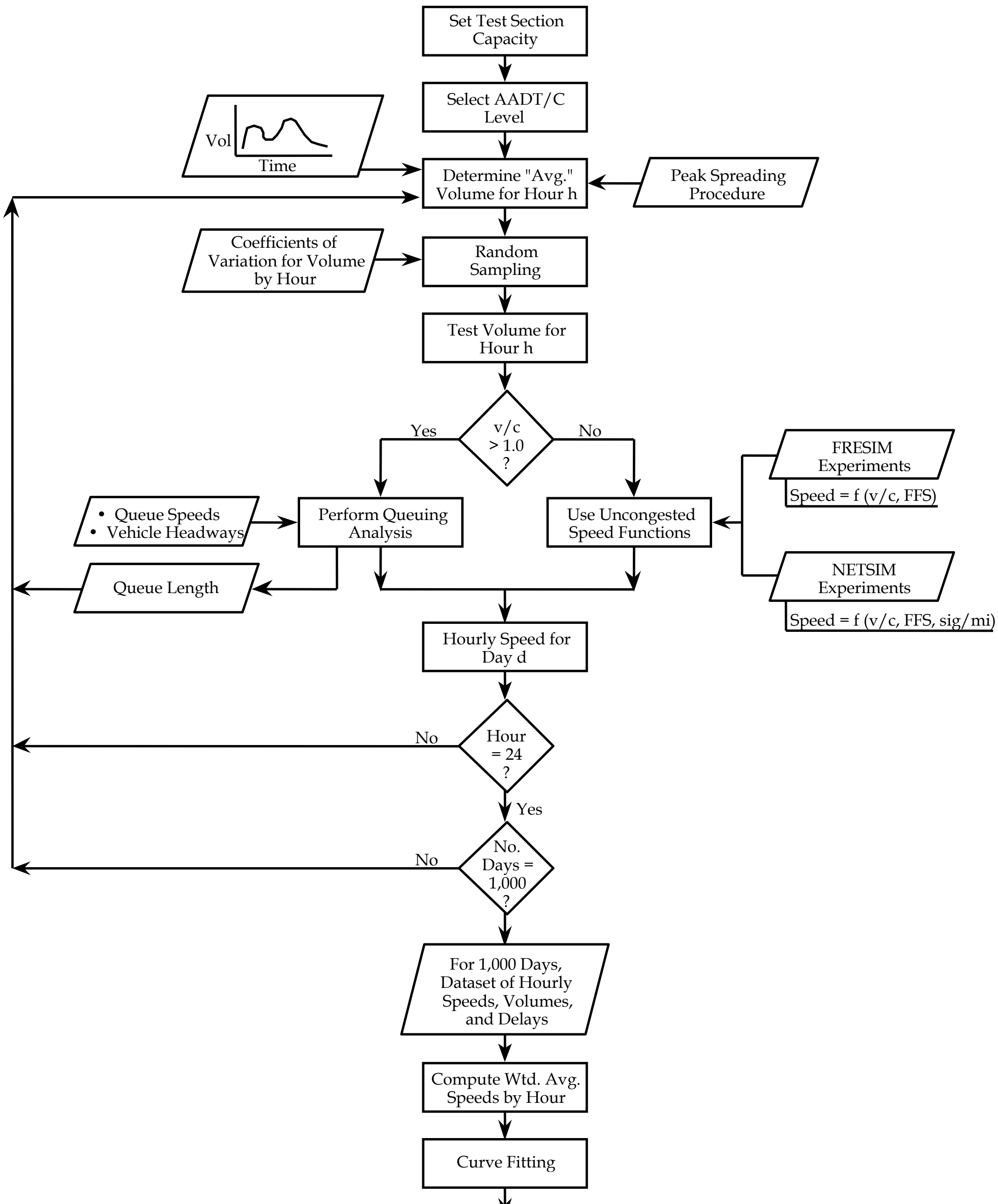
[12] Pedersen, N.J. and Amdahl, Don, NCHRP Report 255, *Highway Traffic Data for Urbanized Area Project Planning and Design*, December 1982.

[13] Cambridge Systematics, Inc., *Sketch Methods for Estimating Incident-Related Impacts*, December 1998.

Figure 2.2 Methodology for Delay Equations



Time Period	Day of Week: Weekday	Weekend	All Days
Daily Peak Period Peak Hour	Speed = f (AADT/C, FFS, sig/mi)		

Source: Cambridge Systematics, Inc., *Sketch Methods for Estimating Incident-Related Impacts*, December 1998.

- The test link is assumed to have a bottleneck at the downstream end and that queuing will back upstream from there. The capacity of the link is assumed to be fixed at 2,400 pcphpl.

- AADT/C levels from 1 to 18 are used. These represent the level of congestion. Since daily and peak-period delays need to be computed, V/C is not a relevant indicator of overall congestion.

- The model considers traffic on an hourly basis. Hourly traffic distributions from a detailed study of urban traffic patterns are used.[14] Peak spreading is built into these equations: as congestion increases, demand is spread into hours around the traditional peak-hours. The hourly demand volume for each run is selected by sampling from this distribution – in this way, the effect of day-to-day traffic variability is captured.

- If volume for an hour is greater than capacity, then a queue is built and carried over to successive hours until it dissipates.

- The procedure is repeated by sampling anew from the hourly traffic distributions. The resulting set of delay values were then used to fit equations.

Note that this method considers the effect of delay from the interaction of demand and physical capacity only (usually termed "recurring" delay).

The basis of the model is the definition of capacity. If a highway section has a reduced capacity from "normal" (e.g., due to weaving or other geometric constraint), then this reduced capacity must be used in the application of this model. Essentially, it treats all bottlenecks the same – just with varying values of capacity. This assumption will miss some of the operational nuances of certain types of conditions (weaves) when flows are restricted but still above level of service F (forced flow); after breakdown occurs, then the queuing procedure probably captures the effects adequately.

So, the concepts of highway capacity are used as a starting point, the resulting delay estimates are higher using this method than if HCM-based methods are used. Because the equations consider queuing, and HCM methods do not, these equations will predict more delay than HCM methods. Note that the HCM recommends that queuing procedures be used for oversaturated conditions, but does not provide a specific method. For example, in Chapter 25 ("Ramp and Ramp Junction"), it simply states that LOS F exists "when demand exceeds capacity." There are no explicit delay calculations for the various degrees of LOS F.

Most of the interchanges studied are of very high designs with no weaving areas, but there are a few (you can tell from the photos which have weaving areas). These were

[14] Margiotta, Richard, and Cohen, Harry, *Roadway Usage Patterns: Urban Case Studies*, prepared for FHWA and VNTSC, July 22, 1994.

ignored in favor of focusing on the merge junctures as the thing that controls capacity for a particular turning movement. Also, note that even though the HCM procedure is complex and requires data we do not have, it still measures delay crudely as one of the LOS categories.

However, to date field data have been lacking to validate this procedure. Also, there is some indication that the traffic variability component is too large for congested highways – day-to-day variability is smaller on congested highways. (The traffic distributions on which the procedure is based are now 15 years old). The HERS model uses this procedure and FHWA staff are aware of the need to rethink the traffic distributions and to perform at least limited field testing of the procedure.

Application to the Current Study

The equations relate the AADT-to-capacity ratio to delay. Directional AADTs were obtained as described above. One-way capacities were calculated using a base capacity of 2,400 pcphpl, adjusted downward for the percentage of trucks at each merge juncture. If there is a lane drop either at the merge juncture or a 1,000-foot downstream, that is included in the analysis; we consider these lane drops to be part of the interchange. Other lane drops (such as those at bridges) are not interchange-related and have been identified in the previous FHWA freight bottleneck study as "general capacity-related bottlenecks."

The equations for estimating total daily delay for each direction were applied to each merge juncture, then, the higher delay was chosen. The travel time without queuing factors (Hu) are small in comparison to those for queuing (Hr). Total delay for each merge juncture is then:

$$\text{Total Delay at Merge Juncture} = (Hu * VMT) + (Hr * AADT)$$

VMT is calculated by multiplying AADT by a half mile, assuming this is the distance traveled by vehicles as they pass through the interchange. Truck delay is obtained by multiplying total delay by percent trucks. This is clearly a simplifying assumption since it is assumed that the temporal distribution of trucks (hourly volumes) follow the same pattern as for total traffic. There is at least some anecdotal evidence suggesting that trucks avoid peak periods in some areas. The implication of this assumption is that peak period truck delays will be overstated when and where peak avoidance by trucks is occurring. However, the current study had neither the data to identify these locations nor a method for adjusting for this problem.

In some cases, interchanges are constructed so that two ramps handling turning movements merge, and then the combined ramp merges with through traffic on the mainline. In such cases, the higher delay (rather than the sum was chosen) because when two bottlenecks are closely spaced, one will control the operation. Therefore, only one delay value for each exiting direction is used. Figure 2.3 shows the equations for estimating the delay factors. Total delay for the interchange is then summed over all exiting directions for the interchange.

Figure 2.3 Delay Equations from Reference 4 Used in the Study

a.m. Peak Direction, 24-hour Delay

Travel Time without Queuing (hours per vehicle mile)

$H_u = 1 / \text{Speed} = (1 / S_f)\ (1 + 5.44E\text{-}12 * X^{10})$

for X <=8

$H_u = 1 / \text{Speed} = (1 / S_f)\ (1.23E{+}00 - 7.12E\text{-}02 * X + 6.78E\text{-}03 * X^2 - 1.83E\text{-}04 * X^3)$

for X >=8

Delay Due to Recurring Queues (hours per vehicle using the bottleneck)

$H_r = \text{RECURRING DELAY} = 0$

for X <=8

$H_r = \text{RECURRING DELAY} = 6.77E\text{-}03 * (X-8) - 4.13E\text{-}03 * (X-8)^2 + 1.29E\text{-}03 * (X-8)^3$

for X >=8

p.m. Peak Direction, 24-hour Delay

Travel Time without Queuing (hours per vehicle mile)

$H_u = 1 / \text{Speed} = (1 / S_f)\ (1 + 7.37E\text{-}12 * X^{10})$

for X <=8

$H_u = 1 / \text{Speed} = (1 / S_f)\ (1.13E{+}00 - 4.39E\text{-}02 * X + 4.68E\text{-}03 * X^2 1.32E\text{-}04 * X^3)$

for X >=8

Delay Due to Recurring Queues (hours per vehicle using the bottleneck)

$H_r = \text{RECURRING DELAY} = 0$

for X <=8

$H_r = \text{RECURRING DELAY} = 4.11E\text{-}03 * (X-8) + 1.26E\text{-}03 * (X-8)^2 + 4.03E\text{-}04 * (X-8)^3$

for X >=8

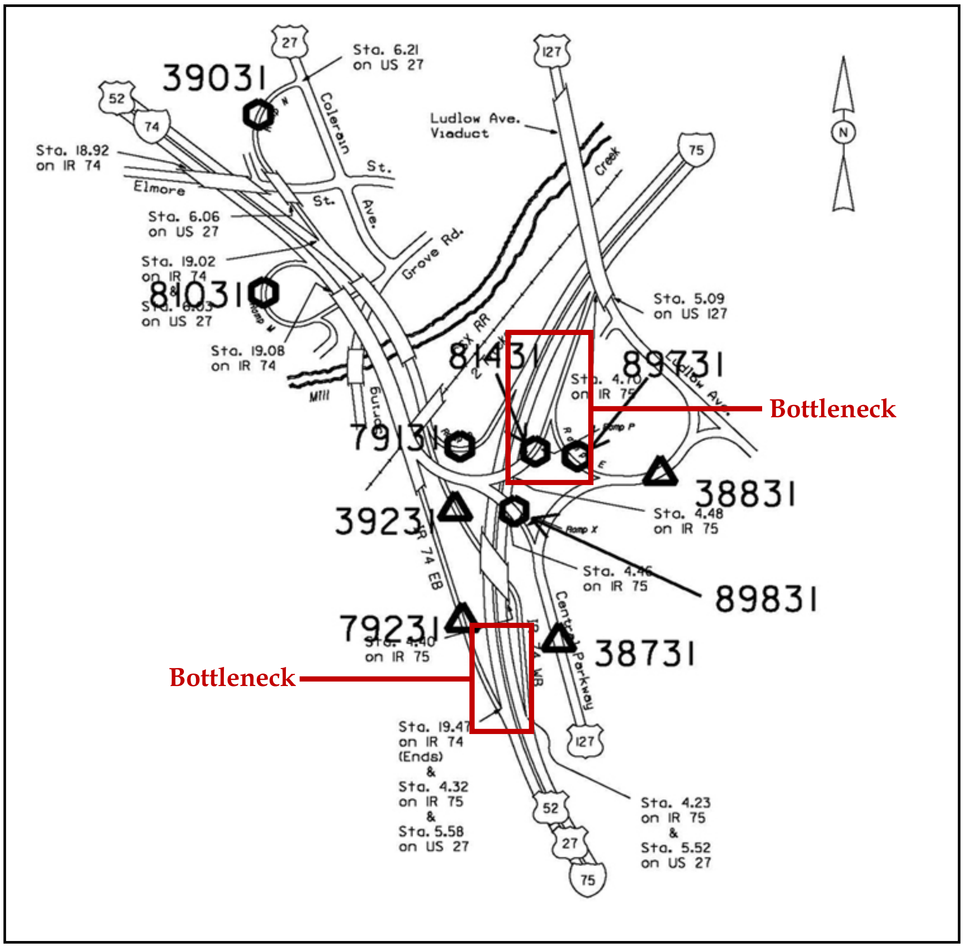
Where: S_f = free flow speed = 60 mph

X = AADT/C

Figure 2.4 shows an example of what the analysis reveals at an individual interchange. Note that only two merge junctures create delay problems.[15] These results are very typical – not all ramps and turning problems are bottlenecks at an interchange.

[15]Note: This figure is from the *Ohio Freight Mobility* report, but the same two ramps are identified as bottlenecks in both studies.

Figure 2.4 Merge Junctures That Are Bottlenecks, I-74/I-75 Interchange
Cincinnati, Ohio



Limitations of the Methodology

The goal of this project was to see if a cost-effective methodology could be developed for analyzing bottlenecks that is based on the specific physical restrictions of complex types of bottlenecks (interchanges). Generally, as analytic procedures become more detailed, their replication of reality will increase in accuracy and fewer assumptions have to be made, but their data requirements and operation become more onerous. For bottleneck analysis, the methods range from:

- The very abstract approach used in the AHUA and previous FHWA bottleneck studies (using the highest value for AADT/C for the intersecting highways, based on HPMS data); to

- Microsimulation of the entire interchange using actual hourly (or subhourly) traffic volumes.

The methodology used here falls between these two ends of the spectrum, closer to the AHUA methodology because it is still a "planning level" analysis (in HCM terms). The major limitations of the methodology are as follows:

- Turning movements (total daily volume) on the ramps of the interchanges are derived synthetically rather than using actual (measured) turning volumes. While the method used to derive turning movements has been in standard planning practice for a long time, there is still error associated with it.

- Truck volumes on the interchange ramps are computed using global percentages from HPMS (to adjust capacity) and from FAF (to get "freight truck" delay").

- Hourly distributions of traffic are assumed to be the same as those that were to develop the HERS delay equations. Hourly truck distributions are assumed to follow the same temporal pattern as total traffic.

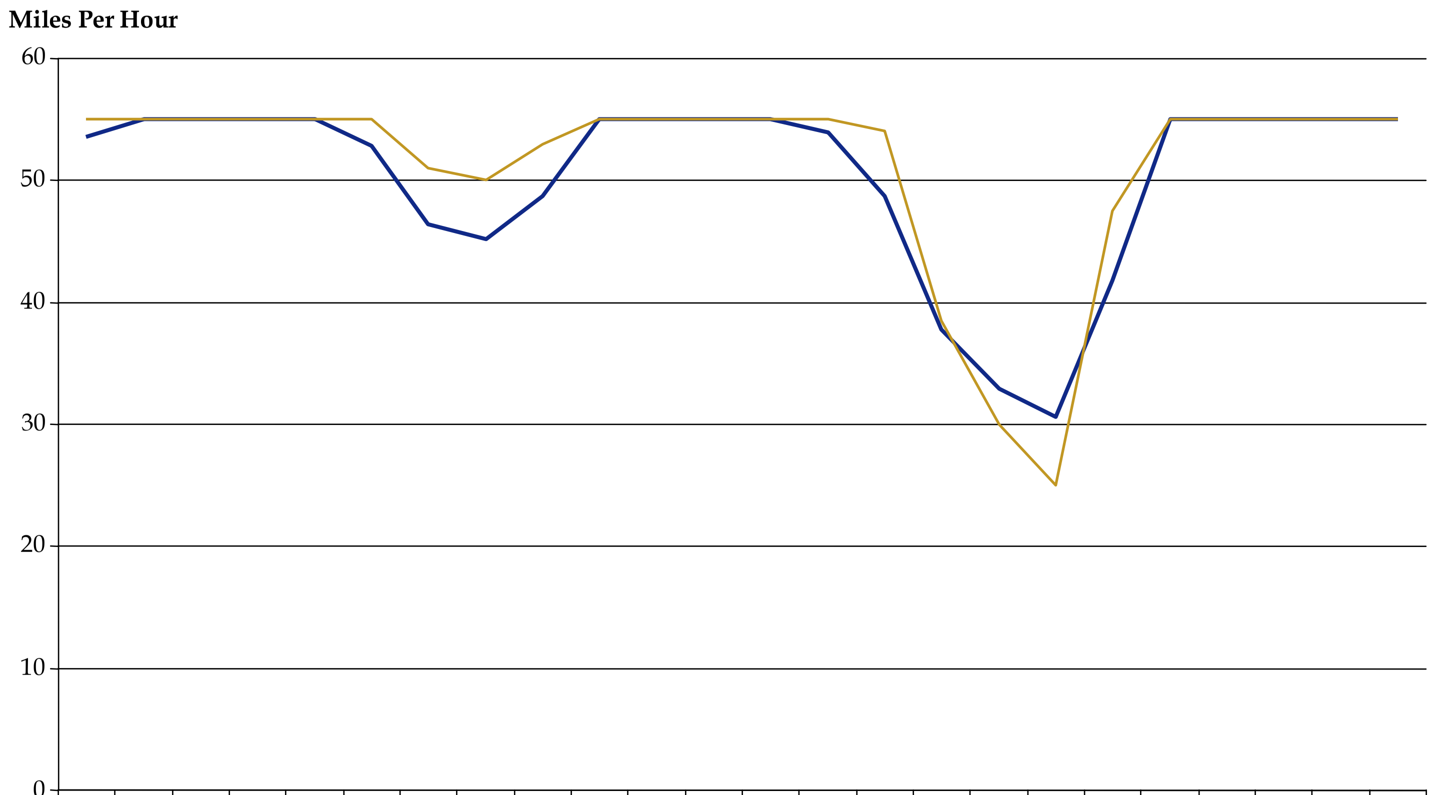
- The internal workings of the HERS delay equations need to be checked. The assumptions used in the development of the equations are now 15 years old and need to be revisited.

ATRI Truck Speeds

ATRI provided to FHWA under a separate contract data on truck speeds occurring at the initial list of bottleneck locations. ATRI bases these data on truck time and position data received via GPS technology. Truck locations are then "snapped" to a highway network, and travel times can be derived from the time and space measurements. For this study, ATRI provided average truck speeds by hour of the data for all the legs emanating from the bottleneck locations, usually for a two-mile distance on each leg. Data were summarized for weekdays for a one-year period between June 2006 and May 2007; the number of trucks on which the speed values are based varies by bottleneck location. Figure 2.5 shows an example of the data provided. The speeds shown are for trucks traveling on all legs of the bottleneck.

Delay estimates were derived from these data by combining AADT and truck percentage information from HPMS and the hourly temporal distributions used in the detailed ramp analysis. First, total bottleneck VMT for all vehicles and trucks were derived, using the AADT and truck percentage for all the legs, combined with the ATRI-provided highway mileage. Then, a unit delay rate (hours per vehicle-mile) was computed from the inverse of the speed and assuming that free flow conditions occur at 55 mph. Total delay is then calculated as the product of VMT and the delay rate.

Figure 2.5 Mean and Median Speed by Time of Day
Phoenix – 1-10 and 1-17 (The Stack)



	00:00 01:00	01:00 02:00	02:00 03:00	03:00 04:00	04:00 05:00	05:00 06:00	06:00 07:00	07:00 08:00	08:00 09:00	09:00 10:00	10:00 11:00	11:00 12:00
Mean Speed	53.57	55.00	55.00	55.00	55.00	52.83	46.36	45.14	48.65	55.00	55.00	55.00
Median Speed	55	55	55	55	55	55	51	50	53	55	55	55

	12:00 13:00	13:00 14:00	14:00 15:00	15:00 16:00	16:00 17:00	17:00 18:00	18:00 19:00	19:00 20:00	20:00 21:00	21:00 22:00	22:00 23:00	23:00 00:00
Mean Speed	55.00	53.94	48.65	37.78	32.92	30.63	41.81	55.00	55.00	55.00	55.00	55.00
Median Speed	55	55	54	38.5	30	25	47.5	55	55	55	55	55

Time of Day

3.0 Highway Truck Bottlenecks

3.1 National Inventory of Truck Bottlenecks

Overview

We located and estimated truck hours of delay for the various types of highway truck bottlenecks. Table 3.1 lists the types of bottlenecks and the annual truck hours of delay associated with each type. The bottleneck types are sorted in descending order of truck hours of delay by constraint type and then within each group by the truck hours of delay for each bottleneck type.

Table 3.1 also shows the delay values from Reference 1. It must be noted that the 2004 and 2006 numbers are not directly comparable, because the 2004 values are based on truck volumes from the FAF while the 2006 numbers are based on truck volumes from HPMS. Further, the number of bottlenecks is not directly comparable due to additional sources being used in 2006 (inclusion of the I-95 Corridor Coalition identified locations) and changes in HPMS data.

In 2006, the bottlenecks accrued 226 million hours of delay. At a delay cost of $32.15 per hour, the conservative value used by the FHWA's Highway Economic Requirements System model for estimating national highway costs and benefits, the direct user cost of the bottlenecks is about $7.3 billion per year.[16]

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[16] The FHWA Highway Economic Requirements System model uses a current value of truck time of $32.15 per hour. Other researchers have suggested higher rates, typically between $60 and $70 per hour.

Table 3.1 Truck Hours of Delay by Type of Highway Freight Bottleneck

Constraint	Highway Type	Freight Route	National Annual Truck Hours of Delay, 2006 (Estimated)	National Annual Truck Hours of Delay, 2004 (Reference 1)
Interchange and Lane Drop	Freeway	Urban Freight Corridor	151,519,000	
		Intercity Freight Corridor	36,000	
		Subtotal	**151,555,000**	**134,517,000**
Steep Grade	Arterial	Intercity Freight Corridor	15,001,000	
		Urban Freight Corridor	471,000	
	Freeway	Intercity Freight Corridor	10,697,000	
		Subtotal	**26,169,000**	**32,859,000**
Signalized Intersections	Arterial	Urban Freight Corridor	43,462,000	
		Intercity Freight Corridor	4,799,000	
		Subtotal	**48,261,000**	**43,113,000**
		Total	**225,985,000**	**210,489,000**

Notes:

1. **Interchange and Lane Drops –** The delay estimation methodology calculated delay resulting from queuing on the critically congested roadway of the interchange (as identified by the scan) and the immediately adjacent highway sections. Estimates of truck hours of delay are based on two-way traffic volumes. The bottleneck delay estimation methodology also did not account for the effects of weaving and merging at interchanges, which aggravates delay, but could not be calculated from the available HPMS data.

2. **Steep Grades and Signalized Intersections –** The total delay shown is the expanded delay, assuming that the HPMS Sample data used in the analysis does not cover all possible grades or signals. Unexpanded delay for steep grades and signalized intersections are 11,048,000 and 12,415,000, respectively.

3. **Steep Grades –** It is assumed that the delay is incurred only by trucks on the upgrade (one direction). The delay values in Reference 1 were computed for both directions, so they have been halved here.

Interchange Bottlenecks for Trucks

A total of 326 bottlenecks were identified. Figure 3.1 shows the locations of the bottlenecks overlaid on national speed data produced by the American Transportation Research Institute. Note that this shows only the South and West directions; Appendix F shows the map for the North and East directions.

Figure 3.2 is a histogram showing the distribution of truck hours of delay for all highway interchange bottlenecks for trucks. The individual bottlenecks, each represented on the horizontal axis by an identification number, are sorted in descending order of annual truck hours of delay, which are measured on the vertical axis. Of the 326 highway interchange bottlenecks, 199 cause more than 250,000 truck hours of delay annually (equivalent to a direct user cost of about $8 million per year). By comparison only a few dozen of all the other truck bottlenecks cause more than 250,000 truck hours of delay annually. Table 3.2 presents detailed data for the top 25 truck bottlenecks; Appendix B has the same data for all 326 bottlenecks. Note that this shows only the South and West directions; Appendix F shows the map for the North and East directions.

Figure 3.1 Interchange Bottlenecks Identified with the HPMS Scan Method and National Truck Speeds
2006 (South and West Directions)

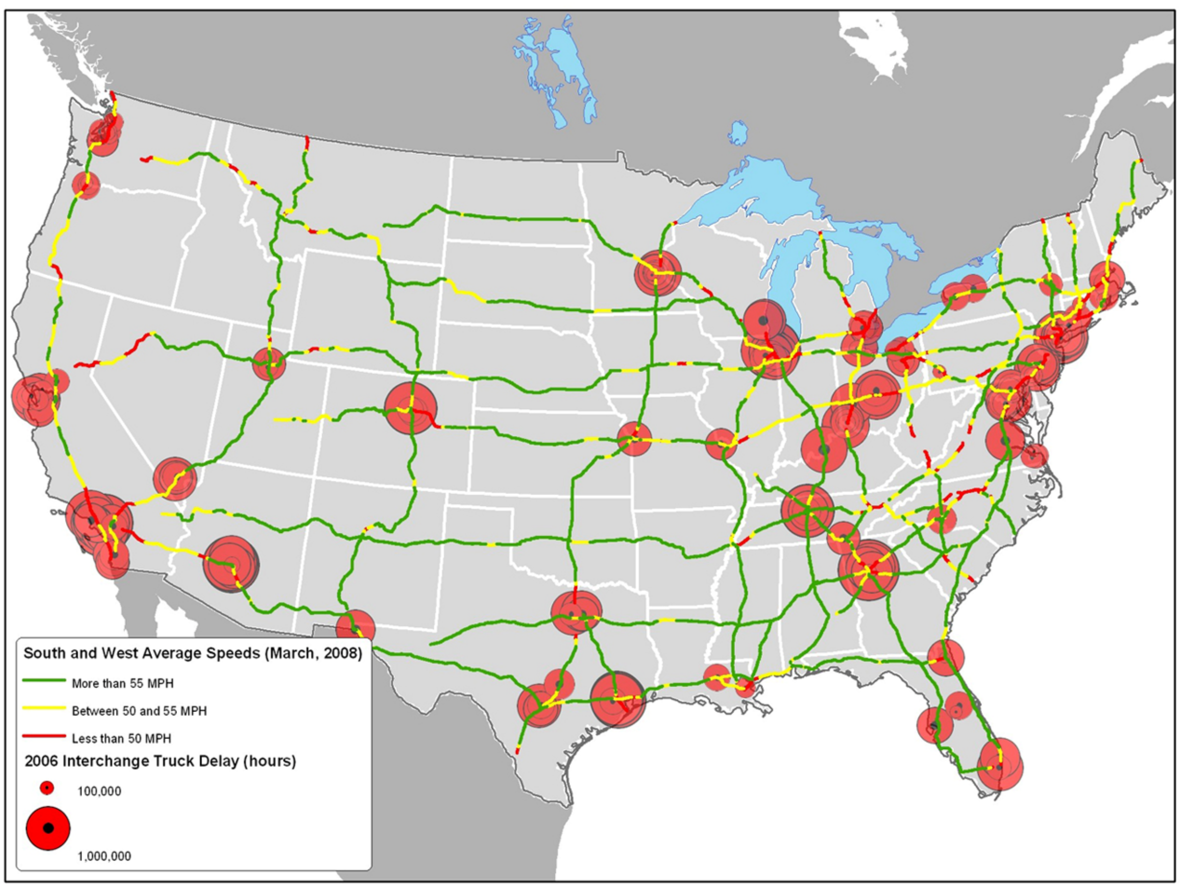


Figure 3.2 Interchange Bottleneck Delay Histogram
2006

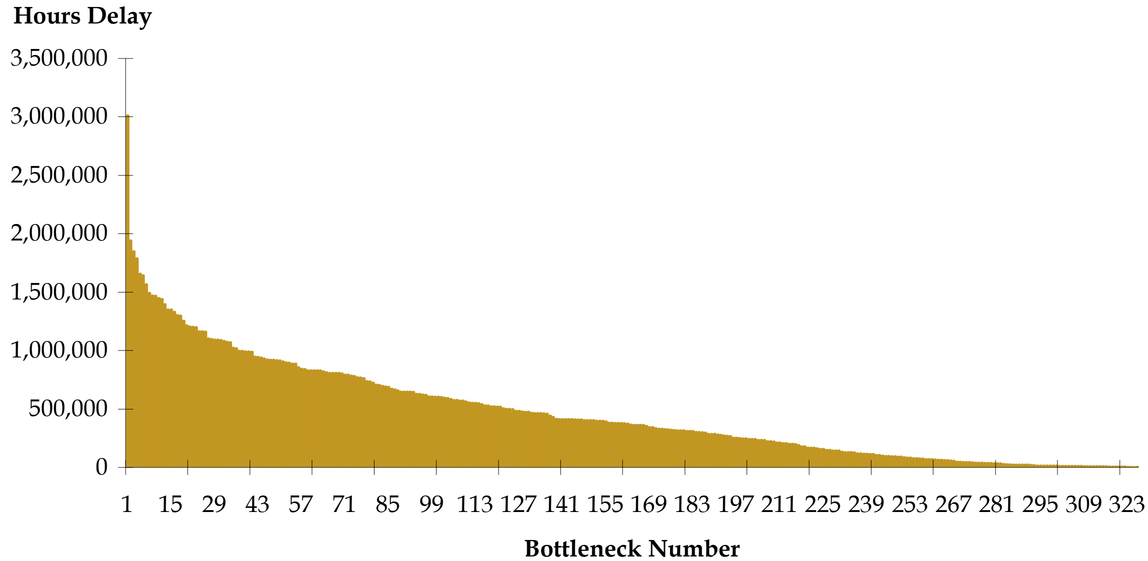


Table 3.2 Top 25 Interchange Bottlenecks
2006, Using the HPMS Scan Method

Bottleneck Name	County/State	AADT	Number of Lanes	Percent Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-10 at SR 51/SR 202 Interchange ("Mini-Stack")	Maricopa, Arizona	290,700	8	18%	16,819,619	3,010,355
I-75 at I-85 Interchange	Fulton, Georgia	246,330	6	13%	14,923,927	1,940,111
I-10 at I-17 Interchange West (the "Stack")	Maricopa, Arizona	252,048	8	18%	10,325,070	1,847,968
I-90 at I-94 Interchange ("Edens Interchange")	Cook, Illinois	294,746	6	10%	17,857,216	1,785,722
I-25 at I-76 Interchange	Adams, Colorado	237,900	6	11%	14,413,195	1,655,113
SR 60 at SR 57 Interchange	Los Angeles, California	343,000	10	10%	16,424,480	1,642,448
I-45 at I-610 Interchange	Harris, Texas	258,359	6	10%	15,652,706	1,565,271
I-5 (Santa Ana Freeway) at SR 22/ SR 57 Interchange ("Orange Crush")	Orange, California	335,000	10	10%	14,909,403	1,490,940

Table 3.2 Top 25 Interchange Bottlenecks (continued)
2006, Using the HPMS Scan Method

Bottleneck Name	County/State	AADT	Number of Lanes	Percent Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-5 (Santa Ana Freeway) at SR 22/ SR 57 Interchange ("Orange Crush")	Orange, California	335,000	10	10%	14,909,403	1,490,940
I-610 at I-10 Interchange (West)	Harris, Texas	284,010	8	10%	14,702,536	1,470,254
I-40 at I-65 Interchange	Davidson, Tennessee	167,050	4	14%	10,120,741	1,467,110
I-45 (Gulf Freeway) at U.S. 59 Interchange	Harris, Texas	238,850	6	10%	14,470,751	1,447,075
I-278 (BQE) at Grand Central Pkwy Interchange	Queens, New York	237,645	6	10%	14,397,746	1,439,775
I-880 at I-238	Alameda, California	268,000	8	11%	12,158,763	1,395,664
I-105 at U.S. 107 Interchange	Los Angeles, California	247,000	8	15%	8,995,970	1,349,395
I-70 at I-695	Baltimore, Maryland	227,133	6	10%	13,245,227	1,348,578
I-285 at I-85 Interchange ("Spaghetti Junction")	DeKalb, Georgia	265,110	8	11%	11,567,473	1,329,896
U.S. 101 (Ventura Freeway) at I-405 Interchange	Los Angeles, California	325,000	10	10%	13,020,385	1,302,038
I-290 at I-355 Interchange	DuPage, Illinois	204,905	6	13%	9,977,963	1,297,135
I-40 at I-24 Interchange	Davidson, Tennessee	148,330	4	14%	8,649,842	1,253,888
I-95 at SR 4	Bergen, New Jersey	312,592	10	11%	11,099,297	1,213,658
I-94 (Dan Ryan Expressway) at I-90 Skyway Split (Southside)	Cook, Illinois	238,387	8	10%	11,983,269	1,203,147
I-264 east of I-64	Norfolk, Virginia	198,317	5	10%	12,015,055	1,201,506
I-95 at SR 9A (Westside Hwy)	New York, New York	297,342	10	13%	9,208,672	1,197,127
I-495 at I-95/U.S. 1 Interchange (Maryland)	Prince Georges, Maryland	191,610	5	10%	11,330,138	1,162,339
I-95/I-495	Prince Georges, Maryland	191,610	5	10%	11,330,138	1,162,339

Steep-Grade Bottlenecks for Trucks

We located 818 bottlenecks created by steep grades on freeways and arterials. These bottlenecks were located by scanning the HPMS Sample database for roadway sections with grades greater than 4.5 percent and more than a mile long. These bottlenecks represent a partial inventory of this type of bottleneck. Using HPMS expansion factors, we estimate that the total delay associated nationally with this type of bottleneck in 2006 was about 26 million truck hours or 12 percent of the total truck hours of delay. At a delay cost of $32.15 per hour, the direct user cost of the bottlenecks is about $836 million per year.

The estimates were made by applying the sample expansion factors provided in the HPMS Sample database to truck hours of delay for each the identified bottlenecks. The statistical framework for the HPMS makes it possible to estimate the total truck hours of delay associated nationally with freight bottlenecks on these roadways but not to estimate the actual number of bottlenecks or pinpoint all their locations. The truck volumes and highway capacity calculations were based on the HPMS Sample statistics.

Figure 3.3 shows the location of the steep-grade bottlenecks. Again, because of the constraints of the HPMS Sample database, the map does not identify all bottlenecks of this type. Figure 3.4 shows a histogram of delay. The drop is even more precipitous for interchange delay as one moves further away from the worst locations. Table 3.3 presents detailed data for the top 25 grade-related truck bottlenecks; Appendix C has the same data for all 326 bottlenecks. Note that this shows only the South and West directions; Appendix F shows the map for the North and East directions.

Figure 3.3 Grade Bottlenecks Identified with the HPMS Scan Method and National Truck Speeds

2006 (South and West Directions)

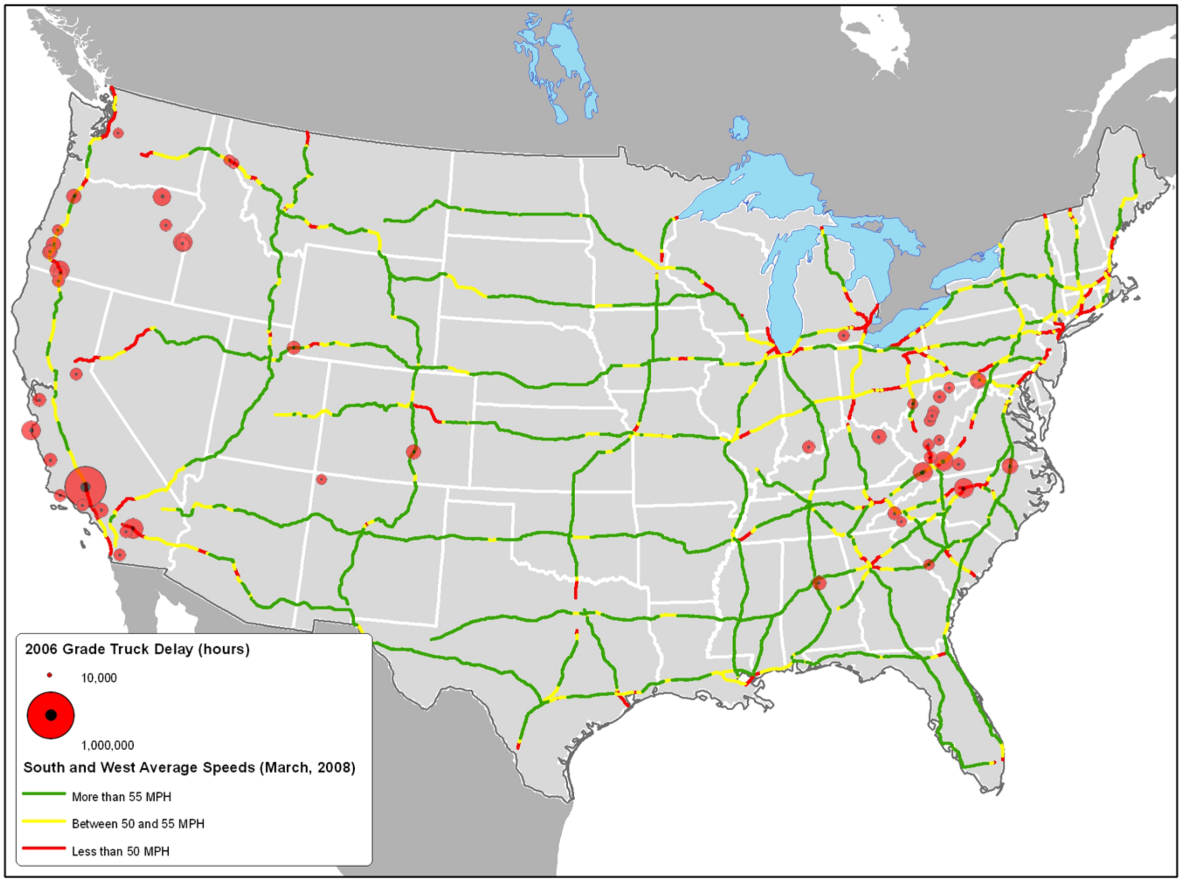


Figure 3.4 Grade Bottleneck Delay Histogram
2006

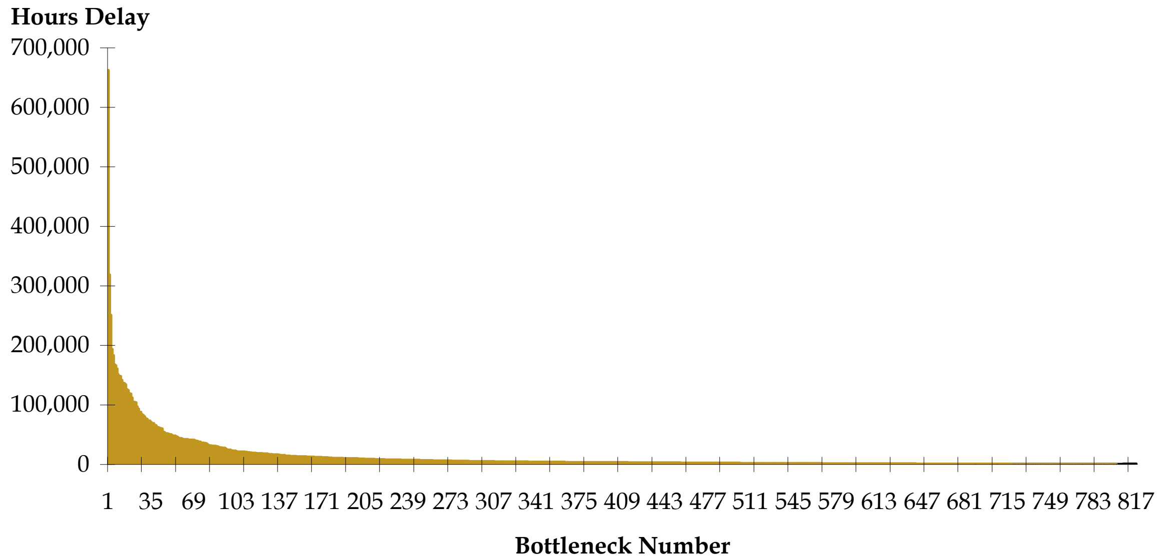


Table 3.3 Top 25 Grade Bottlenecks
2006, Using the HPMS Scan Method

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Kern, California	Interstate	5	10.408	79,000	26,070	662,310	945,778
Fayette, Kentucky	Interstate	75	97.703	57,780	17,912	318,835	318,835
Riverside, California	Interstate	10	0.860	24,000	9,360	251,116	434,180
Montgomery, Virginia	Interstate	81	104.980	42,699	11,956	193,703	624,500
Kern, California	State	58	49.063	22,800	7,524	183,393	503,046
Jackson, Oregon	Interstate	5	11.590	15,900	6,519	167,557	167,557
Raleigh, West Virginia	Interstate	77	48.050	32,000	13,440	166,341	167,672
Mercer, West Virginia	Interstate	77	0.000	30,000	16,500	160,726	162,012
Greenbrier, West Virginia	Interstate	64	156.180	19,000	8,740	151,510	154,995
Smyth, Virginia	Interstate	81	35.800	30,798	7,084	149,125	840,169
Guilford, North Carolina	Interstate	40	205.190	95,000	18,050	148,250	318,737

Table 3.3 Top 25 Grade Bottlenecks (continued)
2006, Using the HPMS Scan Method

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Umatilla, Oregon	Interstate	84	209.540	10,100	4,646	141,707	141,707
Raleigh, West Virginia	Interstate	64	117.930	16,000	7,520	137,104	140,258
San Diego, California	Interstate	8	2.380	22,800	4,560	136,749	236,440
Malheur, Oregon	Interstate	84	356.110	8,400	4,452	134,350	134,350
Crawford, Indiana	Interstate	64	79.530	17,030	6,471	126,213	171,776
Greenbrier, West Virginia	Interstate	64	156.180	19,000	8,740	124,506	127,369
Josephine, Oregon	Interstate	5	67.110	20,600	5,356	119,487	119,487
Braxton, West Virginia	Interstate	79	62.040	22,500	11,025	118,665	118,665
Harrison, West Virginia	Interstate	79	115.330	35,000	12,250	112,225	113,123
Josephine, Oregon	Interstate	5	71.490	19,900	7,761	105,197	105,197
Raleigh, West Virginia	Interstate	64	128.910	18,500	6,660	104,984	107,399
Marion, Oregon	Interstate	5	248.710	60,900	12,789	104,394	104,394
Oklahoma, Oklahoma	Interstate	44	0.000	26,100	5,220	97,421	109,209
Douglas, Oregon	Interstate	5	117.770	19,700	5,713	93,482	93,482

Signalized Intersection Bottlenecks for Trucks

We located 559 truck-related bottlenecks caused by signalized intersections on arterials. These bottlenecks were located by scanning the HPMS Sample database for signalized roadway sections with a volume-to-capacity ratio greater than 0.925. These bottlenecks also represent a partial inventory of this type of bottleneck. Expanding the sample, we estimate that the total delay associated nationally with this type of bottleneck in 2006 was about 48 million truck hours of delay. At a delay cost of $32.15 per hour, the direct user cost of the bottlenecks is about $1.5 billion per year. The truck volumes and highway capacity calculations were based on the HPMS Sample statistics. Figure 3.5 shows the location of the signalized intersection truck bottleneck locations and Figure 3.5 shows the delay histogram. Figure 3.5 does not include the National Speed Map as coverage is spotty on urban arterials. Table 3.4 presents detailed data for the top 25 truck signalized intersection bottlenecks; Appendix D has the same data for all 326 bottlenecks.

Figure 3.5 Signal Bottlenecks Identified with the HPMS Scan Method
2006

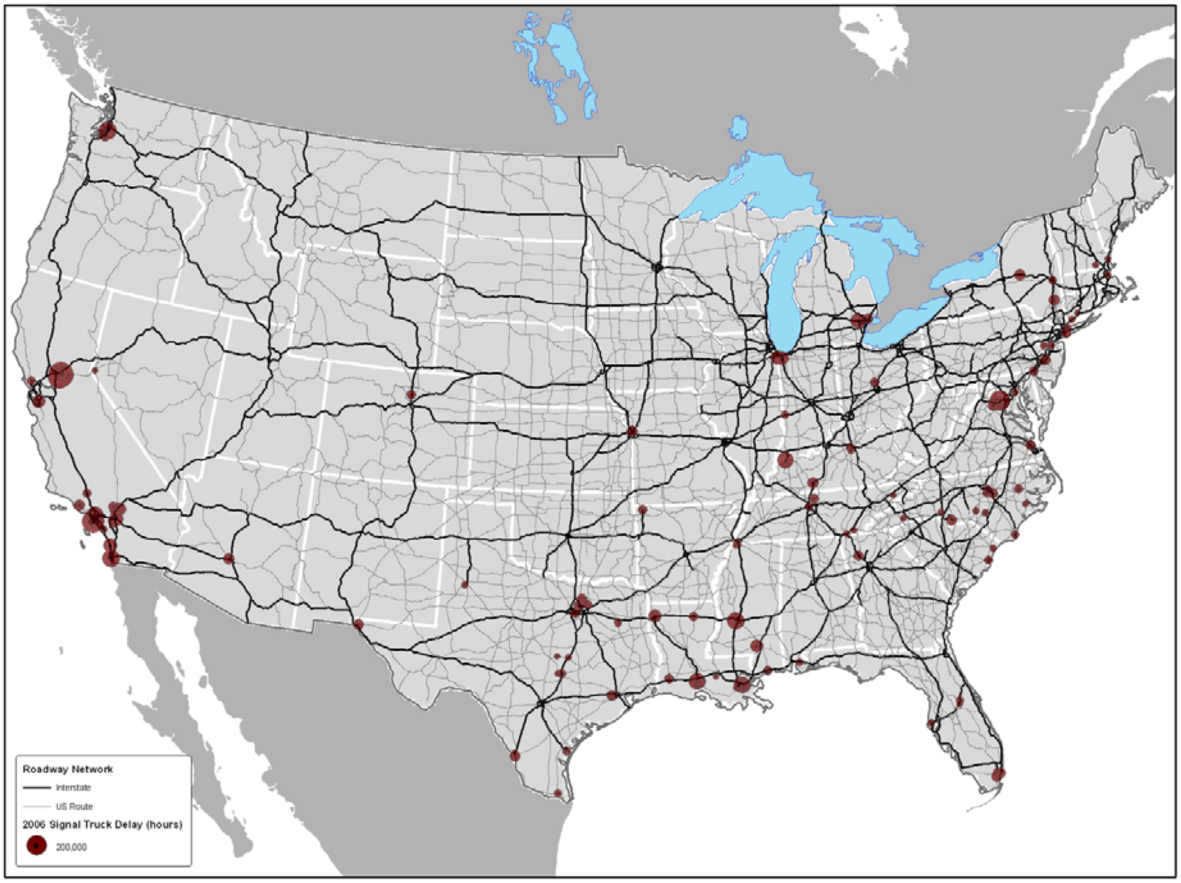


Figure 3.6 Signal Bottleneck Delay Histogram
2006

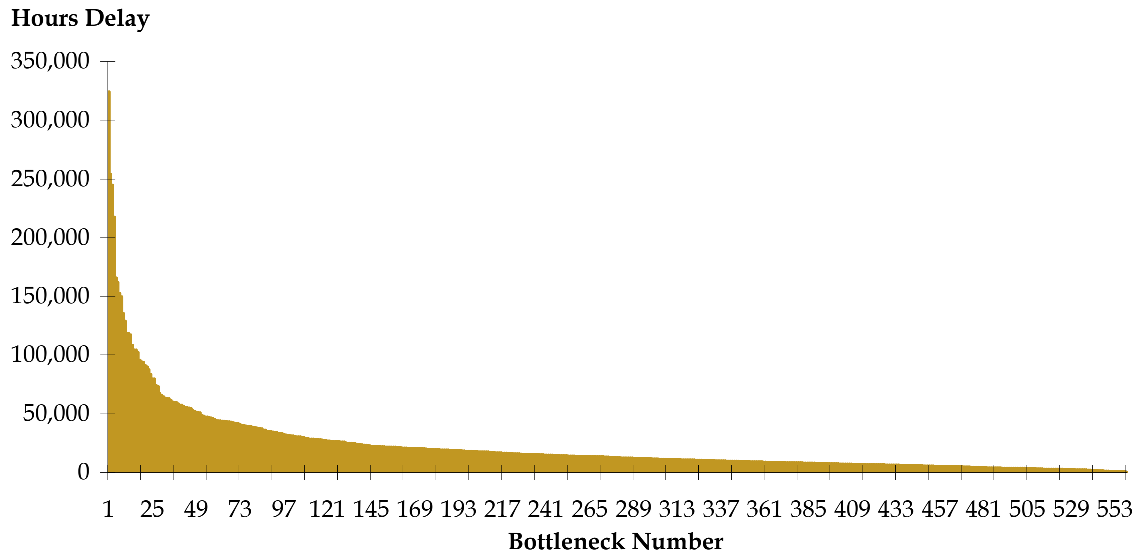


Table 3.4 Top 25 Signal Bottlenecks
2006, Using the HPMS Scan Method

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals per Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Sacramento, California	(Not Signed)	(None)	7.950	86,500	22,496	2.4	324,395	324,395
Los Angeles, California	(Not Signed)	(None)	4.120	35,579	18,300	2.0	254,059	8,170,038
Sacramento, California	(Not Signed)	(None)	5.650	20,261	12,288	0.9	244,899	2,005,965
Fairfax, Virginia	State	SR00028	31.860	106,248	9,754	1.0	217,827	239,610
King, Washington	(Not Signed)	(None)	0.000	35,714	8,060	1.8	165,983	521,021
San Diego, California	(Not Signed)	(None)	0.000	53,540	9,066	1.5	161,920	347,804
Los Angeles, California	(Not Signed)	(None)	0.000	37,914	8,323	3.5	152,650	352,316

Note: Route Numbers of "00000000" indicate that the highway is a local and not signed as state-controlled route.

Table 3.4 Top 25 Signal Bottlenecks (continued)
2006, Using the HPMS Scan Method

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals per Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Hinds, Mississippi	State	18	28.327	35,350	8,007	2.2	149,847	209,186
Henderson, Kentucky	U.S.	41	16.041	40,219	6,033	1.2	135,662	135,662
Jefferson, Louisiana	State	3154	2.040	42,400	10,197	3.7	129,065	268,454
Lafayette, Louisiana	U.S.	90	5.860	53,200	11,534	0.7	118,743	118,743
Lafayette, Louisiana	State	3073	0.000	40,900	7,665	4.3	118,340	167,095
Oakland, Michigan	(Not Signed)	(None)	11.955	41,116	3,683	4.4	117,429	1,715,284
Orleans, Louisiana	U.S.	90	0.830	39,200	3,528	1.6	108,285	225,233
San Bernardino, California	(Not Signed)	(None)	0.000	55,148	4,963	3.3	104,520	104,520
Lake, Indiana	U.S.	30	0.000	42,470	10,045	0.8	104,445	427,493
Lafayette, Louisiana	State	3025	0.000	24,400	4,392	2.7	102,354	260,083
Lafayette, Louisiana	U.S.	167	2.570	55,600	8,654	2.1	95,735	95,735
Lake, Indiana	U.S.	30	10.100	73,700	14,277	1.7	94,260	117,824
San Diego, California	County	12	0.520	53,110	4,249	2.5	93,964	201,834
Lafayette, Louisiana	State	3184	0.000	39,500	4,557	2.5	91,231	128,818
San Bernardino, California	(Not Signed)	(None)	13.450	31,095	4,664	2.1	90,077	90,077
Bossier, Louisiana	State	3	3.000	29,900	4,564	2.9	87,635	304,357
Alameda, California	State	00000262	0.000	89,000	7,120	1.9	83,867	83,867
Lamar, Mississippi	U.S.	00000098	11.034	35,862	3,680	0.8	79,983	95,419

Note: Where route numbers do not exist, the highway is under local control and is not a state-controlled route.

3.2 Detailed Delay Analysis of the Top Bottlenecks

Overview

The national scan of bottlenecks produced a "short list" for more detailed examination. The main criterion for developing this short list was to look at locations with the highest truck delays. This resulted in considering freeway bottlenecks for the next level of analysis, because truck volumes are higher (i.e., more trucks are exposed to congestion on freeways). The bottleneck delay results from the ramp-based delay methodology are shown in Table 3.5 along with delay estimates developed from the ATRI truck speed data. The bottlenecks are listed in order from the highest to the lowest based on the current delay estimates using the ramp-based method. The delay values for the previous FHWA study also are presented. Some 2006 bottlenecks were not identified in 2004, and the delay estimates for common bottlenecks vary widely. A number of reasons exist for this discrepancy, which makes the development of trend information impossible from these data:

- The previous study used FAF truck volumes while the current study uses HPMS truck volumes.
- The two studies used different national scans to get the short list, so some bottlenecks were inevitably left out.
- The HPMS data and satellite imagery used to derive the turning movements and geometric characteristics may have changed between the two studies. More importantly, the process of identifying bottleneck locations in HPMS and coding geometric features from satellite imagery is a manual and somewhat subjective process. Many interchange locations are extremely complex and require substantial judgment on how to assign turning movements and code merge areas using the structure presented in Section 2.0. (Only detailed local knowledge of traffic patterns and physical conditions can compensate for this problem. For example, the "Orange Crush" interchange in near Orange, California (interchange of I-5, SR 22, and SR 57) is highly complex and had to be excluded from the analysis because of our inability to accurately assign traffic volumes (Figure 3.7).

Table 3.5 Annual Delays, Based on Detailed Delay Method, at Major Truck Bottlenecks
2006

No.	Bottleneck Name	County/State	Annual Truck Delay (Hours) 2006[a]	Annual Truck Delay (Hours) 2004[a]	ATRI-Derived Truck Delay[b]	Number of ATRI Trucks Measured[b]	Caltrans HICOMP Congestion[c]
1	I-710 at I-105 Interchange	Los Angeles, California	1,550,000	425,200	1,240,000	27,488	4 of 4 legs
2	I-17 (Black Canyon Freeway): I-10 Interchange (the "Stack") to Cactus	Maricopa, Arizona	1,492,100	493,200	728,100	42,395	
3	I-285 at I-85 Interchange ("Spaghetti Junction")	DeKalb, Georgia	1,415,500	1,815,100	2,063,000	71,865	
4	I-20 at I-75/I-85 Interchange	Fulton, Georgia	1,336,500	285,100	1,446,000	27,537	
5	I-80 at I-94 split in Chicago, Illinois	Cook, Illinois	1,300,000	1,365,300	1,368,400	227,578	
6	SR 60 at SR 57 Interchange	Los Angeles, California	1,259,700	*1,029,700*	705,000	52,140	2 of 3 legs
7	I-80 at I-580/I-880 in Oakland, California	Alameda, California	1,240,000	1,838,700	2,703,000	10,347	
8	I-405 (San Diego Freeway) at I-605 Interchange	Orange, California	1,221,500	2,662,600	273,500	4,426	4 of 4 legs
9	I-90 at I-94 Interchange ("Edens Interchange")	Cook, Illinois	1,185,700	1,600,300	1,266,800	49,923	
10	I-40 at I-65 Interchange (east)	Davidson, Tennessee	1,099,700	Not included	682,100	51,313	
11	I-290 at I-355 Interchange	DuPage, Illinois	1,039,400	263,600	117,000	49,546	
12	I-75 at I-85 Interchange	Fulton, Georgia	920,800	272,600	1,372,500	18,270	
13	I-95 at SR 9A (Westside Highway; George Washington Bridge approach)	New York, New York	919,200	*445,200*	3,095,050[a]	21,896	
14	I-71 at I-70 Interchange	Franklin, Ohio	905,900	*968,800*	354,000	40,718	
15	I-880 at I-238	Alameda, California	883,900	1,200,300	812,987	13,550	3 of 3 legs
16	I-110 at I-105 Interchange	Los Angeles, California	860,000	*910,000*	1,080,600		2 of 4 legs
17	SR 91 at SR 55 Interchange	Orange, California	816,700	*946,900*	458,356	8,163	Not congested
18	I-285 at I-75 Interchange	Cobb, Georgia	772,200	1,815,000	1,253,476	8,532	

[a] 2006 delay numbers based on the ramp-based method. 2004 delay numbers in italics indicate that the "scan" method was used; other values were estimated using the ramp-based method.

[b] ATRI data covers both sides of the George Washington Bridge, including SR 4 in New Jersey and the Westside Highway interchanges; ATRI data for individual locations may be found in Appendix F.

[c] The Caltrans HICOMP report (*State Highway Congestion Monitoring Program, Annual Data Compilation*, November 2007) maybe found at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/pdfs/2006HICOMP.pdf.

Table 3.5 Annual Delays, Based on Detailed Delay Method, at Major Truck Bottlenecks (continued)
2006

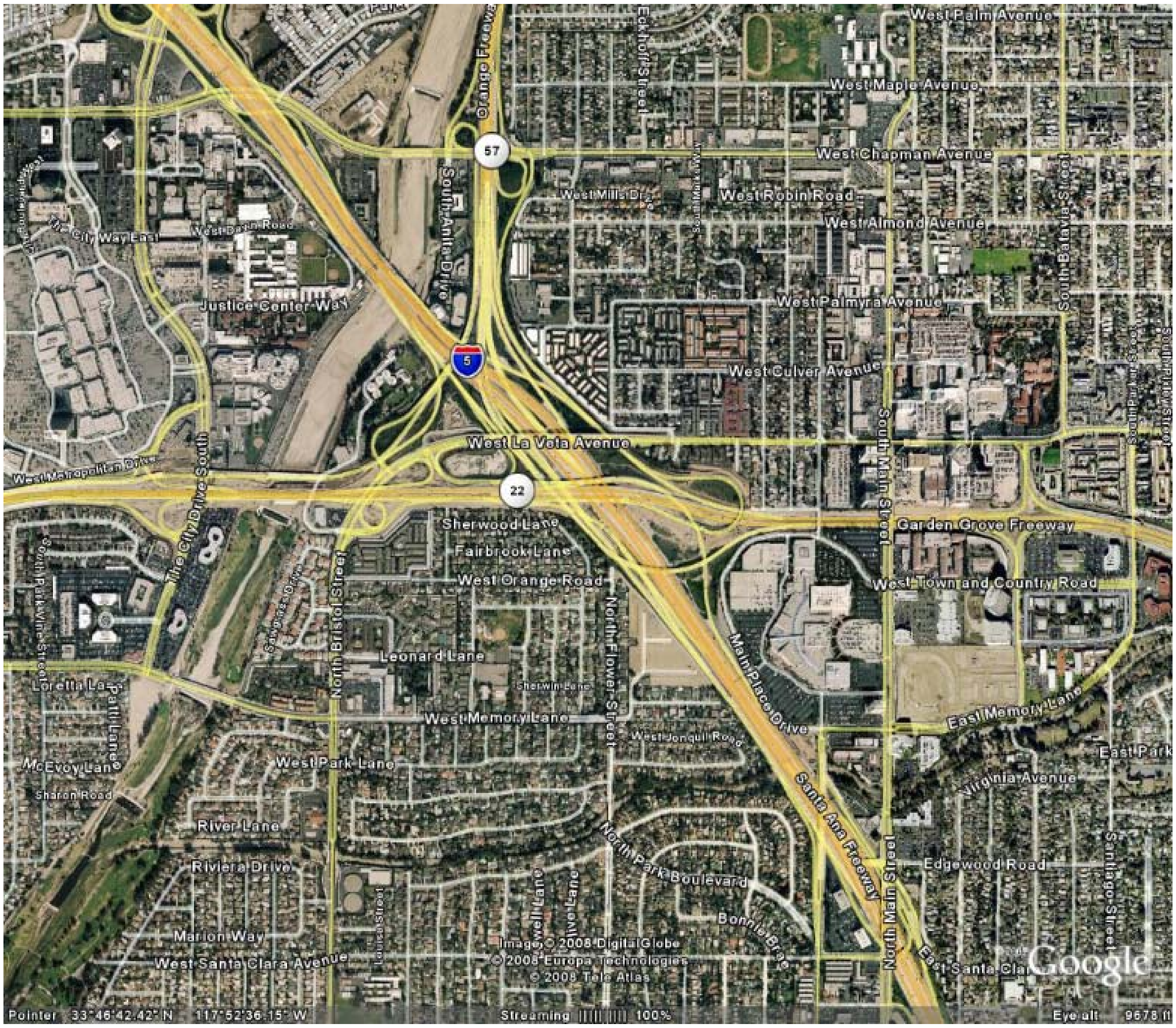
No.	Bottleneck Name	County/State	Annual Truck Delay (Hours) 2006[a]	2004[a]	ATRI-Derived Truck Delay[b]	Number of ATRI Trucks Measured[b]	Caltrans HICOMP Congestion[c]
19	I-695/I-70 and I-95 exit 11	Baltimore, Maryland	748,900	(616,800)	270,000	59,523	
20	I-95 at SR 4 (GW Bridge approach)	Bergen, New Jersey	734,600	Not included	(Note[a])	51,257	
21	I-10 at I-110/U.S. 54 Interchange	El Paso, Texas	664,700	(241,800)	105,900	49,672	
22	I-45 (Gulf Freeway) at U.S. 59 Interchange	Harris, Texas	644,700	(386,900)	778,223	32,627	
23	SR 134 at SR 2 Interchange	Los Angeles, California	598,700	267,600	109,000	4,603	1 of 4 legs
24	I-10 at SR 51/SR 202 Interchange ("Ministack")	Maricopa, Arizona	521,600	(982,600)	872,300	8,322	
25	I-10 at I-15 Interchange	San Bernardino, California	513,600	1,308,000	1,037,400	56,102	2 of 4 legs
26	I-95/I-495	Prince Georges, Maryland	475,400	(1,020,100)	685,100	36,540	
27	I-45 at I-610 Interchange	Harris, Texas	450,600	(452,300)	378,300	46,856	
28	I-10 at I-410 Loop North Interchange	Bexar, Texas	450,200	(418,300)	346,600	15,243	
29	I-75 at I-275 Interchange	Kenton, Kentucky	435,600	(662,900)			
30	I-64 atI-65/I-71 Interchange	Jefferson, Kentucky	432,400	(375,900)			
31	I-94 (Dan Ryan Expressway) at I-90 Skyway	Cook, Illinois	292,300	584,500			
32	I-20 at I-285 Interchange	DeKalb, Georgia	215,600	(1,359,400)			
33	I-35E at I-94 Interchange ("Spaghetti Bowl") – East section	Ramsey, Minnesota	210,300	(230,300)			
34	I-95 at I-476 Interchange	Delaware, Pennsylvania	179,600	(437,300)			
35	I-75 at I-74 Interchange	Hamilton, Ohio	124,800	305,800		6,370	

[a] 2006 delay numbers based on the ramp-based method. 2004 delay numbers in parentheses indicate that the "scan" method was used; other values were estimated using the ramp-based method.

[b] ATRI data covers both sides of the George Washington Bridge, including SR 4 in New Jersey and the Westside Highway interchanges; ATRI data for individual locations may be found in Appendix F.

[c] The Caltrans HICOMP report (*State Highway Congestion Monitoring Program, Annual Data Compilation*, November 2007) maybe found at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/pdfs/2006HICOMP.pdf.

Figure 3.7 The Complexity of "Orange Crush" Interchange in Los Angeles, California



Results

A number of observations regarding the results obtained with the detailed delay analysis can be made.

- As with the previous FHWA freight bottleneck study, the delay estimates change when the ramp-based method is used. The ramp-based method provides a more detailed picture of capacity restrictions at the interchanges. Also, as in the previous study, it was found that truck bottlenecks (in terms of total delay) occur at urban commuter bottlenecks.

- The list of the highest delay bottlenecks in Table 3.5 is thought to be more accurate than the ones identified in the previous study. This is because the initial pool of locations has been expanded by using state-identified bottlenecks from the I-95 Corridor Coalition (CC) and FHWA's bottleneck survey. Also, more recent HPMS and geometric information has been used here.

- As before, there is a much sharper drop off in delay as one proceeds down the list than the list produced by the simple scanning method. The reason for this is that in the original methodology, a single AADT/C value was used for the entire interchange. This value is based on HPMS data and the value tended to be very similar for the high-delay interchanges. In the current methodology, there is much more distinction between both the AADT/C values for the individual merge junctures and the volumes of trucks using them.

- The worst bottleneck is the I-710/I-105 interchange in Los Angeles. I-710 is the major connector to the Port of Long Beach.

- The area around the George Washington Bridge in New York and New Jersey requires special discussion. This is an extremely complex area from a geometric standpoint, with multiple highways merging just prior to the Bridge (eastbound, on the New Jersey side; Bottleneck number 19) and a major bottleneck on the eastern end (Bottleneck number 13). For all practical purposes, this probably should be considered a single bottleneck. Truck travel-time data from the American Transportation Research Institute being used in the I-95 CC bottleneck study indicates that annual truck delay on the approaches to the George Washington Bridge is 1,848,000 hours. If Bottleneck numbers 13 and 19 are added together, total delay is 1,654,000 hours, a close agreement.

- Los Angeles has five of the top truck bottlenecks, Atlanta has four, and Chicago has three. This is roughly commensurate with the number of commuter bottlenecks found in the AHUA study.

- The ATRI estimates are sometimes close to the ramp-based method and sometimes much different. For those locations where differences are present:
  - The ATRI estimates for I-80 at I-580/I-880 in Oakland, California and I-95 at SR 4 in New Jersey are much higher than those of the ramp-based method. Both of these are in the immediate vicinity of a major bridge crossing (Bay Bridge and George Washington Bridge, respectively). The ramp-based method does not detect delay caused by the bridge and associated toll plazas, so the higher delay measured by the ATRI trucks is to be expected.
  - Several other discrepancies – Bottleneck numbers 8, 22, and 23 – may be occurring because the number of ATRI trucks in the sample is low. Other locations that show a high ramp-based method delay and low ATRI-based delay are Bottleneck numbers 11, 14, and 18.
  - Other discrepancies are difficult to explain without more detailed local knowledge. Several of these discrepancies are in the Los Angeles area (Bottleneck numbers 6, 8, 22, and 24). Of these, only number 24 has a higher ATRI-based estimate. A separate data source is available for the California bottlenecks; Caltrans publishes annual congestion statistics in their HICOMP report.[17] Caltrans uses a combination of floating car measurements (limited sample vehicle probe) and roadway detector measurements to estimate congestion, which is defined as speeds 35 mph or lower. The results are published as a series of maps showing congested roadway sections. From these maps the rightmost column in Table 3.5 was derived. Comparing HICOMP to the ramp-based and ATRI methods:
    - **I-710 at I-105 –** HICOMP verifies the high delay predicted by both methods.
    - **SR 60 at SR 57 –** HICOMP shows this section as being moderately to heavily congested, which would tend to verify the ramp-based method.
    - **I-80 at I-580/I-880 (Bay Bridge approach) –** HICOMP indicates that the high delay values shown by ATRI are justified.
    - **I-405 at I-605 –** HICOMP shows this location as heavily congested verifying the ramp-based method; the low number of trucks measured by ATRI is probably producing an underestimate of delay.
    - **I-880 at I-238 –** HICOMP verifies that this location has high delay as predicted by the two methods.
    - **SR 91 at SR 55 –** HICOMP indicates that the lower delay derived from the ATRI method is probably correct.

[17] Caltrans, State Highway Congestion Monitoring Program (HICOMP), Annual Data Compilation, November 2007.

- **SR 134 at SR 2 –** HICOMP shows a low level of congestion, which is probably between the ramp-based and ATRI methods.
- **I-10 at I-15 –** HICOMP shows a moderate level of congestion, which is probably between the ramp-based and ATRI methods.
- **I-100 at I-105 –** HICOMP shows a moderate level of congestion, which is indicated by both methods.

3.3 Recommendations for Future Bottleneck Monitoring (Freight and Nonfreight)

The study demonstrates that the basic information to monitor the performance of bottlenecks – interchange configuration/geometrics and traffic – can be cost effectively obtained from existing sources. However, a few improvements in the process are recommended. More refined traffic data may be obtained directly from state DOTs. This would include primarily directional AADTs on each of the approaches of the interchanges. If temporal traffic distributions could be obtained, then instead of applying the default delay equations (which are based on fixed temporal distributions) the queuing procedures used in the Ohio study could be applied directly to each merge juncture. Finally, data on the temporal distributions of trucks – ideally site-specific – would improve the estimates of truck delay.

The process used to determine the lane configurations and geometrics at merge areas (visual inspection of satellite imagery) is somewhat subjective, and becomes more so as the complexity of the ramp layouts become more complex. Many of these complex locations also are major bottlenecks. Verification of interchange configurations with local data – at least for bottlenecks thought to be of high value – should be undertaken.

Additional types of traffic flow restrictions at interchanges should be considered. The study focused on the worst delay bottlenecks, which tend to be major freeway-to-freeway interchanges. There may be some merit in examining simpler geometric bottlenecks, because they are more amenable to low-cost improvements. This study assumed that the "chokepoints" of the intersection are where two or more freeway ramps merge with each other or the mainline. Given the nature of the interchanges studied, nearly all of which are fully directional or mostly so, this assumption was adequate for our purposes. However, if the method is to be applied more universally, other types of restrictions need to be added, such as:

- Restricted diverge areas;
- Limited acceleration lanes; and
- Other types of limited geometry (short radius loops).

For all of these, the way the method will assess them is through the estimate of capacity (to determine if queuing is occurring).

Along these same lines, coordination with FHWA's Office of Operations Bottleneck Initiative should be undertaken. The Bottleneck Initiative is focusing on low-cost improvements which will be beneficial to improving truck flows in the near term.

The HPMS scanning method (based on the original AHUA methodology) should only be used as a screening tool. It has proven to be an effective first cut at bottleneck delay estimation and ranking, but as this study has shown, interchanges are too unique in geometrics and traffic patterns for that method to produce operations-level rankings.

The restructured HPMS data set (i.e., once states start submitting in the new format) can be used directly by the methods developed here. The restructured HPMS will have ramp AADT, presumably directly measured, which will render the synthetic turning movement calculations unnecessary. However, the detail on the lane configurations at interchange merge points will not be collected by HPMS and will still require manual inspection of satellite photos.

The analytic procedures developed here should be considered for inclusion within the HERS model. Specifically, interchange deficiency analysis should be added to HERS as a companion to its current general capacity deficiency analysis (i.e., number of lanes on mainline, noninterchange-influenced segments). The interchange deficiency analysis would be based on the methodology used here. This inclusion will be particularly valuable when HERS migrates to a network-based (rather than sample section-based) framework. Since it is clear that interchanges and there immediate influence areas are the physical items that control congestion on urban freeways, performing delay analysis based on them will provide a much more realistic assessment of capacity deficiencies and needs.

The HERS delay equations should be reviewed. The data on which they were developed are now 15 years old. In particular, the assumptions about traffic variability need to be checked, particularly for congested highways. Some level of field validation also is probably in order.

Comparison of this study with past bottleneck studies reveals inconsistencies in the results, due to use of different data sources, updates to common data sources, additional locations identified by state personnel for the "pool" of candidate sites (e.g., the I-95 Corridor Coalition states), and the subjective nature of some of the analysis steps. These problems frustrate trends analysis, which could be very informative for policy development. Therefore, it is recommended that FHWA consider undertaking a formal program of bottleneck monitoring that would provide this valuable trend information. The Bottleneck Monitoring Program could span FHWA program areas (e.g., Offices of Policy, Operations, and Planning), especially considering the major overlap between commuter and freight bottlenecks. This program would identify a fixed set of bottlenecks to be analyzed every year, perhaps upward of 50. A selected few bottlenecks may be added from year-to-year. The initial list could be based on those bottlenecks identified here, adjusted to accommodate some from the commuter-only realm. With a finite number of locations to start with, the effort could be concentrated on obtaining the detailed data directly from the states, rather than relying on secondary sources. Where freeway surveillance data are available from FHWA's Mobility Monitoring Program, these could be used instead of the modeling approach discussed in this report. Annual trends in both total and truck-only delay (and travel-time reliability where freeway surveillance data are available) would be an excellent way to "take a pulse" of the system in terms of congestion and its impacts.

Probe-based travel time data – such as those from the ATRI project as well as those data available from other private vendors – represent a very valuable resource for congestion monitoring and bottleneck analysis. For example, vehicle probe data from Inrix is now being provided to several I-95 Corridor Coalition states, primarily as a real-time resource. However, the Coalition plans to use these data for monitoring the performance of long-distance trips and for bottleneck identification. Probe-based travel time data could be used in the Bottleneck Monitoring Program outlined above cost-effectively if the number of locations can be restricted. (Some firms will price the data on a coverage basis.)

Appendix A

Interchange Configurations

Appendix B

Bottleneck Delay

Appendix B

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-10 at SR 51/SR 202 Interchange ("Mini-Stack")	Maricopa, Arizona	290,700	8	18%	16,819,619	3,010,355
I–75 at I–85 Interchange	Fulton, Georgia	246,330	6	13%	14,923,927	1,940,111
I-10 at I-17 Interchange West (the "Stack")	Maricopa, Arizona	252,048	8	18%	10,325,070	1,847,968
I-90 at I-94 Interchange ("Edens Interchange")	Cook, Illinois	294,746	6	10%	17,857,216	1,785,722
I-25 at I-76 Interchange	Adams, Colorado	237,900	6	11%	14,413,195	1,655,113
SR 60 at SR 57 Interchange	Los Angeles, California	343,000	10	10%	16,424,480	1,642,448
I-45 at I-610 Interchange	Harris, Texas	258,359	6	10%	15,652,706	1,565,271
I-5 (Santa Ana Fwy) at SR 22/SR 57 Interchange ("Orange Crush")	Orange, California	335,000	10	10%	14,909,403	1,490,940
I-610 at I-10 Interchange (West)	Harris, Texas	284,010	8	10%	14,702,536	1,470,254
I-40 at I-65 Interchange	Davidson, Tennessee	167,050	4	14%	10,120,741	1,467,110
I-45 (Gulf Freeway) at U.S. 59 Interchange	Harris, Texas	238,850	6	10%	14,470,751	1,447,075
I-278 (BQE) at Grand Central Pkwy Interchange	Queens, New York	237,645	6	10%	14,397,746	1,439,775
I-880 at I-238	Alameda, California	268,000	8	11%	12,158,763	1,395,664
I-105 at U.S. 107 Interchange	Los Angeles, California	247,000	8	15%	8,995,970	1,349,395
I-70 at I-695	Baltimore, Maryland	227,133	6	10%	13,245,227	1,348,578

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-285 at I-85 Interchange ("Spaghetti Junction")	De Kalb, Georgia	265,110	8	11%	11,567,473	1,329,896
U.S. 101 (Ventura Freeway) at I-405 Interchange	Los Angeles, California	325,000	10	10%	13,020,385	1,302,038
I-290 at I-355 Interchange	DuPage, Illinois	204,905	6	13%	9,977,963	1,297,135
I-40 at I-24 Interchange	Davidson, Tennessee	148,330	4	14%	8,649,842	1,253,888
I-95 at SR 4	Bergen, New Jersey	312,592	10	11%	11,099,297	1,213,658
I-94 (Dan Ryan Expressway) at I-90 Skyway Split (Southside)	Cook, Illinois	238,387	8	10%	11,983,269	1,203,147
I-264 east of I-64	Norfolk, Virginia	198,317	5	10%	12,015,055	1,201,506
I-95 at SR 9A (Westside Highway)	New York, New York	297,342	10	13%	9,208,672	1,197,127
I-495 at I-95/U.S. 1 Interchange (Maryland)	Prince Georges, Maryland	191,610	5	10%	11,330,138	1,162,339
I-95/I-495	Prince Georges, Maryland	191,610	5	10%	11,330,138	1,162,339
I-75 at I-275 Interchange	Kenton, Kentucky	179,640	6	19%	6,214,544	1,158,828
I-95 at I-595 Interchange	Broward, Florida	263,000	8	10%	11,009,470	1,100,947
I-64 at I-65/I-71 Interchange ("Spaghetti Junction")	Jefferson, Kentucky	141,927	4	14%	7,644,197	1,095,422
I-95 at I-476	Delaware, PA	173,664	4	10%	10,521,451	1,091,627
I-95 at I-476 Interchange	Delaware, Pennsylvania	173,664	4	10%	10,521,451	1,091,627
I – 35E at I-94 Interchange ("Spaghetti Bowl")	Ramsey, Minnesota	179,724	4	10%	10,888,596	1,088,860
I-678, Queens Co. (note: I-687/NY 25A nrh)	Queens, New York	178,434	4	10%	10,810,442	1,081,044

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-110 at I-105 Interchange	Los Angeles, California	310,000	10	10%	10,724,274	1,072,427
Loop-101 Agua Fria at I-17 Interchange	Maricopa, Arizona	147,737	4	13%	8,476,043	1,068,189
I-17 (Black Canyon Freeway): I-10 Interchange (the “Stack”) to Cactus	Maricopa, Arizona	206,000	6	10%	9,864,265	1,023,451
SR 91 at SR 55 Interchange	Orange, California	233,000	7	10%	10,166,426	1,016,643
I-820 at SR 121	Tarrant, Texas	164,180	4	10%	9,946,862	994,686
I-10 at I-410 Loop North Interchange	Bexar, Texas	164,000	4	10%	9,935,956	993,596
I-495 (Long Island Expressway) at Exit 33	Nassau, New York	206,379	6	10%	9,882,413	988,241
I-495, Queens, Nas. Suf Cos. (note: I-495/Shelter Rock Road nrh)	Nassau, New York	206,379	6	10%	9,882,413	988,241
I-15 at I-215 Interchange (the “Fishbowl”)	Clark, Nevada	206,000	6	10%	9,864,265	986,427
I-278. Kings & Richmond Cos. (note: I-278 at Battery Tunn and Queens Expressway nrh)	Kings, New York	156,632	4	10%	9,454,884	945,488
U.S. 60 (Superstition Fwy) at I-10 Interchange	Maricopa, Arizona	182,000	6	15%	6,296,187	941,867
I-710 at I-105 Interchange	Los Angeles, California	234,000	8	14%	6,829,691	938,078
I-94 W. of Marquette Interchange	Milwaukee, Wisconsin	155,300	4	10%	9,289,398	928,940
I-75 at U.S. 35 Interchange	Montgomery, Ohio	138,690	4	13%	7,077,019	920,012
I-290 (Eisenhower Expressway) Between Exits 17b and 23a	Cook, Illinois	202,168	6	10%	9,172,063	917,206
I-695/I-70 and I-95 exit 11 (note: I-70 N. of here)	Baltimore, Maryland	176,540	5	10%	9,008,414	917,202
I-285 at I-75 Interchange	Cobb, Georgia	184,560	6	14%	6,553,227	914,620
Southern State Parkway at Exit 25A	Nassau, New York	188,074	6	13%	7,021,616	912,810

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-10 (Santa Monica Fwy) at I-5 Interchange	Los Angeles, California	301,000	10	10%	9,052,635	905,263
I-71 at I-70 Interchange	Franklin, Ohio	113,960	2	13%	6,904,278	897,556
I – 35W at SR 62 Interchange	Hennepin, Minnesota	152,156	4	10%	8,937,518	893,752
I-20 at I-285 Interchange	De Kalb, Georgia	187,120	6	13%	6,815,084	885,961
I-70 at U.S. 23 Interchange	Franklin, Ohio	137,530	4	13%	6,806,414	884,834
I-635 at N. Dallas Tollway	Dallas, Texas	242,150	8	11%	7,717,361	856,077
I-405 (San Diego Freeway) at I-605 Interchange	Orange, California	390,000	14	10%	8,423,715	842,372
I-680 at SR 24 Interchange	Contra Costa, California	296,000	10	10%	8,378,381	837,838
SR 57 at U.S. 91	Orange, California	222,000	7	10%	8,288,221	828,822
I-76 at I-676	Philadelphia, Pennsylvania	197,743	6	10%	8,277,740	827,774
I-76 to U.S. 30	Philadelphia, Pennsylvania	197,743	6	10%	8,277,740	827,774
I-76 at I-676 Interchange	Philadelphia, Pennsylvania	197,743	6	10%	8,277,740	827,774
I-95 at Golden Glades Interchange	Palm Beach, Florida	197,500	6	10%	8,267,568	826,757
I-24 at U.S. 27 Interchange	Hamilton, Tennessee	116,160	4	21%	3,807,135	818,461
I-495/1-95 and I-395 Interchange	Fairfax, Virginia	146,114	4	10%	8,056,353	812,643
I-64 at I-95/I-195 Interchange	Richmond, Virginia	146,334	4	10%	8,068,483	806,848
I-10 at I-110/U.S. 54 Interchange	El Paso, Texas	221,431	7	10%	8,064,723	806,472
SR 134 at SR 2 Interchange	Los Angeles, California	246,000	8	10%	8,062,631	806,263

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
U.S. 101 at I-280 Interchange	San Francisco, California	246,000	8	10%	8,062,631	806,263
I-55 at I-90/I-94 Interchange	Cook, Illinois	196,107	6	10%	8,033,464	803,346
I-94 at I-894/U.S. 45 Interchange (the "Zoo")	Milwaukee, Wisconsin	145,500	4	10%	7,931,384	793,138
I-678, Queens Co. (note: I-687/Grand Central Parkway nrh)	Queens, New York	145,193	4	10%	7,914,649	791,465
I-238 at I-550	Alameda, California	133,000	4	13%	6,034,013	784,422
I-10 at I-15 Interchange	San Bernardino, California	240,000	8	11%	7,218,047	779,819
FDR Drive south of Triborough Bridge	New York, New York	181,037	6	13%	5,933,474	771,352
I-76 at I-476 Interchange	Montgomery, Pennsylvania	144,044	4	10%	7,660,982	766,098
I-91/I84/RT 15 Interchange	Hartford, Connecticut	137,500	4	11%	6,695,639	761,185
I-95/U.S. 301 Interchange	New Castle, Delaware	130,459	4	13%	5,577,230	737,336
Fort Pitt Bridge and Tunnel near the interchanges of I-279 with I-376, PA 51, PA 19, and PA 121	Allegheny, Pennsylvania	141,828	4	10%	7,342,105	734,211
I-695 at I-95 Interchange	Baltimore, Maryland	190,204	6	10%	7,101,138	723,011
I-95 at U.S. 90 Interchange	Duval, Florida	165,600	5	10%	7,079,537	707,954
I-678, Queens Co. (note: I-687/Cross Island Parkway nrh)	Queens, New York	140,016	4	10%	7,038,343	703,834
I-75 at I-280 Interchange	Lucas, Ohio	88,388	2	13%	5,354,996	696,149
I-76 from PA Turnpike (I-76) to I-95 (I-76 at South 34th Street)	Philadelphia, Pennsylvania	139,692	4	10%	6,913,412	691,341
I-275 at I-4 Interchange ("Malfunction Junction")	Hillsborough, Florida	189,000	6	10%	6,883,556	688,356
I-94 at I-35W Interchange (East Leg)	Hennepin, Minnesota	138,000	4	10%	6,719,987	671,999

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-93 at I-90 Interchange	Suffolk, Massachusetts	187,600	6	10%	6,661,169	666,117
I-5 (San Diego Freeway) at I-405 Interchange ("El Toro")	Orange, California	328,000	12	10%	6,573,878	657,388
I-66 at Centreville Road	Fairfax, Virginia	187,159	6	10%	6,474,659	647,466
I-93 at end of HOV lane	Suffolk, Massachusetts	187,155	6	10%	6,474,521	647,452
I-95 at Harbison Avenue	Philadelphia, Pennsylvania	178,945	6	12%	5,381,806	645,946
I-95 at SR 90 (Besty Ross Bridge)	Philadelphia, Pennsylvania	178,945	6	12%	5,381,806	645,946
I-5 at SR 56 Interchange	San Diego, California	235,000	8	10%	6,446,490	644,649
I-95 at I-87 Interchange	Bronx, New York	185,965	6	10%	6,263,919	626,392
I-95, Bronx (note: I-95/I-895 nrh)	Bronx, New York	185,965	6	10%	6,263,919	626,392
I–495 at I–270 Interchange	Montgomery, Maryland	233,910	8	10%	6,214,304	621,430
I-95 at Academy Road	Philadelphia, Pennsylvania	176,712	6	12%	5,157,643	619,041
I–35 at I-10 Interchange	Bexar, Texas	176,000	6	12%	4,981,740	606,600
I-95/I-895	Baltimore city, Maryland	168,020	6	14%	4,178,051	604,795
I-70 at I-435 Interchange	Jackson, Missouri	114,566	4	18%	3,343,805	604,146
SR-91 at I-605 Interchange	Los Angeles, California	279,000	10	10%	6,026,196	602,620
I-405 (San Diego Fwy) at I-10 Interchange	Los Angeles, California	278,000	10	10%	6,004,597	600,460
I-805 at SR 15 Interchange (I-15 Ext)	San Diego, California	231,000	8	10%	5,939,398	593,940
Northern State Parkway at Exit 36A	Nassau, New York	171,739	6	13%	4,562,603	593,138
I-15 at I-80 Interchange	Salt Lake, Utah	248,945	9	11%	5,377,030	583,706

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I–35E at I–30 Interchange (“Mixmaster”)	Dallas, Texas	276,291	10	10%	5,750,710	575,071
I-77 between I-277 and SC State Line (I-77 at I-277 NRH)	Mecklenburg, North Carolina	162,000	6	16%	3,499,082	574,283
I-75 at I-74 Interchange	Hamilton, Ohio	170,911	6	13%	4,394,409	571,273
I-15 Between Tropicana and Flamngo	Clark, Nevada	229,000	8	10%	5,694,403	569,440
I-94 at I-75 Interchange	Wayne, Michigan	181,300	6	10%	5,614,855	561,485
I-225 at I-70 Interchange	Arapahoe, Colorado	122,985	4	13%	4,254,596	553,098
I-77 at SR 8 Interchange	Summit, Ohio	122,472	4	13%	4,236,849	550,790
I-77 at I-277 Interchange (south)	Mecklenburg, North Carolina	161,000	6	16%	3,351,048	549,987
U.S. 101 at I-880 Interchange	Santa Clara, California	228,000	8	10%	5,479,268	547,927
I-285/I-75	Clayton, Georgia	210,150	8	14%	3,743,600	539,215
I-83/I-695	Baltimore, Maryland	178,152	6	10%	5,199,672	529,411
I-95 at PA 63	Philadelphia, Pennsylvania	171,300	6	12%	4,404,410	528,635
I-95, Bronx (note: I-95/I-278, I-678, I-295, I-695 nrh)	Bronx, New York	130,012	4	10%	5,208,635	520,863
SR 16 at Sprague Av	Pierce, Washington	129,951	4	10%	5,206,191	520,619
I-95/U.S. 322	Delaware, Pennsylvania	176,592	6	10%	4,998,497	518,607
I-80 at I-94/SR 394 Interchange	Cook, Illinois	103,723	4	24%	2,158,886	518,133
I-70 at U.S. 67 Interchange	St. Louis, Missouri	167,456	6	13%	3,886,451	505,239
I-270 at I-70 Interchange (West)	Franklin, Ohio	120,360	4	13%	3,835,893	498,666
U.S.-50 at I-75 Interchange	Hamilton, Ohio	71,142	2	13%	3,831,712	498,123

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-8 at I-15 Interchange	San Diego, California	247,000	9	10%	4,950,451	495,045
I-35 at Martin Luther King Jr.	Travis, Texas	121,660	4	12%	3,987,397	483,706
I-55 (Stevenson Expressway) at I-294 Interchange	DuPage, Illinois	165,996	6	13%	3,717,933	483,331
I-271 at I-480 Interchange	Cuyahoga, Ohio	142,653	5	13%	3,667,848	476,820
I-787, Albany (note: I-90/I-787 nrh)	Albany, New York	127,228	4	10%	4,749,972	474,997
I-495 I/L & O/L at I-270 (note: I-70/I-495 nrh)	Montgomery, Maryland	126,781	4	10%	4,733,283	473,328
I-880 at SR 237 Interchange	Santa Clara, California	175,000	6	10%	4,649,238	464,924
Baltimore/Washington Parkway: at I-95/495 Interchange	Prince Georges, Maryland	118,581	4	13%	3,566,347	463,625
I-495/I-66 Capital Beltway Interchange	Fairfax, Virginia	174,275	6	10%	4,629,977	462,998
I-66 at I-495 (Capitol Beltway) Interchange	Fairfax, Virginia	174,275	6	10%	4,629,977	462,998
I-15 at SR 56 Interchange	San Diego, California	221,000	8	10%	4,599,885	459,989
I-95 – Woodrow Wilson Bridge	Fairfax, Virginia	197,740	7	10%	4,589,306	458,931
I-95 at I-195 Interchange	Providence, Rhode Island	219,800	8	10%	4,405,300	440,530
I-66 at U.S. 29 Interchange (E. Falls Church)	Arlington, Virginia	116,764	4	13%	3,305,045	429,656
I-55 from Naperville to Weber	Will, Illinois	105,581	4	19%	2,197,559	412,846
I-440S at U.S. 431	Davidson, Tennessee	115,540	4	13%	3,169,479	412,032
I-84 at Exit 1-2 Interchanges	Multnomah, Oregon	171,400	6	10%	4,119,064	411,906
I-4 at SR 408 Interchange (East/West Toll)	Orange, Florida	171,000	6	10%	4,109,451	410,945
I-15 at I-515/U.S. 95/U.S. 93 Interchange ("Spaghetti Bowl")	Clark, Nevada	261,000	10	10%	4,103,909	410,391

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-95 at MD 295	Prince Georges, Maryland	215,700	8	10%	3,999,482	410,300
I-75 at I-696 Interchange	Oakland, Michigan	170,346	6	10%	4,093,734	409,373
I-695/I-83 exit 23	Baltimore, Maryland	192,790	7	10%	4,012,723	408,560
I-695 at I-70 Interchange	Baltimore, Maryland	192,790	7	10%	4,012,723	408,560
NY-590, Monroe Co. (note: I-490/NY 590 nrh)	Monroe, New York	122,727	4	10%	4,022,368	402,237
SR-590 at I-490/I-590 Interchange (“Can of Worms”)	Monroe, New York	122,727	4	10%	4,022,368	402,237
I-90 at I-290 Interchange	Erie, New York	121,236	4	10%	3,863,812	401,829
I-90, Erie Co. (note: I-90 at I-290 nrh)	Erie, New York	121,236	4	10%	3,863,812	401,829
I-95/Route 7 Merge	Fairfield, Connecticut	156,600	6	14%	2,789,664	397,184
I-91 at U.S. 1 Interchange	New Haven, Connecticut	90,800	3	13%	2,975,963	397,027
I-95/I-91/Route 34 Interchange	New Haven, Connecticut	90,800	3	13%	2,975,963	397,027
I-96 at Junction I-275/696	Oakland, Michigan	168,900	6	10%	3,919,964	391,996
SR-562 at I-75 Interchange	Hamilton, Ohio	66,012	2	13%	2,937,909	381,928
I-95 in Stamford	Fairfield, Connecticut	156,200	6	14%	2,671,238	380,323
I-95 Lane Drop (Near Girard Avenue)	Philadelphia, Pennsylvania	184,418	7	12%	3,153,805	378,532
I-95 from the interchange of I-95 and PA 3 to the interchange of I-95 and PA 63 (this first one is	Philadelphia, Pennsylvania	184,418	7	12%	3,153,805	378,532
Interchange of I-95 and I-676 and Ben Franklin Bridge	Philadelphia, Pennsylvania	184,418	7	12%	3,153,805	378,532
Loop 410 at U.S. 281 interchange (north)	Bexar, Texas	168,000	6	10%	3,762,818	376,282

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I–10 at I–110 Interchange	East Baton Rouge, Louisiana	146,200	6	19%	2,014,695	373,789
U.S. 1 at I-95 Interchange	New Castle, Delaware	199,677	8	13%	2,751,629	363,778
U.S. 59 at SR 8 Interchange	Harris, Texas	211,990	8	10%	3,625,324	362,532
I-93 at I-95 Interchange	Norfolk, Massachusetts	167,300	6	10%	3,613,558	361,356
I-93/I-95 Interchange (South)	Norfolk, Massachusetts	167,300	6	10%	3,613,558	361,356
SR 91 at I-215 Interchange	Riverside, California	167,000	6	10%	3,607,078	360,708
SR-99 at Florin Road Interchange	Sacramento, California	164,000	6	11%	3,286,939	352,331
I-277 at I-77 Interchange	Summit, Ohio	64,194	2	13%	2,629,688	341,859
I-95 at PA 291	Delaware, Pennsylvania	164,151	6	10%	3,289,965	341,342
I-70 at I-25 Interchange (“Mousetrap”)	Denver, Colorado	118,600	4	10%	3,357,014	335,701
I-57 at I-94 Interchange	Cook, Illinois	164,335	6	10%	3,293,653	329,365
I-94 Interchange at I-394 Interchange	Hennepin, Minnesota	164,000	6	10%	3,286,939	328,694
I-95 at U.S. 7 Interchange	Fairfield, Connecticut	151,700	6	14%	2,284,502	325,260
I-405 at SR 520 Interchange	King, Washington	216,885	9	13%	2,478,451	322,199
I-476 from PA 3 to I-95 (I-476 at I-95)	Delaware, Pennsylvania	117,378	4	10%	3,219,898	321,990
I-595 at Florida Turnpike	Broward, Florida	185,500	7	10%	3,172,308	317,231
M-39 at I-96 Interchange	Wayne, Michigan	163,300	6	10%	3,149,208	314,921
I-64 at I-264 Interchange	Norfolk, Virginia	140,170	5	10%	3,139,489	313,949
I-64 south of I-264	Norfolk, Virginia	140,170	5	10%	3,139,489	313,949

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-355 at I-88 Interchange	DuPage, Illinois	116,921	4	10%	3,106,249	310,625
I-280 at SR 1 Interchange	San Mateo, California	206,000	8	10%	3,102,224	310,222
I-480 Between SR 10 and SR 17	Cuyahoga, Ohio	109,920	4	13%	2,374,192	308,645
I-580 MP 7-19	Alameda, California	197,000	8	12%	2,476,172	301,602
I-287, Westchester and Rockland Cos. (note: I-287/NY 100 and 119 nrh)	Westchester, New York	153,438	6	13%	2,310,675	300,388
SR 16 at SR 3	Kitsap, Washington	66,977	2	10%	2,980,857	298,086
I-264 at Downtown Tunnel	Norfolk, Virginia	115,286	4	10%	2,964,197	296,420
I-476 at PA-3	Delaware, Pennsylvania	114,809	4	10%	2,854,885	285,489
I-90 at I-87 Interchange	Albany, New York	114,696	4	10%	2,852,075	285,208
I-90, Albany and Ren. Cos. (note: I-87/I-90 nrh)	Albany, New York	114,696	4	10%	2,852,075	285,208
I-495/VA 267	Fairfax, Virginia	203,359	8	10%	2,802,369	280,237
I–35W at SH – 183 Interchange	Tarrant, Texas	108,300	4	13%	2,170,582	277,788
I-95/VA 234 (south end of HOV)	Prince William, Virginia	157,534	6	10%	2,584,278	271,197
I-287, Westchester and Rockland Cos. (note: I-287/I-87 nrh)	Westchester, New York	107,341	4	13%	2,070,050	269,106
I–95 at I-395 Interchange	Baltimore, Maryland	201,900	8	10%	2,658,281	265,828
I-93/Route 3 and Route 128 Interchange	Norfolk, Massachusetts	200,621	8	10%	2,521,685	252,169
I-490, Monroe Co. (note: I-490/Roch Inner Lp Highway nrh)	Monroe, New York	112,114	4	10%	2,511,099	251,110
I-795 at I-695 Interchange	Baltimore, Maryland	111,760	4	10%	2,503,170	250,317

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
SR 4 at Willow Pass Rd	Contra Costa, California	157,000	6	10%	2,468,635	246,864
I-285/I-85 ("Spaghetti Interchange")	Fulton, Georgia	156,700	6	10%	2,463,918	246,392
SR 100 at I-394 Interchange	Hennepin, Minnesota	111,712	4	10%	2,412,898	241,290
I-84 between Interchanges 23 and 25	New Haven, Connecticut	104,500	4	13%	1,787,096	240,957
I-84/Route 8 Interchange	New Haven, Connecticut	104,500	4	13%	1,787,096	240,957
I-278 (Bruckner Expressway) at I-87 Interchange	Bronx, New York	104,828	4	13%	1,792,705	233,052
I-664 at U.S. 13 Interchange	Chesapeake, Virginia	104,475	4	13%	1,786,668	232,267
I-664 in Chesapeake (note: I-64 at I-264 and I-664 nrh)	Chesapeake, Virginia	104,475	4	13%	1,786,668	232,267
I-93/I-95 Interchange (North)	Middlesex, Massachusetts	154,000	6	10%	2,219,366	221,937
I-205 at I-84 Interchange (East)	Multnomah, Oregon	153,400	6	10%	2,210,719	221,072
I-95/I-495, Woodrow Wilson Bridge	Alexandria, Virginia	150,738	6	11%	1,984,665	218,313
I-264 east of Downtown (note: I-264 at U.S. 58 nrh)	Norfolk, Virginia	108,766	4	10%	2,097,530	209,753
I-5 NB at SR 526 in Everett	Snohomish, Washington	152,168	6	10%	2,096,936	209,694
I-80 at Garden State Parkway	Bergen, New Jersey	104,535	4	12%	1,714,852	205,782
I-10 at I-610 Interchange	Orleans, Louisiana	138,700	6	16%	1,297,290	205,242
I-495, Queens, Nas. Suf Cos. (note: I-495/NY 110 nrh)	Suffolk, New York	177,386	8	15%	1,340,611	201,092
I–494 at I-35W Interchange	Hennepin, Minnesota	151,765	6	10%	1,998,187	199,819
I-15 at I-215 Interchange	Salt Lake, Utah	228,945	10	11%	1,827,125	198,344
I-90/94 at I-290 Interchange ("Circle Interchange")	Cook, Illinois	149,671	6	10%	1,881,275	188,127

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-93/Route 24 Interchange, Lane Drop	Norfolk, Massachusetts	148,900	6	10%	1,785,274	178,527
SR 80 (I-80 Ext) at U.S. 101 Interchange	San Francisco, California	190,000	8	10%	1,777,110	177,711
Route 27 Suffolk Co. (note: Rte. 27/Heckscher State Parkway nrh)	Suffolk, New York	146,793	6	10%	1,677,476	167,748
I-278 at I-495 Interchange	Kings, New York	146,717	6	10%	1,676,607	167,661
I-95/VA 7100	Fairfax, Virginia	207,660	9	10%	1,657,257	167,167
I-75, from Ohio River Bridge to I-71 Interchange	Hamilton, Ohio	98,221	4	13%	1,234,579	160,495
I-95 at U.S. 1 Interchange	New Castle, Delaware	175,519	8	13%	1,186,938	156,919
Interchange of I-83 and U.S. 322/ I-283 (Eisenhower Interchange)	Dauphin, Pennsylvania	100,000	4	12%	1,316,632	155,744
U.S. 169 at I-394 Interchange	Hennepin, Minnesota	102,777	4	10%	1,481,168	148,117
I-64 South of Fort Eustis (note: I-64 at VA 143 nrh)	Newport News, Virginia	102,097	4	10%	1,471,368	147,137
I-97/U.S. 50	Anne Arundel, Maryland	99,960	4	11%	1,316,106	143,601
SR 167 at I-405 Interchange	King, Washington	121,232	5	11%	1,319,329	142,153
I-95/Route 9 Lane Drop	Norfolk, Massachusetts	143,700	6	10%	1,414,803	141,480
I-370/I-270	Montgomery, Maryland	219,381	10	10%	1,323,743	132,374
I-84/Route 7 Interchange	Fairfield, Connecticut	120,400	5	10%	1,246,784	130,059
Loop-202: Dobson to I–10	Maricopa, Arizona	178,200	8	11%	1,205,069	129,275
I–475 – 9.63-14.66	Lucas, Ohio	95,287	4	13%	986,731	128,275
I-290, Erie Co. (note: I-290/NY 5 nrh)	Erie, New York	141,089	6	10%	1,252,635	125,263
SR 520 Floating Bridge	King, Washington	99,397	4	10%	1,191,746	119,175

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-84 at SR 2 Interchange ("Mixmaster East")	Hartford, Connecticut	135,600	6	11%	1,024,810	116,504
U.S. 22 from the interchange of U.S. 22 and PA 309 and the interchange of U.S. 22 and PA 33 (U.S. 22 at 3rd	Lehigh, Pennsylvania	96,557	4	11%	1,050,799	115,561
I-5 at I-90 Interchange	King, Washington	214,891	10	10%	1,154,065	115,407
I-95 from Delaware State Line to the PA 291 interchange (I-95 at PA 452)	Delaware, Pennsylvania	137,189	6	10%	1,094,854	113,594
I-20 at I-75/I-85 Interchange	Fulton, Georgia	203,670	10	13%	861,449	111,988
Interchange of I-78 and PA 100 (I-78, Exit 49)	Lehigh, Pennsylvania	82,173	4	22%	467,912	104,737
I-93 Lane Drop	Middlesex, Massachusetts	136,421	6	10%	1,031,015	103,101
I-95 at Route 4 Interchange	Kent, Rhode Island	174,200	8	10%	991,936	99,194
Route 3/Rte. 18 (I added)	Norfolk, Massachusetts	135,967	6	10%	972,380	97,238
I-695/Route 295	Anne Arundel, Maryland	92,912	4	11%	824,903	94,773
I-376 at Squireel Hill Tunnel	Allegheny, Pennsylvania	95,823	4	10%	943,429	94,343
I-10 at U.S. 17A Interchange	Duval, Florida	125,259	6	15%	634,114	92,899
U.S. 29/MD 100	Howard, Maryland	134,230	6	10%	907,724	90,772
U.S. 192 at I-4	Osceola, Florida	131,000	6	11%	790,453	89,536
Interchange of I-79 and I-279/U.S. 22/U.S. 30	Allegheny, Pennsylvania	113,692	5	10%	859,238	85,924
Route 1/Route 60	Suffolk, Massachusetts	89,095	4	13%	637,171	82,832
I-440 between I-40 and Wade Avenue (I-440 at NC 54 nrh)	Wake, North Carolina	85,000	4	16%	512,889	82,062
I-85 West of I-77 and Route 7 (note: I-85 at NC 7 Nrh)	Gaston, North Carolina	118,000	6	16%	469,808	76,960

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I–5: Interstate Bridge and bridge influence area	Multnomah, OR	130,600	6	10%	743,667	76,094
I-93/Route 110 and Route 113 Interchange	Essex, Massachusetts	130,235	6	10%	741,589	74,159
I–494 at I-394 Interchange	Hennepin, Minnesota	91,666	4	10%	731,552	73,155
I-15 at U.S. 89 Interchange	Davis, Utah	129,150	6	10%	693,596	69,360
I-81 from the interchange of I-81 and PA 29 (Exit 164) to the interchange of I-81 and U.S. 6/I-476 (Ex	Luzerne, Pennsylvania	78,391	4	21%	331,565	68,491
Interchange of I-83 and PA 581	Cumberland, Pennsylvania	85,463	4	14%	486,647	67,755
Route 440 at SIE and Korean War Veteran Parkway	Richmond, New York	90,129	4	10%	644,566	64,457
(I-81 at PA 307)	Lackawanna, Pennsylvania	79,336	4	19%	335,562	62,991
Interchange near I-279 and PA 28/I-579	Allegheny, Pennsylvania	108,798	5	10%	619,522	61,952
I-80 from the interchange of I-80 and U.S. 209 (Exit 304) to the New Jersey Border	Monroe, Pennsylvania	75,216	4	23%	265,287	60,910
I-64 (Hampton Roads Tunnel)	Hampton, Virginia	89,110	4	10%	602,602	60,260
(I-81 at U.S. 11 and PA 502)	Lackawanna, Pennsylvania	78,391	4	19%	312,108	58,588
I-87, Bronx (note: I-87/I-95 nrh)	Bronx, New York	106,391	5	10%	538,596	53,860
I-95/I-395 Interchange	New London, Connecticut	84,800	4	11%	429,293	47,841
Route 27 Suffolk Co. (note: Route 27/Patchogue Yaphank Road-County Route 101 nrh)	Suffolk, New York	86,167	4	10%	462,757	46,276
I–12 at Amite River, Baton Rouge	East Baton Rouge, Louisiana	106,800	6	18%	249,578	44,924
I-85/Route 74 Lane Drop	Gaston, North Carolina	77,000	4	16%	271,579	44,488

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
Interchange of I-81 and I-83	Dauphin, Pennsylvania	94,694	6	26%	163,850	42,850
I-87, Albany (note: I-87/I-90 nrh)	Albany, New York	119,487	6	10%	421,430	42,143
I-590, Monroe Co. (note: I-590/I-490 nrh)	Monroe, New York	118,628	6	10%	393,850	39,385
I-390, Monroe Co. (note: I-390/NY 33A nrh)	Monroe, New York	118,578	6	10%	393,684	39,368
I-93 Between Exits 1,2, and 3	Rockingham, New Hampshire	83,000	4	10%	372,862	37,286
I-91 S to I-691 West/Route 15 South	New Haven, Connecticut	109,800	6	13%	271,429	36,212
U.S. 22 at PA 378	Northampton, Pennsylvania	82,718	4	10%	349,867	34,987
Route 3 Lane Drop	Norfolk, Massachusetts	99,191	5	10%	349,847	34,985
I-85 between I-485 and I-77 (I-85 at I-77 nrh)	Mecklenburg, North Carolina	128,000	8	17%	196,899	32,762
I-85/SR 16	Mecklenburg, North Carolina	128,000	8	17%	196,899	32,762
I-85/U.S. 321 Interchange	Gaston, North Carolina	102,000	6	16%	193,446	31,689
U.S. 52 N. of Winston Salem (U.S.-52 at U.S. 158)	Forsyth, North Carolina	79,608	4	10%	280,777	28,078
I-64 at I-95	Henrico, Virginia	109,858	6	10%	256,724	25,672
Route 7/Route 15 Interchange	Fairfield, Connecticut	73,300	4	13%	181,200	23,556
Interchange of I-83 and U.S. 30	York, Pennsylvania	70,106	4	15%	147,049	22,513
I-684, I-84 to I-287 (note: I-684/I-287 nrh)	Westchester, New York	72,171	4	13%	168,654	21,925
I-40/US 15-US 501 Durham/Chapel Hill	Durham, North Carolina	73,000	4	13%	170,591	21,344
Interchange of I-79 and I-279	Allegheny, Pennsylvania	86,051	5	13%	163,199	21,191

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-275 Between I-74 and SR 126	Hamilton, Ohio	121,303	8	13%	162,727	21,154
Interchange of I-95 and U.S. 1	Bucks, Pennsylvania	66,872	4	17%	120,991	20,698
U.S. 202 from U.S. 30 to Delaware County Line (U.S. 202 at U.S. 30)	Chester, Pennsylvania	74,071	4	10%	183,106	18,311
Mid-Hudson Bridge, Route 9 to 9W	Dutchess, New York	38,482	2	13%	120,298	15,639
I-64 High Rise Bridge (note: I-64 measured from N nrh)	Chesapeake, Virginia	71,450	4	10%	149,868	14,987
I-84 and I-380 interchange	Lackawanna, Pennsylvania	44,472	4	27%	53,979	14,362
I-95/Route 9 Interchange	Middlesex, Connecticut	65,900	4	13%	105,126	14,005
I-95/I-16 (Chatham county)	Chatham, Georgia	69,250	6	17%	83,863	13,869
I-95 South of Portland	Cumberland, Maine	67,980	4	11%	117,626	12,736
Interchange of I-76 and I-79	Allegheny, Pennsylvania	74,470	5	13%	98,058	12,733
Interchange of U.S. 422 and PA 23	Montgomery, Pennsylvania	68,792	4	10%	124,465	12,447
I-90/I-84 Interchange	Worcester, Massachusetts	90,808	6	10%	119,570	11,957
I-684, I-84 to I-287 (note: I-684/I-84 nrh)	Putnam, New York	68,422	4	10%	118,391	11,839
Route 24/Route 140 Interchange	Bristol, MA	68,338	4	10%	118,246	11,825
I-90/I-495 Interchange	Worcester, Massachusetts	89,683	6	10%	116,219	11,622
I-190, Grand Island (note: I-190/West River Parkway Nrh)	Erie, New York	67,198	4	10%	111,488	11,149
Bourne Bridge and Bourne Rotary	Barnstable, Massachusetts	61,701	4	13%	84,564	10,993
I–71 at I-75 Interchange	Delaware, Ohio	71,792	7	13%	83,359	10,837
Interchange of I-376 with I-76 (PA Turnpike)/U.S. 22	Allegheny, Pennsylvania	65,772	4	10%	101,175	10,118

Table B.1 Interchange Bottlenecks
2006, Using the HPMS Scan Method (continued)

Bottleneck Name	County/State	AADT	No. Lanes	Pct Trucks	Annual Total Delay 2006 (Hours)	Annual Truck Delay 2006 (Hours)
I-264 Downtown Tunnel	Chesapeake, Virginia	51,669	3	10%	93,485	9,348
I-40/I-540	Durham, North Carolina	54,000	6	16%	58,173	9,308
Interchange of U.S. 422 and PA 363	Montgomery, Pennsylvania	62,914	4	10%	88,352	8,835
Route 15 to I-91 North/I-691 West	New Haven, Connecticut	53,500	4	13%	65,864	8,787
Route 9 and Route 66	Middlesex, Connecticut	61,600	4	10%	82,636	8,264
U.S. 17/U.S. 76 in Wilmington	Brunswick, North Carolina	60,000	4	10%	77,753	7,775
I-95 between I-40 and Business 95 in Fayetteville (I-95 at U.S. 421)	Harnett, North Carolina	49,000	4	13%	59,673	7,758
I-495/Route 24 Interchange Lane Drop	Plymouth, Massachusetts	56,238	4	10%	69,942	6,994
Interchange of U.S. 15 and U.S. 11/PA 581	Cumberland, Pennsylvania	52,578	4	10%	64,350	6,435
Sagamore Bridge	Barnstable, Massachusetts	51,824	4	10%	63,305	6,330
From Squirrel Hill Tunnel (I-376) to I-279	Allegheny, Pennsylvania	48,663	4	10%	59,172	5,917
U.S. 321 N. of U.S. 70	Catawba, North Carolina	43,000	4	10%	50,841	5,084
U.S. 64 through Rocky Mount	Nash, North Carolina	36,000	3	10%	43,696	4,533
I-81, Exits 14 to 15 (note: I-81/U.S. 11 nrh)	Onondaga, New York	37,767	4	10%	41,458	4,146
I-81, Exits 7 to 8 (note: I-81/NY 26 nrh)	Broome, New York	26,892	4	18%	20,963	3,738
I-81 Exits 15 to 16 (note: I-81/NY 80 nrh)	Onondaga, New York	32,310	4	10%	30,625	3,062
Route 146/Boston Road	Worcester, Massachusetts	30,904	4	10%	27,334	2,733
I-40/Pigeon River Gorge (border with Tennessee)	Haywood, North Carolina	23,000	4	19%	13,520	2,569
					1,348,027,162	**151,018,274**

Appendix C

Grade Bottlenecks

Appendix C: Grade Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Kern, CA	INTERSTATE	00000005	10.408	79,000	26,070	662,310	945,778
Fayette, KY	INTERSTATE	0000075	97.703	57,780	17,912	318,835	318,835
Riverside, CA	INTERSTATE	00000010	0.860	24,000	9,360	251,116	434,180
Montgomery, VA	INTERSTATE	IS00081	104.980	42,699	11,956	193,703	624,500
Kern, CA	STATE	00000058	49.063	22,800	7,524	183,393	503,046
Jackson, OR	INTERSTATE	00000005	11.590	15,900	6,519	167,557	167,557
Raleigh, WV	INTERSTATE	00000077	48.050	32,000	13,440	166,341	167,672
Mercer, WV	INTERSTATE	77	0.000	30,000	16,500	160,726	162,012
Greenbrier, WV	INTERSTATE	64	156.180	19,000	8,740	151,510	154,995
Smyth, VA	INTERSTATE	IS00081	35.800	30,798	7,084	149,125	840,169
Guilford, NC	INTERSTATE	00000040	205.190	95,000	18,050	148,250	318,737
Umatilla, OR	INTERSTATE	00000084	209.540	10,100	4,646	141,707	141,707
Raleigh, WV	INTERSTATE	64	117.930	16,000	7,520	137,104	140,258
San Diego, CA	INTERSTATE	00000008	2.380	22,800	4,560	136,749	236,440
Malheur, OR	INTERSTATE	00000084	356.110	8,400	4,452	134,350	134,350
Crawford, IN	INTERSTATE	00000064	79.530	17,030	6,471	126,213	171,776
Greenbrier, WV	INTERSTATE	64	156.180	19,000	8,740	124,506	127,369
Josephine, OR	INTERSTATE	00000005	67.110	20,600	5,356	119,487	119,487
Braxton, WV	INTERSTATE	79	62.040	22,500	11,025	118,665	118,665
Harrison, WV	INTERSTATE	79	115.330	35,000	12,250	112,225	113,123
Josephine, OR	INTERSTATE	00000005	71.490	19,900	7,761	105,197	105,197
Raleigh, WV	INTERSTATE	00000064	128.910	18,500	6,660	104,984	107,399
Marion, OR	INTERSTATE	00000005	248.710	60,900	12,789	104,394	104,394
Oklahoma, OK	INTERSTATE	00000044	0.000	26,100	5,220	97,421	109,209
Douglas, OR	INTERSTATE	00000005	117.770	19,700	5,713	93,482	93,482
Sequoyah, OK	INTERSTATE	00000040	1.220	16,300	6,194	88,125	98,083
Lincoln, OK	INTERSTATE	00000044	0.000	26,100	6,003	87,903	98,540
Northampton, NC	INTERSTATE	00000095	175.220	36,000	6,840	84,301	128,558
Summers, WV	INTERSTATE	64	138.380	13,700	8,083	82,632	84,533
Kanawha, WV	INTERSTATE	00000077	75.000	32,000	6,720	80,889	81,536
Jackson, OR	INTERSTATE	00000005	5.690	14,800	6,068	77,565	77,565
Kern, CA	STATE	00000058	52.330	23,000	7,590	76,496	209,828
Alameda, CA	INTERSTATE	00000680	0.000	149,000	10,430	73,891	94,063
Summers, WV	INTERSTATE	00000064	143.750	13,800	8,142	73,854	75,553
Carter, KY	INTERSTATE	00000064	148.665	11,681	3,621	71,731	71,731
Lewis, WV	INTERSTATE	00000079	104.690	24,800	10,416	69,565	69,565
Imperial, CA	INTERSTATE	00000008	0.000	15,300	3,060	69,153	75,446
Washington, MD	INTERSTATE	00000068	0.040	18,810	4,514	66,862	157,459
Monongalia, WV	INTERSTATE	00000079	142.370	33,000	6,930	65,637	66,163
Bath, KY	INTERSTATE	00000064	115.647	19,800	6,138	62,856	62,856
Malheur, OR	INTERSTATE	00000084	356.110	8,400	4,032	62,572	62,572
Greenbrier, WV	INTERSTATE	00000064	170.090	16,500	6,930	61,441	62,854
Siskiyou, CA	INTERSTATE	00000005	36.431	14,700	4,704	60,721	66,246
Salt Lake, UT	INTERSTATE	00000080	115.550	46,135	8,766	60,119	128,234
Preston, WV	INTERSTATE	00000068	14.660	17,500	3,675	54,764	56,024
Frederick, MD	INTERSTATE	00000070	5.860	65,360	11,765	53,582	170,714
Douglas, OR	INTERSTATE	00000005	146.280	22,600	8,588	52,037	52,037
Madison, NC	INTERSTATE	00000026	3.340	10,000	2,300	51,984	96,273
Santa Barbara, CA	U.S.	00000101	6.970	23,200	3,016	51,777	142,023
Washington, MD	INTERSTATE	00000068	8.280	18,810	4,514	50,717	119,439
Muskogee, OK	INTERSTATE	00000040	2.290	14,000	5,880	50,412	56,108
Braxton, WV	INTERSTATE	79	51.610	14,400	2,880	48,910	50,035
Kerr, TX	INTERSTATE	_IH0010_	499.673	11,200	2,912	48,486	170,379
Polk, NC	INTERSTATE	00000026	30.890	32,000	6,080	48,286	73,635
Lewis, WV	INTERSTATE	79	83.550	22,500	4,275	47,546	47,546
Uinta, WY	INTERSTATE	00000I80	2.180	12,850	5,911	46,355	178,051
Rockbridge, VA	INTERSTATE	IS00064	43.100	8,686	2,172	44,836	57,659
Franklin, VA	U.S.	US00220	29.750	13,959	2,094	44,321	362,017
Preston, WV	INTERSTATE	68	18.120	17,000	3,570	43,940	44,951
Oklahoma, OK	INTERSTATE	00000044	0.000	26,100	5,220	42,951	48,148
San Juan, NM	U.S.	00000064	7.835	13,540	1,489	42,559	142,700
King, WA	INTERSTATE	00000090	15.240	29,559	6,207	42,435	70,442
Campbell, KY	STATE	0000009	10.201	24,089	5,781	42,331	76,027
Roane, WV	INTERSTATE	00000079	25.790	11,000	2,310	42,311	43,284
Monongalia, WV	INTERSTATE	00000079	157.000	25,000	3,750	41,585	41,585

Appendix C: Grade Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Alleghany, VA	INTERSTATE	IS00064	16.030	8,335	2,084	41,581	53,473
Wood, WV	INTERSTATE	77	170.030	20,500	4,305	41,522	41,522
Douglas, OR	INTERSTATE	00000005	135.140	29,800	7,450	41,517	41,517
Pueblo, CO	INTERSTATE	0000025A	100.681	15,200	2,888	41,234	81,354
Roane, WV	INTERSTATE	00000079	21.280	15,000	3,150	40,171	41,095
Union, OR	INTERSTATE	00000084	243.990	9,800	4,508	39,523	39,523
Braxton, WV	INTERSTATE	79	54.180	22,500	4,500	39,218	39,218
Kittitas, WA	INTERSTATE	00000082	0.000	15,579	3,895	38,335	62,831
Nevada, CA	INTERSTATE	00000080	2.237	30,000	4,800	37,917	76,820
Douglas, OR	INTERSTATE	00000005	136.200	23,000	7,360	36,824	36,824
San Diego, CA	INTERSTATE	00000008	2.380	12,925	2,585	36,391	39,703
Union, OR	INTERSTATE	00000084	253.410	9,800	4,214	36,146	36,146
Kootenai, ID	INTERSTATE	00000090	8.110	13,000	2,340	35,770	35,770
12086	COUNTY	CR 948	2.131	41,208	4,121	35,243	297,454
Mesa, CO	INTERSTATE	0000070A	25.563	6,600	1,716	33,604	57,529
Perry, KY	STATE	0000015	15.968	9,516	1,523	32,408	61,803
Las Animas, CO	INTERSTATE	0000025A	13.000	9,700	1,649	31,888	54,592
Madera, CA	STATE	00000041	0.000	17,500	1,925	31,461	123,358
Mineral, MT	INTERSTATE	00090	21.727	6,500	2,080	31,340	67,538
Union, OR	INTERSTATE	00000084	262.340	9,700	4,462	31,242	31,242
Bell, KY	U.S.	0000025E	0.835	18,485	2,218	31,003	71,678
Henry, VA	U.S.	US00220	6.750	17,153	2,573	30,382	189,523
Shoshone, ID	INTERSTATE	00000090	70.680	6,500	2,015	30,242	30,242
Cleveland, NC	U.S.	00000074	0.000	26,000	3,640	29,147	92,979
Placer, CA	INTERSTATE	00000080	0.000	26,500	2,650	28,684	49,594
Miami, IN	U.S.	00000031	177.000	20,170	3,026	28,648	65,977
Grady, OK	INTERSTATE	00000044	0.000	9,400	1,692	28,210	29,311
Aiken, SC	U.S.	00000001	4.270	22,200	1,776	27,978	34,832
Madison, NC	INTERSTATE	00000026	0.350	8,600	1,978	27,527	28,381
Montgomery, NY	INTERSTATE	00000090	33.030	28,545	5,138	25,877	145,768
Wood, WV	INTERSTATE	77	156.990	20,500	4,305	24,841	24,841
Josephine, OR	INTERSTATE	00000005	79.290	19,700	5,516	24,827	24,827
Macon, NC	U.S.	00000023	16.160	22,000	3,080	24,727	78,880
Floyd, KY	STATE	00000080	0.000	12,681	1,395	23,605	57,785
Clay, KY	STATE	0009006	24.548	6,397	1,215	23,383	44,592
Winona, MN	INTERSTATE	00000090	249.103	10,743	2,041	23,208	42,007
Elko, NV	INTERSTATE	00080	303.847	4,850	1,940	22,925	81,545
Halifax, VA	U.S.	US00058	310.470	9,001	1,530	21,846	71,260
Allegany, MD	INTERSTATE	00000068	0.000	18,683	3,923	21,654	50,995
Siskiyou, CA	STATE	00000089	0.000	2,100	714	21,531	51,934
Marshall, AL	STATE	00069	275.435	13,510	2,432	21,505	133,826
Humboldt, CA	U.S.	00000101	52.590	22,500	2,475	21,473	58,900
Grainger, TN	U.S.	00000025	7.420	8,470	1,609	21,429	152,169
Braxton, WV	INTERSTATE	79	46.220	12,700	2,667	21,351	21,842
Cherokee, NC	U.S.	00000019	0.000	7,900	1,106	20,921	45,587
Imperial, CA	INTERSTATE	00000008	0.000	15,300	3,060	20,856	22,754
Cherokee, NC	U.S.	00000064	0.000	4,300	602	20,249	31,467
Pulaski, KY	STATE	0000080	28.037	7,334	1,027	20,173	38,470
Doddridge, WV	U.S.	50	0.000	6,388	1,022	20,124	196,467
Haywood, NC	U.S.	00000019	12.010	7,300	730	20,040	139,498
Summit, CO	INTERSTATE	0000070A	203.144	19,100	2,483	19,346	38,169
Lake, CA	STATE	00000020	0.000	6,100	915	19,287	41,948
Nevada, CA	INTERSTATE	00000080	0.000	27,000	2,970	19,114	33,048
Salt Lake, UT	STATE	00000210	2.000	5,780	925	19,012	107,628
Kootenai, ID	INTERSTATE	00000090	11.305	13,000	2,340	18,884	18,884
San Luis Obispo, CA	STATE	00000046	24.542	8,000	1,760	18,788	40,864
Lafayette, MS	U.S.	00000278	18.320	7,579	1,440	18,788	67,729
Sierra, NM	INTERSTATE	00000025	62.024	7,779	2,489	18,670	38,347
Bannock, ID	U.S.	000US030	371.843	4,300	989	18,543	35,751
Swain, NC	U.S.	00000074	16.900	7,300	1,022	18,512	40,337
Union, NC	U.S.	00000601	5.000	12,000	1,680	18,403	48,878
Windsor, VT	INTERSTATE	00089	3.919	14,500	3,190	18,068	18,068
Kent, MI	STATE	00000057	11.163	13,931	1,254	17,771	99,639
Siskiyou, CA	U.S.	00000097	0.000	7,000	2,450	17,391	37,825
Clay, NC	U.S.	00000064	7.220	8,000	800	17,205	119,765

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Perry, KY	STATE	0009006	51.026	6,802	1,088	17,165	32,733
Shasta, CA	STATE	00000299	0.000	3,850	501	16,801	40,525
Caledonia, VT	INTERSTATE	00093	0.205	5,900	944	16,630	16,630
Cass, MI	U.S.	00000012	0.348	7,559	529	16,531	251,338
Blount, AL	U.S.	00278	1.060	7,156	3,006	16,429	79,075
Webster, MS	U.S.	00000082	0.000	5,538	1,052	16,416	59,179
Millard, UT	INTERSTATE	00000070	0.180	5,390	2,210	15,878	44,585
Stanly, NC	STATE	00000024	15.540	11,000	1,100	15,649	151,643
Kent, MI	STATE	00000037	5.937	9,652	1,544	15,570	236,730
Idaho, ID	U.S.	000US095	223.658	2,000	340	15,524	29,930
Clay, KY	STATE	0009006	17.285	7,780	1,245	15,358	29,287
Franklin, MS	U.S.	00000084	19.267	5,151	979	14,681	52,926
San Bernardino, CA	STATE	00000330	3.809	10,350	414	14,618	79,391
Humboldt, CA	STATE	00000299	28.230	3,400	510	14,448	34,849
Lawrence, IN	U.S.	00000050	72.890	5,140	925	14,326	38,107
Nelson, VA	U.S.	US00029	95.830	11,471	1,377	14,186	115,870
Emery, UT	INTERSTATE	00000070	159.000	5,330	2,718	14,117	39,641
Greenville, SC	U.S.	00000025	1.120	11,000	1,100	14,088	65,184
Jackson, AL	STATE	00072	124.320	11,886	1,783	14,062	82,359
Utah, UT	U.S.	00000006	164.000	6,675	2,336	13,772	50,805
Jackson, NC	U.S.	00000064	0.000	7,300	730	13,585	94,564
Martin, IN	U.S.	00000231	69.380	5,440	979	13,551	36,046
Windsor, VT	INTERSTATE	00091	0.000	12,900	2,451	13,522	13,522
Montmorency, MI	STATE	00000032	3.241	4,357	349	13,421	24,023
Orange, VT	INTERSTATE	00091	20.186	5,300	954	13,416	13,416
Box Elder, UT	U.S.	00000091	8.483	14,885	2,084	13,385	25,926
Frederick, VA	U.S.	US00522	131.500	8,466	1,185	13,383	43,655
Eaton, MI	STATE	00000050	0.000	2,483	397	13,276	81,273
Tulare, CA	STATE	00000198	11.001	7,050	635	12,963	28,194
Klickitat, WA	U.S.	00000097	1.180	4,393	1,186	12,955	27,749
Big Horn, MT	INTERSTATE	00090	497.595	3,420	1,060	12,903	27,806
Caledonia, VT	INTERSTATE	00091	0.000	4,700	1,034	12,754	12,754
Columbia, OR	U.S.	00000030	42.000	13,600	1,768	12,708	14,195
Lenawee, MI	U.S.	00000012	0.000	5,909	532	12,648	57,195
Henry, VA	U.S.	US00220	0.000	21,642	3,246	12,606	68,754
Lewis and Clark, MT	INTERSTATE	00015	192.226	4,230	719	12,542	27,028
Transylvania, NC	U.S.	00000064	22.660	6,300	630	12,396	86,290
Yuba, CA	STATE	00000020	1.472	9,200	552	12,354	26,869
Caribou, ID	U.S.	000US030	378.390	4,300	989	12,293	23,702
San Bernardino, CA	STATE	00000038	30.360	2,550	332	12,224	69,773
Del Norte, CA	U.S.	00000101	0.583	5,000	750	11,911	25,906
Siskiyou, CA	U.S.	00000097	10.829	3,100	1,178	11,845	28,570
Muskegon, MI	STATE	00000037	4.929	7,318	659	11,800	179,402
Carson City city, NV	U.S.	00050	17.567	12,200	1,342	11,771	22,683
Campbell, VA	U.S.	US00029	48.600	19,272	1,349	11,620	72,486
Dearborn, IN	STATE	00000001	1.870	5,430	652	11,559	123,401
Fresno, CA	STATE	00000180	62.087	2,850	285	11,493	27,721
Caldwell, NC	U.S.	00000321	14.220	7,700	1,078	11,489	25,035
Sullivan, NH	INTERSTATE	00000089	43.090	15,514	1,396	10,990	11,397
Graham, NC	STATE	00000028	5.250	1,600	160	10,910	39,267
Shasta, CA	STATE	00000299	24.055	4,450	1,335	10,879	26,240
Terrell, TX	U.S.	_US0090_	219.948	1,232	604	10,861	27,045
Belknap, NH	STATE	00000028	30.246	8,804	880	10,780	28,482
Jasper, TX	U.S.	_US0096_	59.621	7,119	1,210	10,778	64,958
Hertford, NC	U.S.	00000158	1.490	3,000	420	10,726	16,669
Colusa, CA	STATE	00000020	13.930	5,600	896	10,546	22,938
Humboldt, CA	STATE	00000299	1.210	3,900	390	10,488	25,296
El Dorado, CA	U.S.	00000050	8.297	13,200	528	10,477	31,085
Macon, NC	U.S.	00000064	22.480	3,100	310	10,440	42,928
Klickitat, WA	U.S.	00000097	4.020	3,794	1,214	10,431	22,344
Harlan, KY	U.S.	0000421	18.151	2,597	260	10,415	51,317
Lane, OR	STATE	00000058	58.900	2,800	840	10,277	20,235
San Bernardino, CA	STATE	00000002	0.000	3,975	437	10,224	58,356
San Luis Obispo, CA	STATE	00000041	0.000	7,500	750	10,193	22,170
Jackson, NC	U.S.	00000019	7.880	3,100	310	10,033	41,256

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Fremont, ID	U.S.	000US020	365.000	3,500	840	10,024	19,326
Montague, TX	U.S.	_US0082_	335.436	3,918	1,136	9,999	24,898
Clay, NC	U.S.	00000064	12.650	4,500	450	9,975	41,017
Orleans, VT	INTERSTATE	00091	4.418	4,700	1,269	9,960	9,960
Grays Harbor, WA	U.S.	00000101	66.910	4,080	857	9,679	20,733
Yakima, WA	U.S.	00000097	75.450	3,449	1,173	9,658	20,686
Noble, IN	U.S.	00000033	71.560	7,310	1,608	9,539	25,373
Humboldt, CA	U.S.	00000101	3.904	6,100	915	9,443	20,538
Humboldt, CA	STATE	00000299	37.855	3,400	476	9,440	22,768
Nottoway, VA	STATE	SR00307	2.830	5,309	584	9,298	30,331
Pittsylvania, VA	STATE	SR00040	50.210	2,765	387	9,214	67,683
Chatham, NC	U.S.	00000421	18.270	11,000	1,540	9,159	24,326
Caldwell, NC	U.S.	00000321	30.450	7,700	1,078	9,100	19,829
Sonoma, CA	U.S.	00000101	3.225	14,700	1,470	9,088	26,965
Searcy, AR	U.S.	00000065	0.250	4,900	1,078	9,069	54,170
Latah, ID	U.S.	000US095	329.891	4,935	642	9,057	17,462
Newton, TX	U.S.	_US0190_	567.415	5,199	780	8,911	93,890
Jefferson, CO	U.S.	0000285D	237.159	29,400	2,058	8,866	24,188
Chaffee, CO	U.S.	0000050A	216.986	2,590	622	8,814	40,881
Kemper, MS	U.S.	00000045	0.000	3,737	710	8,708	24,635
Letcher, KY	STATE	00000015	0.000	9,683	871	8,596	16,392
Greenup, KY	U.S.	0000023	11.734	12,000	1,920	8,583	21,011
Jackson, MI	STATE	00000050	5.717	12,678	507	8,530	47,826
San Bernardino, CA	STATE	00000330	2.004	10,350	725	8,467	45,986
Watauga, NC	U.S.	00000421	0.000	8,900	1,246	8,428	18,364
Arenac, MI	U.S.	00000023	0.000	6,903	345	8,288	37,476
Leslie, KY	STATE	0009006	35.929	5,220	783	8,277	15,783
Moore, NC	U.S.	00000001	0.000	9,000	1,260	8,259	17,996
Greene, VA	U.S.	US00029	149.130	29,360	1,174	8,225	44,861
Siskiyou, CA	U.S.	00000097	8.380	3,100	1,178	8,220	19,827
Siskiyou, CA	U.S.	00000097	30.475	3,100	1,209	8,139	19,631
Mendocino, CA	U.S.	00000101	17.477	6,000	960	8,052	17,514
Llano, TX	STATE	_SH0071_	69.409	3,664	440	8,050	73,801
Jackson, AL	STATE	00117	31.231	3,375	338	7,982	119,528
Jackson, IN	U.S.	00000050	81.810	3,710	705	7,980	21,858
Val Verde, TX	U.S.	_US0090_	288.264	1,899	798	7,974	19,855
Shenandoah, VA	U.S.	US00211	0.120	5,840	701	7,819	25,505
Sherman, OR	U.S.	00000097	0.200	2,600	806	7,798	15,355
King George, VA	U.S.	US00301	128.750	16,142	1,937	7,792	48,605
Leslie, KY	STATE	0009006	44.188	5,500	825	7,772	14,820
Marquette, MI	U.S.	00000041	0.000	3,143	471	7,751	13,874
Hemphill, TX	U.S.	_US0060_	179.873	1,740	626	7,662	19,078
Madison, NC	U.S.	00000025	11.350	3,700	370	7,658	31,490
Searcy, AR	U.S.	00000065	0.930	4,300	1,118	7,605	45,425
Harney, OR	U.S.	00000020	160.850	1,200	420	7,522	14,811
Dubois, IN	STATE	00000056	48.800	3,480	418	7,512	37,124
Macon, NC	U.S.	00000064	2.410	2,400	240	7,486	26,941
Madison, NC	U.S.	00000023	3.680	1,600	224	7,426	11,539
Unicoi, TN	INTERSTATE	00000026	15.820	9,450	1,040	7,323	12,816
Lake, CA	STATE	00000029	31.053	8,600	860	7,323	15,927
Jefferson, CO	U.S.	0000285D	244.121	25,912	1,036	7,300	19,916
Idaho, ID	U.S.	000US095	255.180	2,837	482	7,295	14,064
Charlevoix, MI	U.S.	00000131	11.186	10,705	535	7,273	60,912
Macon, NC	U.S.	00000064	33.570	7,300	730	7,231	50,335
Esmeralda, NV	U.S.	00095	231.633	1,900	399	7,131	24,060
Jackson, NC	STATE	00000107	17.020	4,300	430	7,109	29,230
Clarke, VA	STATE	SR00007	10.880	23,887	955	7,004	38,201
Page, VA	U.S.	US00340	72.740	4,958	248	6,972	51,219
Randolph, NC	STATE	00000049	14.940	4,600	644	6,926	10,763
Klamath, OR	STATE	00000140	5.700	1,300	299	6,867	13,521
Breckinridge, KY	U.S.	00000060	2.009	3,048	457	6,857	22,684
Trinity, CA	STATE	00000299	67.156	3,200	672	6,751	16,284
Gila, AZ	STATE	00000087	115.250	10,746	1,075	6,735	26,848
Malheur, OR	U.S.	00000020	243.000	1,500	525	6,718	13,228
Teton, MT	INTERSTATE	00015	309.663	4,120	824	6,716	14,474

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Rosebud, MT	U.S.	00212	39.090	1,722	293	6,617	15,807
Morgan, AL	STATE	00067	8.180	3,402	476	6,606	23,420
Letcher, KY	U.S.	00000119	10.309	2,045	225	6,452	21,343
Lapeer, MI	STATE	00000024	1.222	14,337	430	6,440	36,112
Jackson, NC	STATE	00000107	8.300	5,100	510	6,405	44,584
Rosebud, MT	U.S.	00212	42.119	1,635	409	6,389	15,264
Ventura, CA	STATE	00000023	3.783	7,200	1,152	6,355	47,848
Mendocino, CA	U.S.	00000101	21.666	5,500	605	6,348	13,807
Franklin, IN	U.S.	00000052	136.320	2,640	264	6,303	31,147
Erath, TX	U.S.	_US0281_	135.790	4,168	500	6,271	57,492
Hamilton, TX	U.S.	_US0281_	149.453	3,455	484	6,253	57,329
Antrim, MI	U.S.	00000131	3.759	5,346	481	6,233	28,187
Van Buren, MI	STATE	00000051	0.000	6,089	365	6,230	94,718
Deschutes, OR	U.S.	00000020	2.020	2,600	572	6,110	12,030
Douglas, CO	STATE	0000083A	42.341	6,900	483	6,066	40,383
Tillamook, OR	U.S.	00000101	39.990	4,600	322	6,061	11,934
Van Buren, AR	U.S.	00000065	0.330	5,300	1,007	6,044	60,539
Le Flore, OK	U.S.	00000259	15.680	1,100	374	6,004	24,708
Greene, VA	U.S.	US00033	53.860	4,823	386	5,972	8,618
Blaine, ID	STATE	000SH075	102.124	3,428	480	5,915	14,805
Alger, MI	STATE	00000028	8.177	3,398	170	5,908	10,575
Douglas, NV	U.S.	00050	10.809	10,900	1,199	5,839	11,252
Person, NC	U.S.	00000158	0.000	2,500	350	5,811	9,030
Mendocino, CA	U.S.	00000101	21.666	6,000	960	5,762	12,533
Cache, UT	U.S.	00000089	482.424	2,770	499	5,733	18,605
San Luis Obispo, CA	STATE	00000166	15.400	3,000	720	5,699	32,529
Lake, CA	STATE	00000029	25.300	10,600	636	5,694	16,894
Bourbon, KY	U.S.	0000027	8.731	5,300	848	5,619	10,716
Fresno, CA	STATE	00000168	44.083	10,200	714	5,549	30,137
Spencer, IN	U.S.	00000231	24.380	4,910	982	5,534	15,159
Van Buren, TN	STATE	00000111	13.960	4,650	698	5,505	24,172
Lake, MT	U.S.	00093	72.067	6,610	727	5,467	13,028
Spencer, IN	U.S.	00000231	29.960	6,440	1,159	5,458	14,518
Meade, KY	U.S.	00000060	0.000	5,322	479	5,457	10,406
Adair, OK	U.S.	00000059	12.500	1,900	475	5,410	22,261
Nelson, KY	U.S.	0000031E	20.536	5,698	570	5,366	47,977
Grant, OR	U.S.	00000026	181.970	950	276	5,349	10,531
Rutland, VT	U.S.	00004	27.241	9,900	792	5,336	5,363
Leslie, KY	STATE	00000118	0.000	4,550	455	5,320	26,213
Belknap, NH	U.S.	00000003	14.970	13,000	1,170	5,281	10,900
Cedar, NE	U.S.	081	188.700	2,785	501	5,269	15,633
Columbia, WA	U.S.	00000012	369.770	2,146	537	5,246	11,237
San Juan, UT	STATE	00000095	110.190	530	297	5,236	25,374
Juab, UT	U.S.	00000006	122.370	545	267	5,210	25,247
Nicholas, KY	U.S.	00000068	0.000	6,419	706	5,204	9,923
Lewis and Clark, MT	U.S.	00012	34.396	3,765	527	5,175	12,364
Grafton, NH	STATE	00000010	8.067	4,400	440	5,138	10,985
Clay, NC	STATE	00000069	0.000	8,900	890	5,090	35,434
Baraga, MI	U.S.	00000041	37.800	3,256	423	5,083	9,099
Lane, OR	STATE	00000126	1.440	5,100	561	5,072	29,970
San Mateo, CA	STATE	00000001	18.189	6,600	396	5,047	37,999
Mono, CA	U.S.	00000395	26.149	4,175	543	5,018	12,104
Lewis and Clark, MT	STATE	00200	110.346	1,190	214	5,002	11,951
Madera, CA	STATE	00000041	1.810	16,400	984	4,972	19,497
Hillsdale, MI	STATE	00000099	0.000	1,850	241	4,957	30,348
Curry, OR	U.S.	00000101	331.070	3,900	585	4,937	9,720
Clay, NC	U.S.	00000064	22.050	2,700	270	4,928	20,265
Lassen, CA	STATE	00000036	23.604	4,450	1,024	4,926	11,883
Iron, MI	U.S.	00000002	9.486	3,240	324	4,831	8,648
Gasconade, MO	STATE	19	93.516	2,336	327	4,821	83,246
Tazewell, VA	U.S.	US00019	67.900	12,021	841	4,814	39,322
San Juan, UT	STATE	00000095	93.390	530	297	4,811	23,313
Butte, CA	STATE	00000032	18.021	3,125	219	4,807	27,441
Washington, KS	U.S.	00000036	3.957	2,019	464	4,802	24,524
Musselshell, MT	U.S.	00087	29.654	2,775	361	4,793	11,451

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Washington, NY	STATE	00000149	3.830	8,701	1,044	4,773	39,794
Jefferson, MT	INTERSTATE	00015	166.476	4,010	561	4,769	10,277
Sequatchie, TN	STATE	00000008	28.680	5,080	762	4,756	33,769
Wheatland, MT	U.S.	00191	0.000	1,794	395	4,753	11,356
Harney, OR	U.S.	00000020	175.060	1,200	420	4,751	9,356
Iron, UT	STATE	00000014	0.100	860	189	4,715	22,851
Alexander, NC	STATE	00000016	7.780	7,600	760	4,693	32,668
Meade, KY	U.S.	0000060	11.523	8,310	748	4,649	8,866
Warren, IN	STATE	00000028	6.640	3,790	455	4,579	22,628
Greene, VA	U.S.	US00033	48.370	4,823	386	4,540	6,551
San Saba, TX	U.S.	_US0190_	219.343	1,650	347	4,519	11,253
Lampasas, TX	U.S.	_US0281_	197.508	3,589	467	4,516	11,244
Rensselaer, NY	U.S.	00000200	6.860	5,670	680	4,509	37,591
Owen, IN	U.S.	00000231	109.510	5,430	706	4,476	11,907
Mills, TX	U.S.	_US0084_	345.758	1,815	309	4,438	38,015
Park, CO	U.S.	0000285D	172.397	3,400	408	4,435	20,568
Daggett, UT	STATE	00000044	21.930	1,655	530	4,425	21,445
Orleans, VT	STATE	00105	0.000	580	128	4,392	9,179
Alpine, CA	STATE	00000088	0.600	3,550	178	4,383	10,571
Summit, CO	STATE	0000009D	118.213	2,700	297	4,379	49,853
Barren, KY	U.S.	0000031E	12.457	4,955	496	4,365	21,507
Mono, CA	U.S.	00000395	42.350	4,175	543	4,358	10,510
Hillsborough, NH	STATE	00000009	33.925	5,120	461	4,347	6,108
Del Norte, CA	U.S.	00000199	37.602	3,100	372	4,322	10,425
Daggett, UT	STATE	00000044	22.006	935	262	4,258	20,634
Humboldt, CA	U.S.	00000101	59.390	4,500	630	4,245	10,239
Washington, KY	U.S.	0000150	10.471	2,405	385	4,194	12,004
Gunnison, CO	U.S.	0000050A	122.000	2,821	367	4,160	19,294
Simpson, MS	STATE	00000013	0.000	3,452	690	4,132	62,648
Hamilton, TX	STATE	_SH0036_	105.044	2,400	624	4,131	35,382
El Dorado, CA	U.S.	00000050	15.148	13,200	528	4,124	12,236
Carroll, VA	U.S.	US00058	214.460	3,013	211	4,100	30,117
Grafton, NH	INTERSTATE	00000093	126.240	6,523	587	4,096	4,096
Berrien, MI	U.S.	00000012	0.791	9,761	781	4,096	62,276
Houghton, MI	U.S.	00000041	0.000	3,927	432	4,092	7,325
Idaho, ID	U.S.	000US095	240.334	2,000	340	4,068	7,843
Harrison, OH	U.S.	US000022	15.810	1,673	251	4,051	11,139
Coos, NH	U.S.	00000002	7.013	6,315	568	4,038	5,674
Lewis and Clark, MT	STATE	00200	83.155	1,394	195	4,013	9,588
Benewah, ID	U.S.	000US095	372.500	2,771	360	3,982	7,677
Chaffee, CO	U.S.	0000024A	221.000	2,400	240	3,963	18,382
Jefferson, IN	STATE	00000056	126.320	3,110	187	3,952	10,824
La Crosse, WI	U.S.	014E	0.890	5,674	681	3,941	38,043
Bedford, VA	STATE	SR00122	38.100	3,171	190	3,936	28,917
Riverside, CA	STATE	00000074	47.200	3,600	252	3,915	22,348
Riverside, CA	STATE	00000074	70.641	6,000	420	3,887	29,263
Addison, VT	STATE	0022A	0.000	3,200	704	3,884	9,816
Klamath, OR	STATE	00000058	75.300	3,000	900	3,881	7,642
Washington, ID	U.S.	000US095	92.263	2,600	468	3,875	7,471
San Diego, CA	STATE	00000094	0.000	6,550	524	3,844	8,361
Mono, CA	U.S.	00000395	42.350	4,175	543	3,839	9,261
San Juan, NM	U.S.	00000064	7.835	4,672	327	3,825	24,570
Le Flore, OK	U.S.	00000259	3.950	970	330	3,820	15,719
Page, VA	U.S.	US00211	5.360	5,653	678	3,815	12,446
Franklin, IN	STATE	00000101	18.670	4,150	374	3,794	18,751
Ventura, CA	STATE	00000023	3.042	7,200	1,152	3,786	28,506
Transylvania, NC	U.S.	00000064	18.780	4,800	480	3,760	15,461
Scott, IN	STATE	00000056	112.270	7,430	892	3,759	40,135
El Dorado, CA	U.S.	00000050	15.148	13,200	528	3,747	11,116
Wheeler, OR	U.S.	00000026	62.550	800	152	3,732	7,349
Hamilton, TX	STATE	_SH0022_	0.330	1,631	212	3,728	31,929
Fresno, CA	STATE	00000198	28.426	2,950	531	3,716	21,211
Fresno, CA	STATE	00000180	51.847	2,850	399	3,694	8,909
Edmonson, KY	STATE	00000259	8.876	3,458	207	3,689	18,178
Clinton, KY	U.S.	0000127	11.017	1,834	202	3,688	12,201

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Jefferson, MT	INTERSTATE	00015	169.963	2,650	477	3,665	7,897
Klamath, OR	STATE	00000140	64.690	2,500	575	3,651	7,190
Harlan, KY	U.S.	00000119	0.000	6,664	333	3,637	6,935
Sierra, CA	STATE	00000049	16.446	1,100	363	3,632	20,600
Lane, OR	U.S.	00000101	167.610	2,600	208	3,630	7,147
Windham, VT	STATE	00009	14.491	5,700	570	3,616	3,634
Jewell, KS	STATE	00000014	7.072	629	170	3,611	56,975
Bledsoe, TN	U.S.	00000127	27.270	2,250	518	3,600	15,809
Grant, WI	STATE	011E	5.020	3,982	478	3,591	25,419
Mono, CA	U.S.	00000395	114.621	3,550	178	3,585	8,648
Lyon, MN	U.S.	00000059	58.660	3,200	288	3,577	13,495
Flathead, MT	U.S.	00002	106.876	3,156	379	3,559	8,502
Pickett, TN	STATE	00000111	8.600	4,640	464	3,555	15,609
Summit, CO	U.S.	0000006F	221.000	1,300	260	3,554	33,423
El Dorado, CA	U.S.	00000050	15.148	9,000	360	3,528	7,674
Williams, ND	U.S.	00000002	45.389	1,875	263	3,527	7,192
Union, OR	STATE	00000082	1.940	1,400	280	3,521	6,933
Magoffin, KY	STATE	00000114	0.000	5,618	562	3,519	6,711
Cascade, MT	STATE	00200	116.882	1,220	232	3,516	8,400
Fauquier, VA	U.S.	US00211	51.930	17,931	538	3,511	21,900
Halifax, VA	STATE	SR00040	80.870	1,111	133	3,507	39,702
Harlan, KY	U.S.	0000421	0.000	3,244	162	3,503	17,258
Lewis, ID	U.S.	000US095	279.601	3,216	482	3,497	6,743
Calaveras, CA	STATE	00000004	40.388	4,100	246	3,490	19,921
Nevada, CA	STATE	00000020	0.000	8,400	420	3,483	7,577
De Kalb, AL	STATE	00117	13.330	2,653	318	3,466	51,904
Gem, ID	STATE	000SH016	8.359	8,198	410	3,438	6,450
Linn, OR	U.S.	00000020	19.380	1,100	77	3,432	6,758
McCormick, SC	STATE	00000028	0.180	3,719	260	3,424	27,038
Coos, NH	U.S.	00000002	16.477	5,382	484	3,418	4,803
Riverside, CA	STATE	00000074	92.231	6,000	420	3,408	3,408
Millard, UT	U.S.	00000006	90.000	440	224	3,395	11,017
Dakota, NE	U.S.	020	413.290	2,640	502	3,369	9,996
Sullivan, NH	STATE	0000012A	12.157	3,366	337	3,340	7,140
Pend Oreille, WA	STATE	00000020	403.530	2,096	482	3,332	11,613
Hardin, IL	STATE	00000034	2.140	1,887	264	3,327	128,618
Fresno, CA	STATE	00000180	56.207	2,850	285	3,326	8,023
Le Flore, OK	U.S.	00000259	20.690	1,200	408	3,314	13,639
Holmes, OH	STATE	00000000	0.000	2,605	313	3,299	37,846
Fresno, CA	(NOT SIGNED)	00000000	11.560	34,510	345	3,279	14,423
Prince Edward, VA	STATE	SR00307	0.000	5,187	571	3,263	10,645
Grant, OR	U.S.	00000395	10.050	600	174	3,251	6,401
Jackson, KY	U.S.	00000421	3.799	3,620	290	3,246	15,993
Kootenai, ID	U.S.	000US095	405.739	7,100	426	3,242	6,082
Wasco, OR	U.S.	00000097	73.270	2,300	207	3,232	6,364
Jackson, MI	STATE	00000099	0.468	2,067	207	3,185	19,500
Morgan, AL	STATE	00036	40.209	5,343	534	3,169	27,045
Bonner, ID	U.S.	000US002	21.831	4,670	607	3,153	6,079
Childress, TX	STATE	_SH0256_	58.647	626	288	3,147	26,952
Wise, VA	U.S.	US00023	29.520	7,950	398	3,140	10,242
Wasco, OR	U.S.	00000197	46.080	1,000	90	3,135	9,725
Montgomery, KY	U.S.	0000460	0.000	1,901	285	3,128	8,952
Lincoln, MT	U.S.	00002	2.637	1,788	304	3,125	7,466
Brown, IN	STATE	00000046	64.030	7,420	445	3,123	8,308
Mono, CA	U.S.	00000395	93.636	3,550	178	3,120	7,525
El Dorado, CA	STATE	00000049	13.973	2,050	205	3,119	17,692
Newton, TX	STATE	_SH0063_	53.868	1,288	193	3,077	7,661
Pulaski, KY	U.S.	00000027	0.000	6,262	188	3,044	5,806
Jefferson, WA	U.S.	00000101	285.790	854	290	3,041	6,514
Linn, OR	STATE	00000126	0.190	1,700	289	3,027	5,960
Page, VA	U.S.	US00211	19.910	2,568	180	3,016	4,352
Morgan, KY	U.S.	00000460	0.000	2,160	194	3,005	8,601
Ontonagon, MI	U.S.	00000045	14.232	1,694	186	2,982	5,338
Watauga, NC	U.S.	00000321	22.150	3,300	462	2,968	4,612
Whitman, WA	STATE	00000127	11.230	870	383	2,966	6,353

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Pierce, WA	STATE	00000410	6.760	1,447	174	2,950	10,282
Alger, MI	STATE	00000028	2.970	3,837	192	2,944	5,270
Wheatland, MT	U.S.	00191	12.902	1,895	360	2,939	7,022
Rutland, VT	U.S.	00004	29.356	5,600	504	2,936	2,950
Elmore, ID	U.S.	000US020	112.980	1,664	216	2,912	5,614
Kent, TX	U.S.	_US0380_	144.866	514	134	2,907	24,899
Bennington, VT	U.S.	00007	13.373	6,300	630	2,897	2,911
McKenzie, ND	U.S.	00000085	176.720	2,557	563	2,894	5,900
Escambia, AL	STATE	00031	50.196	3,640	437	2,855	42,746
Shasta, CA	STATE	00000044	10.770	4,700	282	2,839	6,847
Pendleton, KY	U.S.	00000027	0.000	3,004	270	2,832	9,368
Yuma, CO	U.S.	0000385C	210.205	1,100	209	2,826	13,106
Graham, NC	STATE	00000028	0.000	2,600	260	2,824	4,389
Monterey, CA	STATE	00000001	78.182	3,300	66	2,823	16,114
Richmond, NC	U.S.	00000001	11.180	3,800	532	2,797	4,347
Guernsey, OH	U.S.	US000022	23.320	1,496	209	2,787	7,663
Salt Lake, UT	STATE	00000190	1.000	2,975	446	2,783	26,826
Humboldt, CA	STATE	00000036	25.765	1,050	263	2,778	15,756
Boyd, KY	U.S.	0000060	8.520	21,981	659	2,776	3,084
San Juan, UT	STATE	00000095	76.610	275	154	2,757	13,359
San Juan, CO	U.S.	0000550B	51.203	2,000	160	2,752	12,765
Yuma, CO	U.S.	0000385D	243.000	1,200	300	2,747	12,739
Idaho, ID	STATE	000SH013	1.120	1,180	212	2,740	7,261
Benton, OR	STATE	00000223	25.480	1,200	216	2,718	8,432
Douglas, OR	U.S.	00000101	204.330	4,900	539	2,717	5,350
Humboldt, CA	STATE	00000299	28.230	3,700	407	2,711	6,540
Holmes, OH	STATE	00000000	6.760	3,093	309	2,672	30,649
San Juan, UT	STATE	00000276	51.340	295	77	2,661	12,896
Rappahannock, VA	U.S.	US00211	23.960	2,390	167	2,654	3,829
Humboldt, CA	U.S.	00000101	80.173	4,500	630	2,638	6,362
Humboldt, CA	STATE	00000299	1.210	3,700	407	2,630	6,344
Coos, NH	U.S.	00000002	16.475	3,200	288	2,625	3,549
Grayson, VA	STATE	SR00089	0.000	4,552	319	2,595	19,065
Jackson, NC	STATE	00000107	0.000	1,700	170	2,571	9,254
Henderson, NC	U.S.	00000074	0.000	1,400	140	2,537	9,131
Marion, OR	STATE	00000022	5.690	3,700	370	2,529	4,980
Cass, MI	STATE	00000040	6.813	1,737	174	2,529	15,483
Patrick, VA	STATE	SR00008	16.660	2,189	197	2,516	28,486
Grant, OR	U.S.	00000395	110.580	380	122	2,497	4,916
La Plata, CO	U.S.	0000550B	44.004	4,100	369	2,485	11,528
Fresno, CA	STATE	00000168	61.135	1,250	88	2,477	14,048
Boone, WV	STATE	00000099	0.000	2,192	307	2,471	26,412
Henderson, NC	U.S.	00000064	10.610	2,900	290	2,455	10,097
Chelan, WA	U.S.	00000002	64.640	3,781	416	2,454	5,257
Apache, AZ	U.S.	00000180	273.609	1,453	203	2,434	8,631
Hood River, OR	STATE	00000035	98.620	1,200	120	2,425	4,774
Oakland, MI	STATE	00000015	0.784	18,588	372	2,424	14,675
Fresno, CA	STATE	00000198	21.536	1,150	196	2,387	13,536
Essex, VT	U.S.	00002	10.765	2,300	552	2,381	2,384
Rensselaer, NY	STATE	00000002	11.250	5,357	429	2,380	58,474
Union, OR	STATE	00000082	0.890	2,000	400	2,374	4,675
Colusa, CA	STATE	00000020	13.930	5,600	560	2,372	5,159
Colusa, CA	STATE	00000020	1.451	5,600	560	2,365	5,143
Greene, TN	STATE	00000070	1.520	2,460	344	2,360	41,542
Berkshire, MA	STATE	00000008	23.280	2,265	340	2,353	13,214
Essex, VT	U.S.	00002	14.708	3,000	420	2,333	2,335
Shasta, CA	STATE	00000044	45.535	1,100	132	2,326	5,610
Lane, OR	U.S.	00000101	167.610	2,300	184	2,319	4,566
Lake, OR	STATE	00000031	69.060	570	114	2,315	7,180
Harrison, KY	U.S.	00000027	0.000	2,956	266	2,311	7,644
Hood River, OR	STATE	00000035	70.660	1,800	180	2,300	4,529
Gallatin, MT	U.S.	00191	8.531	1,790	394	2,297	5,488
Tehama, CA	STATE	00000036	42.657	1,100	165	2,297	13,027
Cheshire, NH	STATE	00000119	0.030	2,846	285	2,279	4,873
Wayne, OH	STATE	00000000	4.840	2,560	282	2,277	26,116

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Washakie, WY	U.S.	0000US16	36.000	790	87	2,275	7,576
Sublette, WY	U.S.	000US191	77.000	1,820	218	2,263	7,536
Mendocino, CA	STATE	00000001	15.149	2,900	464	2,260	12,898
Iron, MI	STATE	00000069	1.440	1,729	225	2,237	13,698
Bennington, VT	STATE	00009	5.901	3,600	468	2,237	2,239
Leslie, KY	U.S.	0000421	10.725	4,122	330	2,233	11,001
Riverside, CA	STATE	00000243	10.000	2,050	82	2,228	12,638
Siskiyou, CA	STATE	00000003	0.000	190	57	2,221	12,597
Douglas, OR	STATE	00000230	10.320	560	112	2,219	6,882
Appomattox, VA	U.S.	US00060	106.770	992	198	2,216	25,087
Kent, TX	U.S.	_US0380_	139.189	665	180	2,194	18,791
Grant, OR	U.S.	00000395	81.030	390	125	2,188	4,309
Owyhee, ID	U.S.	000US095	0.000	1,600	288	2,167	4,178
San Bernardino, CA	STATE	00000247	68.557	2,200	330	2,135	12,108
Tuolumne, CA	STATE	00000120	12.007	5,300	318	2,129	4,630
Greenville, SC	STATE	00000011	5.490	3,312	232	2,081	16,432
White Pine, NV	U.S.	00000050	397.405	800	168	2,073	6,995
Logan, KS	STATE	00000025	0.000	216	102	2,071	32,671
Greenbrier, WV	U.S.	00000219	27.330	1,450	189	2,066	14,236
Mason, WA	U.S.	00000101	336.030	2,133	448	2,062	4,416
Trigg, KY	U.S.	00000068	0.000	2,580	361	2,058	6,809
Gunnison, CO	U.S.	0000050A	130.022	2,800	448	2,056	9,535
Harney, OR	U.S.	00000020	177.530	1,200	420	2,055	4,046
Buncombe, NC	U.S.	00000074	20.150	5,100	510	2,053	14,289
Douglas, OR	STATE	00000138	2.500	1,700	136	2,038	6,323
Bourbon, KY	U.S.	0000460	10.143	1,811	163	2,034	5,821
Kern, CA	STATE	00000178	92.863	2,250	248	2,033	11,532
Franklin, ID	STATE	000SH034	8.560	2,096	189	2,031	5,383
Caledonia, VT	U.S.	00302	0.950	2,100	189	2,029	4,241
Oconee, SC	STATE	00000011	23.690	4,440	311	2,020	15,954
Bennington, VT	STATE	00009	6.135	3,600	468	2,018	2,020
Kane, UT	STATE	00000014	30.200	850	187	2,016	9,771
Kalamazoo, MI	STATE	00000089	1.694	5,087	203	2,013	30,609
Hardy, WV	STATE	55	42.240	2,150	280	2,005	13,813
Grayson, KY	STATE	0000259	15.553	2,713	271	1,990	9,803
Jackson, NC	U.S.	00000064	9.070	4,000	400	1,979	8,136
Mono, CA	U.S.	00000395	86.287	3,150	315	1,975	4,763
Jefferson, OH	STATE	SR000043	1.470	17,035	681	1,962	2,005
Mercer, KY	U.S.	0000068	17.800	2,860	286	1,959	9,653
Johnson, TN	U.S.	00000421	3.760	2,640	132	1,958	62,034
Morgan, TN	STATE	00000062	4.020	770	254	1,944	34,214
Blaine, ID	U.S.	000US020	171.079	1,600	256	1,934	3,728
Plumas, CA	STATE	00000070	7.096	1,375	481	1,927	10,929
Cass, NE	STATE	066	115.440	2,520	151	1,923	11,952
Haskell, TX	STATE	_SH0006_	97.397	1,009	121	1,922	16,461
Okanogan, WA	STATE	00000020	287.800	1,554	109	1,902	6,630
Latah, ID	STATE	000SH003	39.495	552	199	1,902	5,040
Benewah, ID	STATE	000SH003	79.000	1,800	342	1,880	4,981
Hillsdale, MI	STATE	00000049	10.606	2,699	135	1,878	37,933
Mountrail, ND	STATE	00000023	59.907	2,893	203	1,878	3,829
Napa, CA	STATE	00000128	23.879	1,750	158	1,876	10,643
Windham, VT	STATE	00030	25.768	2,600	182	1,872	4,732
Flathead, MT	U.S.	00002	184.254	1,870	112	1,852	4,425
Chaffee, CO	U.S.	0000285B	122.752	2,000	260	1,850	8,581
Tuolumne, CA	STATE	00000120	12.007	5,300	318	1,845	4,014
San Luis Obispo, CA	STATE	00000046	21.823	3,700	185	1,822	10,399
Douglas, WA	STATE	00000174	0.140	635	140	1,811	6,312
Ada, ID	STATE	000SH055	11.233	5,000	350	1,811	3,398
Chouteau, MT	U.S.	00087	52.308	1,405	155	1,811	4,327
Grafton, NH	STATE	00000010	12.973	3,339	334	1,810	3,869
Grant, OR	U.S.	00000395	66.610	370	118	1,805	3,555
Washington, UT	(NOT SIGNED)	00000000	2.820	1,305	91	1,785	5,793
Yuba, CA	STATE	00000049	3.578	1,000	270	1,760	9,981
Butte, CA	STATE	00000032	26.676	1,750	123	1,759	9,978
Franklin, VA	STATE	SR00122	0.310	5,214	365	1,758	17,471

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Malheur, OR	U.S.	00000026	231.230	390	168	1,736	3,419
McCone, MT	STATE	00013	0.015	649	123	1,732	10,320
Russell, KY	U.S.	0000127	0.000	1,571	94	1,732	5,729
Madison, VA	STATE	SR00230	3.410	3,486	174	1,701	12,493
Stokes, NC	STATE	00000008	20.310	2,200	220	1,694	6,098
Scott, VA	STATE	SR00071	13.560	3,351	168	1,650	12,118
Floyd, VA	U.S.	US00221	67.540	2,660	106	1,649	12,116
Fergus, MT	U.S.	00087	73.116	1,330	120	1,649	3,939
Shasta, CA	STATE	00000044	51.707	1,225	135	1,621	3,910
Fergus, MT	U.S.	00087	81.037	1,125	146	1,615	3,858
St. Clair, MO	U.S.	54	45.907	1,818	382	1,614	8,838
Alpine, CA	STATE	00000089	0.000	330	26	1,614	9,152
Transylvania, NC	U.S.	00000178	0.000	1,200	120	1,606	5,781
Alpine, CA	STATE	00000089	16.346	3,500	175	1,594	3,846
Elmore, ID	U.S.	000US020	106.000	1,700	204	1,579	3,045
Riverside, CA	STATE	00000243	20.413	2,050	82	1,558	8,837
McCreary, KY	STATE	0000090	0.000	1,358	41	1,544	4,419
Hocking, OH	STATE	00000000	0.360	2,424	194	1,542	7,451
Yuba, CA	(NOT SIGNED)	00000000	22.889	412	62	1,541	8,739
Lincoln, MN	STATE	00000019	0.000	1,123	168	1,535	21,242
Calaveras, CA	STATE	00000004	8.143	4,850	243	1,534	8,758
Garfield, MT	STATE	00200	219.122	360	86	1,519	3,628
Lake, OR	STATE	00000031	18.280	910	182	1,518	4,710
Marshall, KY	STATE	0000402	0.000	1,573	157	1,515	4,336
Greenville, SC	STATE	00000011	10.240	2,110	148	1,511	12,379
McKenzie, ND	STATE	00000023	1.850	949	142	1,497	3,052
Adair, KY	STATE	0000061	14.516	2,520	227	1,497	7,373
Malheur, OR	U.S.	00000026	276.510	390	168	1,485	2,924
Douglas, WA	U.S.	00000002	120.010	1,960	372	1,482	3,174
Shoshone, ID	STATE	000SH003	48.236	576	138	1,469	3,894
Lincoln, WY	U.S.	000US189	27.000	1,250	213	1,469	11,334
Schenectady, NY	U.S.	00000200	4.450	5,546	333	1,468	12,238
Orange, VA	U.S.	US00033	66.920	5,050	354	1,455	14,460
Linn, OR	U.S.	00000020	14.170	1,100	77	1,450	2,855
Pierce, WA	STATE	00000007	47.400	2,134	256	1,444	5,033
Clark, AR	STATE	00000051	24.800	2,170	174	1,440	25,742
Inyo, CA	STATE	00000178	14.920	875	79	1,433	8,129
Mineral, CO	U.S.	0000160A	175.000	2,500	275	1,428	6,621
Baker, OR	U.S.	00000026	203.820	320	138	1,426	2,808
Morton, ND	STATE	00000025	0.000	1,564	78	1,419	4,563
Lake, OR	STATE	00000140	71.660	610	140	1,417	2,790
Inyo, CA	STATE	00000190	37.540	700	42	1,415	8,028
Grayson, VA	STATE	SR00016	8.050	1,402	196	1,411	15,978
Hutchinson, TX	STATE	_SH0152_	46.118	2,400	216	1,411	12,084
Litchfield, CT	U.S.	00000044	28.550	4,900	343	1,409	1,881
Garfield, UT	STATE	00000276	9.809	505	131	1,401	6,788
Sierra, CA	STATE	00000049	36.201	330	109	1,395	7,910
Montgomery, VA	STATE	SR00114	3.660	9,803	196	1,392	13,834
Dawes, NE	STATE	071	128.650	860	112	1,384	13,149
Mecklenburg, VA	STATE	SR00092	11.540	3,950	277	1,374	10,096
Fresno, CA	STATE	00000198	12.330	1,200	204	1,374	7,792
Green, KY	STATE	0000061	0.000	1,481	148	1,373	3,930
Fillmore, MN	STATE	00000043	22.465	3,682	331	1,373	18,620
Wasco, OR	U.S.	00000197	16.020	1,300	117	1,373	4,259
Kershaw, SC	STATE	00000097	10.110	2,400	168	1,373	11,246
Blount, AL	U.S.	00231	26.650	3,866	271	1,354	4,801
Clackamas, OR	STATE	00000211	26.410	2,400	240	1,351	4,190
Shenandoah, VA	STATE	SR00055	5.530	4,356	305	1,338	1,931
Adams, OH	STATE	SR000032	19.990	4,290	257	1,337	3,676
Yell, AR	STATE	00000007	0.000	760	68	1,334	7,968
Coos, NH	U.S.	00000003	16.677	2,800	280	1,333	2,849
Mountrail, ND	STATE	00001804	269.234	410	123	1,320	4,243
Glacier, MT	U.S.	00089	103.398	1,105	99	1,318	7,857
Boise, ID	STATE	000SH021	97.540	430	52	1,315	3,484
Franklin, KY	U.S.	0000421	5.220	2,720	109	1,311	6,460

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Wexford, MI	STATE	00000037	4.073	2,230	201	1,311	8,026
Blaine, ID	U.S.	000US020	186.310	1,400	182	1,299	2,504
Lincoln, MT	U.S.	00002	67.701	1,197	180	1,288	3,076
Ballard, KY	STATE	0000121	0.238	1,581	395	1,265	3,620
Delaware, NY	STATE	00000080	0.590	1,604	241	1,255	7,807
Roosevelt, MT	U.S.	00002	644.619	1,130	102	1,246	2,976
Jackson, KS	STATE	00000016	5.208	3,363	202	1,239	22,037
Washington, VT	STATE	00100	22.069	3,800	190	1,233	3,117
Stevens, WA	STATE	00000025	114.160	473	175	1,227	4,278
Skagit, WA	STATE	00000020	47.450	637	89	1,218	4,246
Benton, OR	STATE	00000034	50.560	1,700	153	1,208	3,748
Preston, WV	U.S.	219	0.800	1,600	208	1,199	8,257
Alpine, CA	STATE	00000089	21.214	2,700	162	1,174	6,703
Kootenai, ID	STATE	000SH003	101.000	1,445	231	1,146	3,038
Petroleum, MT	STATE	00200	148.699	473	61	1,141	2,725
Morgan, OH	STATE	00000000	19.380	1,258	126	1,130	5,460
Lake, MT	U.S.	00093	64.490	4,133	165	1,130	2,699
Glacier, MT	U.S.	00002	197.816	1,573	94	1,123	2,682
Wallowa, OR	STATE	00000003	6.270	290	58	1,112	3,448
Carter, TN	U.S.	00000321	3.580	1,910	96	1,102	4,840
Ouray, CO	U.S.	0000550B	88.000	2,300	276	1,102	5,111
Grafton, NH	STATE	00000010	33.549	2,862	286	1,094	2,339
Wasco, OR	U.S.	00000197	30.140	1,300	117	1,087	3,373
Ferry, WA	U.S.	00000395	246.380	533	144	1,087	2,328
Orange, VT	U.S.	00302	7.244	3,300	231	1,083	2,736
McDowell, WV	STATE	00000016	4.050	1,567	172	1,083	11,574
Harney, OR	STATE	00000205	6.110	380	125	1,069	3,315
Berkshire, MA	STATE	0000008A	2.730	4,200	210	1,052	1,221
Wilkes, NC	U.S.	00000021	5.110	2,600	260	1,051	4,320
Carroll, NH	U.S.	00000302	40.314	2,093	188	1,040	1,406
Inyo, CA	STATE	00000190	59.543	700	28	1,039	5,891
Pierce, WA	STATE	00000123	7.520	655	66	1,025	3,572
Ferry, WA	STATE	00000020	296.790	814	204	1,014	3,534
Owyhee, ID	STATE	000SH051	71.456	1,079	76	1,008	2,671
Garfield, MT	STATE	00200	161.577	435	74	988	2,360
Garfield, MT	STATE	00000200	226.736	362	87	977	2,334
Cumberland, KY	STATE	00000061	0.284	1,310	131	975	2,790
McKenzie, ND	STATE	00000022	133.179	640	58	968	3,111
Brown, IN	STATE	00000135	101.160	4,490	135	966	4,773
Guernsey, OH	U.S.	US000022	23.320	3,514	246	965	2,654
Fremont, WY	U.S.	0000US26	119.000	1,180	106	962	3,204
Marin, CA	STATE	00000001	23.700	3,100	155	959	5,475
McCormick, SC	STATE	00000028	32.560	1,458	102	950	7,779
Lincoln, MT	STATE	00037	37.400	360	119	948	5,648
Russell, VA	STATE	SR00071	27.070	3,575	107	933	6,851
Orange, VT	U.S.	00302	1.919	3,800	228	932	2,356
Stevens, WA	STATE	00000025	38.160	632	133	931	3,244
Whatcom, WA	STATE	00000020	129.830	746	104	930	3,242
Trinity, CA	STATE	00000036	26.448	380	42	920	5,219
Daniels, MT	STATE	00013	51.521	435	100	910	5,424
Wallowa, OR	STATE	00000003	18.470	290	58	896	2,780
Sioux, NE	U.S.	020	25.240	590	136	891	2,644
Ingham, MI	STATE	00000036	2.373	2,223	67	887	5,430
Windham, VT	STATE	00100	24.973	1,300	130	883	1,846
Hood River, OR	STATE	00000035	69.200	1,200	84	882	1,737
Lane, OR	STATE	00000200	9.950	2,000	160	881	2,733
Fresno, CA	STATE	00000168	54.395	1,250	25	881	4,995
Blount, TN	U.S.	00000321	4.870	5,810	116	872	6,189
San Bernardino, CA	STATE	00000127	34.140	850	85	871	4,938
Menifee, KY	U.S.	00000460	0.000	3,433	103	852	4,196
Franklin, VT	STATE	00105	28.264	990	158	851	1,779
Jackson, OR	STATE	00000140	21.470	2,800	140	839	1,652
Flathead, MT	U.S.	00002	163.504	1,798	126	837	2,000
Flathead, MT	U.S.	00002	153.392	1,740	122	837	1,999
Sanders, MT	STATE	00028	20.938	1,030	113	835	4,973

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
McCone, MT	STATE	00200	0.000	415	87	826	1,974
McKenzie, ND	STATE	00000068	0.000	356	71	817	2,626
McDowell, WV	STATE	00000016	23.760	2,250	135	806	5,555
Humboldt, CA	STATE	00000096	37.725	770	69	798	4,527
Hillsdale, MI	STATE	00000049	0.446	1,523	107	789	4,833
Garfield, UT	STATE	00000095	43.070	275	110	786	3,809
Sioux, ND	STATE	00000024	9.436	1,783	71	782	2,514
San Juan, UT	STATE	00000276	86.843	295	77	781	3,784
Whitley, KY	STATE	0000090	1.600	1,196	72	766	2,193
Berkshire, MA	STATE	00000002	17.733	2,212	133	766	888
Dunn, ND	STATE	00000022	119.492	435	52	762	2,451
Teton, WY	U.S.	0000US26	14.000	1,130	79	759	2,528
Wheeler, OR	STATE	00000019	62.580	330	69	759	2,355
Carroll, OH	STATE	00000000	2.510	2,077	83	757	3,655
Park, MT	U.S.	00212	0.000	782	31	755	4,502
Stone, AR	STATE	00000014	4.170	2,400	168	755	13,495
Berkshire, MA	STATE	00000002	10.500	1,400	154	751	871
Owyhee, ID	STATE	000SH051	69.918	380	46	748	1,982
Madison, NC	U.S.	00000025	18.040	2,200	220	746	2,684
Cascade, MT	U.S.	00089	8.435	350	32	744	4,431
Jefferson, CO	(NOT SIGNED)	00000000	0.000	1,663	67	743	6,990
Garfield, MT	STATE	00200	206.821	440	75	742	1,773
Chariton, MO	STATE	5	87.932	726	138	740	12,772
Elliott, KY	STATE	00000007	7.173	3,361	302	730	3,599
Park, CO	U.S.	0000024A	229.000	2,000	100	727	6,832
Abbeville, SC	STATE	00000184	3.680	652	46	722	5,918
San Benito, CA	STATE	00000025	0.000	810	73	715	4,055
Frederick, VA	STATE	SR00055	1.780	2,215	155	710	1,025
Barry, MO	STATE	76	67.545	412	58	700	12,091
Chouteau, MT	STATE	00080	0.523	557	56	693	4,131
Linn, OR	STATE	00000226	21.940	1,500	135	662	2,052
Carter, MT	STATE	00007	0.000	299	45	660	3,934
Reynolds, MO	STATE	106	37.606	384	84	612	10,570
Orange, VT	U.S.	00302	10.689	1,300	130	605	1,265
Madison, KY	STATE	0001295	0.000	2,489	124	604	1,728
Custer, NE	STATE	040	11.100	320	54	599	5,686
Albany, WY	STATE	00WYO230	31.000	760	167	598	4,618
Swain, NC	STATE	00000028	34.400	430	43	594	2,137
Tehama, CA	STATE	00000036	42.657	430	82	586	3,326
Franklin, KY	U.S.	0000421	11.132	1,142	46	580	1,659
Park, WY	U.S.	0000US14	0.000	1,240	62	579	1,928
Fremont, WY	U.S.	0000US26	117.117	1,130	79	574	1,912
Shasta, CA	STATE	00000036	0.000	425	34	574	3,254
Madison, MO	STATE	72	114.695	1,248	100	569	9,829
Navajo, AZ	STATE	00000264	81.674	1,903	95	561	1,988
Boundary, ID	STATE	000SH001	6.325	628	57	551	1,461
Trinity, CA	STATE	00000036	34.838	380	42	550	3,120
Gilliam, OR	STATE	00000019	23.440	160	56	540	1,676
Inyo, CA	STATE	00000190	45.550	700	28	524	2,972
Okanogan, WA	STATE	00000020	203.480	634	89	519	1,810
Carbon, MT	U.S.	00212	71.599	470	38	516	3,077
Benton, OR	STATE	00000034	33.050	860	86	501	1,554
Mono, CA	STATE	00000120	0.000	265	37	501	2,840
Ravalli, MT	U.S.	00093	0.105	925	93	488	1,165
Lassen, CA	STATE	00000139	53.950	550	55	477	2,704
Nelson, ND	STATE	00000001	136.778	281	48	471	961
Teton, MT	U.S.	00287	53.840	376	26	469	2,792
Pondera, MT	U.S.	00089	68.264	460	37	467	2,783
Jackson, OR	STATE	00000066	13.660	510	36	464	1,438
Litchfield, CT	U.S.	00000007	51.560	2,600	130	458	2,549
Meagher, MT	U.S.	00089	49.499	372	26	442	2,636
Ventura, CA	STATE	00000033	17.689	635	25	435	2,468
Trinity, CA	STATE	00000003	0.000	440	48	431	2,446
Los Angeles, CA	STATE	00000002	15.166	3,475	104	426	2,432
Polk, OR	STATE	00000194	2.410	1,100	44	421	1,307

Appendix C: Grade Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Annual Truck Delay	Annual Truck Delay Expanded
Union, OR	STATE	00000204	21.190	660	40	416	1,289
Bath, VA	U.S.	US00220	135.740	2,711	190	415	3,051
56047	U.S.	0000US20	19.000	500	55	411	3,172
Wheeler, OR	STATE	00000019	78.640	250	53	410	1,271
Gilliam, OR	STATE	00000019	15.410	270	95	409	1,268
Windsor, VT	STATE	00100	8.795	1,200	72	405	846
Cecil, MD	STATE	00000276	0.360	1,250	113	400	2,055
Boise, ID	STATE	000SH021	78.855	300	36	383	1,014
Teton, WY	U.S.	0000US26	22.000	1,130	79	369	1,229
Knox, NE	STATE	012	140.890	570	63	364	3,454
Baker, OR	STATE	00000007	21.170	530	27	351	1,088
Huron, MI	STATE	00000025	20.445	1,557	78	346	2,119
Grayson, VA	U.S.	US00021	2.710	2,020	81	346	3,916
Grant, ND	STATE	00000031	19.380	200	32	342	1,099
Napa, CA	STATE	00000121	10.560	3,025	91	337	1,924
Carbon, MT	STATE	00078	6.052	793	16	337	2,008
Douglas, MO	STATE	14	79.034	470	42	323	5,570
Fremont, WY	U.S.	000US287	31.818	530	42	306	1,018
Los Angeles, CA	STATE	00000039	9.998	530	16	292	1,655
Asotin, WA	STATE	00000129	20.150	300	75	292	1,016
Cowlitz, WA	STATE	00000503	27.600	887	62	280	977
Mariposa, CA	STATE	00000120	0.000	2,450	49	261	630
Boise, ID	STATE	000SH021	78.855	302	36	228	604
Hampshire, MA	STATE	00000143	22.530	2,116	42	225	1,263
Wabasha, MN	STATE	00000060	213.772	626	19	224	3,098
El Paso, CO	(NOT SIGNED)	00000000	0.000	1,533	46	217	2,045
Sioux, ND	STATE	00000024	29.914	260	18	205	418
Morgan, OH	STATE	00000000	23.690	634	51	202	974
El Paso, CO	(NOT SIGNED)	00000000	0.000	1,606	48	176	1,659
Fentress, TN	U.S.	00000127	28.420	1,520	15	146	643
Big Horn, WY	U.S.	0000US14	205.011	650	65	145	484
Fentress, TN	STATE	00000052	0.000	710	21	107	1,877
Fentress, TN	U.S.	00000127	25.140	1,520	15	99	436
Larimer, CO	STATE	0000007A	6.314	1,900	19	80	751
Los Angeles, CA	STATE	00000023	0.000	665	13	77	435
Morrow, OR	STATE	00000207	8.420	200	8	65	201
Los Angeles, CA	STATE	00000039	16.283	530	11	48	271
						11,048,189	26,169,334

Appendix D

Signal Bottlenecks

Appendix D: Signal Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Sacramento, CA	(NOT SIGNED)	00000000	7.950	86,500	22,496	2.4	324,395	324,395
Los Angeles, CA	(NOT SIGNED)	00000000	4.120	35,579	18,300	2.0	254,059	8,170,038
Sacramento, CA	(NOT SIGNED)	00000000	5.650	20,261	12,288	0.9	244,899	2,005,965
Fairfax, VA	STATE	SR00028	31.860	106,248	9,754	1.0	217,827	239,610
King, WA	(NOT SIGNED)	00000000	0.000	35,714	8,060	1.8	165,983	521,021
San Diego, CA	(NOT SIGNED)	00000000	0.000	53,540	9,066	1.5	161,920	347,804
Los Angeles, CA	(NOT SIGNED)	00000000	0.000	37,914	8,323	3.5	152,650	352,316
Hinds, MS	STATE	00000018	28.327	35,350	8,007	2.2	149,847	209,186
Henderson, KY	U.S.	0000041	16.041	40,219	6,033	1.2	135,662	135,662
Jefferson, LA	STATE	3154	2.040	42,400	10,197	3.7	129,065	268,454
Lafayette, LA	U.S.	90	5.860	53,200	11,534	0.7	118,743	118,743
Lafayette, LA	STATE	3073	0.000	40,900	7,665	4.3	118,340	167,095
Oakland, MI	(NOT SIGNED)	00000000	11.955	41,116	3,683	4.4	117,429	1,715,284
Orleans, LA	U.S.	90	0.830	39,200	3,528	1.6	108,285	225,233
San Bernardino, CA	(NOT SIGNED)	00000000	0.000	55,148	4,963	3.3	104,520	104,520
Lake, IN	U.S.	00000030	0.000	42,470	10,045	0.8	104,445	427,493
Lafayette, LA	STATE	3025	0.000	24,400	4,392	2.7	102,354	260,083
Lafayette, LA	U.S.	167	2.570	55,600	8,654	2.1	95,735	95,735
Lake, IN	U.S.	00000030	10.100	73,700	14,277	1.7	94,260	117,824
San Diego, CA	COUNTY	00000S12	0.520	53,110	4,249	2.5	93,964	201,834
Lafayette, LA	STATE	3184	0.000	39,500	4,557	2.5	91,231	128,818
San Bernardino, CA	(NOT SIGNED)	00000000	13.450	31,095	4,664	2.1	90,077	90,077
Bossier, LA	STATE	3	3.000	29,900	4,564	2.9	87,635	304,357
Alameda, CA	STATE	00000262	0.000	89,000	7,120	1.9	83,867	83,867
Lamar, MS	U.S.	00000098	11.034	35,862	3,680	0.8	79,983	95,419
Orleans, LA	U.S.	90	0.830	39,700	3,801	3.4	79,858	166,105
San Bernardino, CA	(NOT SIGNED)	00000000	11.260	53,542	4,819	1.5	74,276	83,857
Sacramento, CA	(NOT SIGNED)	00000000	16.030	89,281	18,749	2.4	73,446	73,446
Oneida, NY	STATE	0000005A	1.500	30,840	8,804	2.5	67,433	119,963
Jefferson, LA	U.S.	90	0.010	38,000	4,911	0.9	65,675	136,604
Maricopa, AZ	(NOT SIGNED)	90000000	55.614	43,508	19,408	1.3	64,731	598,375
Warren, KY	U.S.	0000231	10.453	26,763	1,873	2.6	63,657	72,633
Dutchess, NY	U.S.	00000090	17.810	53,557	3,038	5.2	63,367	128,128
Burlington, NJ	STATE	NJ 73	27.300	64,061	9,526	1.4	62,958	189,693
Union, NC	U.S.	00000074	10.870	55,000	5,957	3.7	61,725	132,894
Ventura, CA	STATE	00000118	10.366	75,000	8,526	0.7	60,239	60,239
Los Angeles, CA	STATE	00000001	36.052	78,000	2,901	1.6	60,126	195,108
12086	COUNTY	CR 992	0.000	64,665	6,467	1.2	59,695	324,623
St. Tammany, LA	MUNICIPAL	APPROACH	0.000	58,200	11,640	0.5	58,667	58,667
Fauquier, VA	U.S.	US00029	207.370	45,417	7,216	0.7	57,656	121,711
Webb, TX	U.S.	_US0083_	692.630	36,000	6,120	3.5	57,631	77,744
Clay, MO	STATE	9	11.061	34,046	3,745	3.7	56,434	142,100
12086	U.S.	US 1	6.646	92,500	7,400	1.1	55,534	232,576
San Bernardino, CA	(NOT SIGNED)	00000000	16.350	35,764	5,365	1.8	55,376	55,376
El Paso, TX	U.S.	_US0062_	12.486	36,000	6,840	1.0	55,203	94,177
Denton, TX	STATE	_SH0121_	59.223	50,000	3,500	1.9	54,595	73,102
Johnston, NC	U.S.	00000070	0.000	47,000	5,925	0.8	53,015	87,634
Bartow, GA	U.S.	00000041	9.460	42,280	2,836	1.2	52,449	52,449
Macomb, MI	(NOT SIGNED)	00000000	2.714	45,623	3,247	0.8	51,621	635,812
Harris, TX	STATE	_FM1093_	47.547	76,000	1,520	4.9	51,233	64,963
Lafayette, LA	U.S.	90	1.940	53,200	12,395	0.5	51,056	51,056
Tarrant, TX	STATE	_FM0157_	14.937	60,000	3,000	3.6	48,596	96,755
New Castle, DE	U.S.	0000US13	0.000	77,183	14,252	1.5	48,329	76,795
Sumner, TN	U.S.	0000031E	13.520	47,920	2,534	1.2	47,567	91,709
Harris, TX	STATE	_FM1093_	50.591	76,000	1,520	4.2	47,532	60,270
Newport News, VA	U.S.	US00017	51.130	45,616	1,368	4.0	46,896	121,414
Harris, TX	STATE	_FM1093_	45.508	61,000	2,440	3.4	46,665	260,671
Collin, TX	STATE	_SH0289_	43.530	47,000	2,820	3.4	46,180	136,231
Nassau, NY	STATE	00000240	0.990	54,424	5,399	7.4	45,419	394,735
Denton, TX	U.S.	_US0380_	367.903	24,000	3,840	4.8	44,522	56,587
Nassau, NY	STATE	00000107	15.030	49,216	3,445	3.7	44,285	384,881
Weld, CO	STATE	0000119C	63.000	34,962	10,271	1.6	44,147	70,061
Rankin, MS	U.S.	00000049	14.601	43,391	5,448	2.3	43,927	61,322
Sonoma, CA	STATE	00000037	0.000	37,500	4,690	0.5	43,899	77,745
Williamson, TX	U.S.	_US0079_	270.573	45,000	7,650	3.1	43,720	58,542

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Denton, TX	STATE	_BS0121H	5.729	41,000	2,870	3.2	43,447	50,833
San Bernardino, CA	STATE	00000018	104.662	48,000	3,139	1.1	43,421	49,023
Benton, AR	U.S.	00000071	0.170	27,200	5,233	1.9	43,224	171,902
Los Angeles, CA	(NOT SIGNED)	00000000	1.650	37,712	18,300	1.7	42,654	1,371,658
Delaware, OH	U.S.	US000023	8.390	34,155	5,978	3.3	42,251	43,645
Calcasieu, LA	U.S.	171	0.000	33,700	4,043	3.0	42,137	63,163
Ouachita, LA	U.S.	165	5.950	54,000	1,626	2.0	41,854	41,854
Boone, KY	U.S.	0000042	12.964	40,100	3,609	3.6	40,820	114,705
Los Angeles, CA	STATE	00000138	0.000	33,500	1,643	4.4	40,282	79,798
Georgetown, SC	U.S.	00000017	18.640	33,500	1,803	1.0	40,218	109,233
12086	U.S.	US 1	2.899	86,325	6,906	1.6	39,765	166,535
Delaware, OH	STATE	SR000750	6.810	47,959	2,398	3.7	39,526	81,701
Wake, NC	U.S.	00000001	12.680	53,000	8,148	5.0	39,424	136,604
Harrison, MS	U.S.	00000049	3.599	32,320	4,848	4.1	39,159	101,070
Fairfax, VA	STATE	SR00028	28.260	80,726	7,447	0.8	38,664	141,588
Fayette, KY	STATE	00000004	0.000	48,500	3,841	2.6	38,547	48,762
Pitt, NC	U.S.	00000264	19.600	33,000	1,413	3.5	38,299	59,784
Orleans, LA	STATE	428	0.620	28,500	4,452	4.1	37,619	121,809
Dallas, TX	(NOT SIGNED)	00000000	90.315	59,750	1,793	3.6	37,521	74,705
Bossier, LA	STATE	3105	1.140	27,000	1,890	4.7	37,422	129,967
Nueces, TX	STATE	_SH0357_	5.292	34,000	3,060	1.5	36,353	110,550
Dallas, TX	STATE	_SH0078_	74.406	36,000	4,320	2.9	36,272	122,092
Harrison, MS	U.S.	00000049	2.636	32,892	4,741	7.6	35,101	90,597
Albany, NY	U.S.	00000200	4.570	42,344	4,276	2.4	35,085	248,157
Lafayette, LA	STATE	3073	2.170	40,900	7,665	1.0	34,876	49,245
Davidson, TN	STATE	00000155	2.980	27,800	6,018	3.1	34,725	296,412
Hall, GA	STATE	00000060	13.330	25,920	3,888	0.7	34,444	73,365
Santa Clara, CA	(NOT SIGNED)	00000000	3.930	54,800	3,836	4.9	34,307	80,759
Wake, NC	U.S.	00000070	6.730	58,000	5,735	2.8	33,589	59,083
Vigo, IN	U.S.	00000041	110.990	43,830	3,805	2.2	33,566	39,373
Cameron, TX	STATE	_BU0083S	45.075	32,000	3,840	3.7	33,265	47,170
Middlesex, NJ	U.S.	US 1	18.000	54,845	2,742	1.1	32,546	245,984
New Hanover, NC	U.S.	00000421	10.150	29,000	2,331	2.8	32,098	107,304
Davidson, TN	STATE	00000155	2.980	31,170	13,926	1.0	32,035	273,449
Orange, FL	U.S.	US 17	0.139	66,500	4,356	2.3	31,759	223,904
Pierce, WA	TOWNSHIP	00000000	1.970	21,639	3,665	3.4	31,464	152,256
Dallas, TX	STATE	_SH0121_	71.255	74,000	3,700	1.4	31,442	32,668
Oakland, MI	(NOT SIGNED)	00000000	6.001	55,934	4,050	8.8	30,761	126,520
Orange, CA	(NOT SIGNED)	00000000	4.600	66,000	3,013	3.4	30,683	262,037
12086	(NOT SIGNED)	00000000	0.000	50,593	5,059	2.5	30,622	214,752
Baldwin, AL	U.S.	00090	18.280	22,939	2,665	0.8	30,434	112,545
Nueces, TX	STATE	_FM0043_	10.038	37,000	3,330	4.1	29,998	32,458
Lafayette, LA	U.S.	90	1.940	56,900	7,665	2.6	29,981	29,981
Jefferson, LA	U.S.	61	1.580	28,200	8,278	1.9	29,275	94,793
Jessamine, KY	U.S.	0000027	13.695	40,616	6,499	0.6	29,192	29,192
Calcasieu, LA	U.S.	171	2.010	33,700	4,043	5.2	28,595	42,864
Hunterdon, NJ	U.S.	US 202	7.190	47,663	2,383	1.1	28,590	216,082
Camden, NJ	STATE	NJ 70	2.870	54,458	4,853	0.9	28,547	331,003
Pierce, WA	(NOT SIGNED)	00000000	0.000	41,772	3,665	3.4	28,492	89,436
Harrison, MS	U.S.	00000049	5.196	64,640	3,423	3.0	28,372	29,564
Anne Arundel, MD	STATE	00000003	5.650	65,390	5,781	1.5	28,054	97,067
Smith, TX	U.S.	_US0271_	134.302	30,000	3,000	3.0	28,034	45,191
Webb, TX	(NOT SIGNED)	00000000	15.500	35,630	1,069	2.5	27,851	37,571
Camden, NJ	U.S.	US 30	4.260	35,358	1,752	4.8	27,531	189,990
Fayette, KY	U.S.	0000060	2.253	47,293	3,311	1.1	27,308	34,545
Cumberland, NC	U.S.	00000401	3.800	35,000	3,271	1.2	27,051	54,047
San Bernardino, CA	STATE	00000018	90.399	44,000	3,139	4.5	26,986	26,986
Moore, NC	U.S.	00000001	8.470	39,000	3,095	2.3	26,625	108,816
Pinellas, FL	STATE	SR 686	10.613	96,000	7,055	1.4	26,491	112,138
12086	U.S.	US 1	5.986	89,500	7,160	1.0	26,489	110,936
Fairfax, VA	U.S.	US00050	68.440	53,439	5,126	2.7	26,463	130,090
Broome, NY	STATE	00000434	5.240	37,300	2,238	1.3	26,438	26,438
Fairfield, CT	U.S.	00000001	22.770	22,200	5,397	5.6	26,230	73,050
Riverside, CA	(NOT SIGNED)	00000000	13.860	42,008	840	1.7	26,203	26,203
Horry, SC	U.S.	00000501	5.860	53,600	1,596	1.0	26,112	43,476

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Terrebonne, LA	STATE	3040	2.140	38,200	3,438	1.6	25,295	25,295
Henderson, NC	U.S.	00000064	0.000	40,000	3,477	2.9	25,094	41,782
Tarrant, TX	STATE	_FM0157_	7.810	41,000	2,050	4.3	25,005	84,166
Riverside, CA	(NOT SIGNED)	00000000	4.810	35,557	2,133	1.1	25,003	25,003
Lubbock, TX	STATE	_FM1730_	0.000	38,000	4,940	1.3	24,911	31,736
Harris, TX	STATE	_SH0006_	481.709	60,000	3,600	1.9	24,777	138,407
Suffolk, MA	(NOT SIGNED)	00000000	0.860	47,014	2,076	2.3	24,346	300,871
Williamson, TX	U.S.	_US0183_	303.150	47,000	1,880	3.5	24,108	47,565
DeSoto, MS	STATE	00000302	9.925	42,420	2,863	2.0	23,919	23,919
Pierce, WA	TOWNSHIP	00000000	1.190	25,191	3,665	6.1	23,636	125,602
Forrest, MS	STATE	00000198	0.461	36,208	3,766	4.3	23,563	28,111
Mecklenburg, NC	STATE	00000016	23.150	36,000	4,180	0.6	23,385	122,443
Orleans, LA	U.S.	90	0.540	55,800	3,315	3.7	23,302	133,333
Collin, TX	STATE	_SH0289_	35.788	47,000	1,880	2.4	22,813	43,984
Calcasieu, LA	U.S.	171	0.000	27,800	6,516	2.4	22,486	33,707
Collin, TX	(NOT SIGNED)	00000000	34.542	36,760	1,103	3.7	22,448	75,562
Shelby, TN	U.S.	00000061	5.790	47,310	3,787	1.1	22,435	121,529
Hamilton, TN	STATE	00000153	0.920	43,500	7,268	2.8	22,396	78,497
Bradley, TN	STATE	00000060	10.348	26,670	3,491	3.5	22,380	33,861
King, WA	STATE	00000513	0.080	46,477	3,352	1.3	22,221	54,064
Rockingham, NH	U.S.	00000001	2.247	21,000	1,470	1.2	22,136	30,504
Kent, MI	(NOT SIGNED)	00000000	1.596	67,072	2,683	1.0	22,054	23,575
Bell, TX	U.S.	_US0190_	308.499	41,000	6,150	1.3	21,949	21,949
Harrison, MS	U.S.	00000049	4.044	48,480	5,795	1.9	21,931	25,243
Smith, TX	U.S.	_US0069_	139.634	39,000	1,560	3.9	21,930	29,825
St. Lucie, FL	STATE	SR 716	5.129	51,000	3,060	1.4	21,790	95,418
Los Angeles, CA	STATE	00000164	6.224	51,500	2,060	0.9	21,766	243,841
Burlington, NJ	STATE	NJ 38	4.400	40,730	4,793	1.4	21,733	149,977
Dallas, TX	(NOT SIGNED)	00000000	17.568	60,300	1,809	5.0	21,550	42,905
Hillsborough, NH	STATE	0000101A	4.928	47,000	2,580	1.2	21,448	21,448
New Haven, CT	STATE	00000034	23.560	29,500	5,129	1.9	21,386	49,829
Boone, KY	STATE	0000018	12.718	47,100	4,239	0.9	21,132	34,953
Iberville, LA	STATE	1	15.680	25,700	5,086	1.0	20,986	28,416
Benton, AR	U.S.	00000062	0.000	33,800	3,779	3.9	20,914	83,257
Douglas, NV	U.S.	00395	30.000	33,000	2,107	3.0	20,836	59,508
St. Charles, LA	U.S.	90	5.640	31,500	4,902	0.9	20,820	67,414
Coryell, TX	U.S.	_US0190_	276.885	52,999	4,770	0.5	20,806	21,284
Okaloosa, FL	U.S.	US 98	17.487	51,500	1,741	2.2	20,800	62,920
Greene, TN	U.S.	0000011E	10.660	38,260	2,905	3.5	20,601	25,031
Martin, FL	STATE	SR 714	13.849	56,000	5,040	2.7	20,587	28,862
Los Angeles, CA	STATE	00000001	36.052	129,000	2,901	1.4	20,452	20,452
DeSoto, MS	STATE	00000302	2.932	28,986	2,317	1.3	20,410	43,514
Craven, NC	U.S.	00000017	4.210	26,000	2,186	0.9	20,375	65,323
Orange, FL	U.S.	US 17	4.863	66,500	2,405	1.3	20,332	143,340
Craven, NC	U.S.	00000017	0.000	19,000	2,660	0.8	20,260	55,572
Fairfax, VA	STATE	SR00007	49.670	62,068	3,721	1.9	19,875	157,069
Jefferson, WV	STATE	9	0.000	18,962	1,941	0.6	19,873	187,525
San Luis Obispo, CA	STATE	00000046	24.035	25,600	7,450	3.3	19,823	20,338
East Baton Rouge, LA	STATE	67	5.830	33,800	1,682	0.8	19,652	42,035
Maricopa, AZ	(NOT SIGNED)	00000000	31.329	35,139	2,811	1.0	19,604	181,217
Lafayette, LA	STATE	3095	3.260	32,100	1,926	2.4	19,568	23,697
Monterey, CA	(NOT SIGNED)	00000000	0.060	42,870	1,971	3.5	19,528	70,986
Maricopa, AZ	(NOT SIGNED)	00000000	9.022	25,530	3,574	1.0	19,445	163,050
East Baton Rouge, LA	STATE	67	3.440	21,700	1,682	6.0	19,408	65,833
Horry, SC	U.S.	00000501	31.660	35,900	1,926	3.0	19,360	30,782
Macomb, MI	(NOT SIGNED)	00000000	7.526	55,521	3,390	1.2	19,329	79,502
DuPage, IL	STATE	00000083	50.420	69,300	4,065	1.9	19,322	317,609
Collier, FL	STATE	SR 951	16.205	33,000	2,611	0.5	19,231	23,635
New Castle, DE	U.S.	0000US40	2.380	36,064	5,017	1.0	19,148	96,122
Hunterdon, NJ	U.S.	US 202	14.730	59,539	2,977	0.9	19,146	212,442
Fayette, KY	U.S.	0000027	1.679	51,300	4,104	5.6	19,004	24,040
Davidson, TN	STATE	00000155	2.980	27,800	5,771	2.1	18,854	160,941
Carter, KY	STATE	0000001	10.646	22,500	2,250	3.5	18,847	18,847
Fayette, KY	U.S.	0000027	0.000	53,700	4,296	2.1	18,708	23,665
East Baton Rouge, LA	STATE	37	3.390	36,300	5,257	2.1	18,643	31,880

Appendix D: Signal Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Maricopa, AZ	(NOT SIGNED)	90000000	57.614	39,621	7,695	1.0	18,473	170,761
Shelby, TN	STATE	00000177	6.040	61,730	1,852	2.3	18,360	49,353
Greene, MO	U.S.	160	91.784	24,008	2,161	1.3	18,292	54,034
Morris, NJ	STATE	NJ 10	0.000	68,094	4,025	1.2	18,223	202,204
Hall, GA	STATE	00000060	9.950	38,770	1,939	8.3	18,164	18,164
Harris, TX	(NOT SIGNED)	00000000	47.875	52,350	1,571	4.9	18,088	143,294
Harrison, WV	U.S.	50	11.380	40,880	3,929	0.5	17,959	22,018
Cameron, TX	STATE	_SH0004_	0.060	21,000	1,680	8.3	17,872	18,408
Calcasieu, LA	STATE	14	7.800	27,800	2,827	3.6	17,825	26,720
Harrison, MS	U.S.	00000049	3.599	39,390	5,632	2.3	17,792	23,965
Lincoln, KY	U.S.	0000027	17.233	43,500	4,350	2.0	17,675	17,675
St. Louis city, MO	MUNICIPAL	KINGSHIG	4.099	62,326	4,363	1.7	17,639	20,585
Snohomish, WA	STATE	00000527	3.870	35,334	2,120	0.8	17,636	55,361
New Hanover, NC	U.S.	00000017	0.300	42,000	5,547	2.5	17,626	125,511
Forrest, MS	U.S.	00000049	33.030	37,014	4,969	2.7	17,545	20,931
Webb, TX	STATE	_FM1472_	32.784	28,000	4,760	1.6	17,313	30,141
Harrison, MS	U.S.	00000049	4.367	48,480	4,936	2.4	17,207	19,806
New London, CT	STATE	00000002	24.350	25,300	2,926	2.2	17,033	114,837
Hunterdon, NJ	U.S.	US 202	11.880	59,539	2,977	1.7	16,957	188,155
Pierce, WA	(NOT SIGNED)	00000000	0.830	20,958	4,009	1.0	16,879	81,678
Skagit, WA	STATE	00000020	59.410	29,911	3,400	0.8	16,785	42,029
Yakima, WA	TOWNSHIP	00000000	3.270	23,232	2,261	2.0	16,742	21,229
Harrison, MS	U.S.	00000049	12.411	63,717	3,882	3.1	16,593	17,290
Hennepin, MN	STATE	00000101	39.624	45,449	5,342	2.7	16,543	21,473
Middlesex, NJ	U.S.	US 1	29.040	78,948	3,947	2.6	16,502	102,181
Hudson, NJ	STATE	NJ 139	1.100	65,127	5,861	2.9	16,421	182,209
Cumberland, NC	U.S.	00000401	10.210	27,000	3,271	0.8	16,414	49,800
Shelby, TN	STATE	00000177	4.920	60,530	1,816	3.3	16,227	43,618
Mercer, NJ	U.S.	US 1	11.390	80,291	4,015	2.4	16,169	100,118
San Bernardino, CA	STATE	00000018	88.879	48,000	3,139	0.7	16,108	18,186
Muskingum, OH	U.S.	00000000	7.030	20,980	2,404	2.0	15,981	56,446
Middlesex, NJ	U.S.	US 1	17.540	54,845	2,742	2.2	15,957	120,599
Queens, NY	(NOT SIGNED)	00000000	1.940	19,374	5,160	2.9	15,659	446,137
Oakland, MI	U.S.	00000024	0.000	88,582	2,964	1.3	15,628	32,835
Hinds, MS	STATE	00000025	1.273	68,540	2,514	1.3	15,594	15,594
Hardin, KY	U.S.	0000031H	0.946	20,931	1,256	1.1	15,592	15,592
Anoka, MN	STATE	00000065	8.211	53,412	3,790	0.9	15,581	68,119
Beaufort, SC	U.S.	00000278	0.000	47,800	1,848	0.9	15,579	93,617
Arapahoe, CO	(NOT SIGNED)	00000000	0.000	38,219	1,911	1.3	15,562	219,741
Greene, MO	BUSINESS	65	3.905	40,898	2,863	2.2	15,537	15,708
Whatcom, WA	STATE	00000539	10.800	33,104	2,639	1.5	15,444	15,444
Howard, IN	U.S.	00000031	170.910	24,500	3,837	0.7	15,358	15,358
Leon, FL	U.S.	US 319	5.103	66,000	1,402	1.7	15,304	35,995
Lafayette, LA	STATE	3095	1.720	32,100	1,926	1.3	15,222	18,434
New Castle, DE	U.S.	0000US13	1.850	25,992	3,639	0.6	15,111	34,604
Bell, TX	U.S.	_US0190_	311.650	24,999	4,000	0.9	15,062	15,062
New Haven, CT	STATE	00000034	16.220	38,400	2,206	2.9	15,012	27,157
Sherburne, MN	U.S.	00000010	198.870	32,564	2,994	4.3	14,978	23,621
Westchester, NY	STATE	00000100	4.210	36,946	1,847	7.5	14,882	617,779
Collin, TX	(NOT SIGNED)	00000000	20.221	46,540	1,396	2.3	14,758	43,535
Bexar, TX	STATE	_SH0016_	353.526	70,000	2,100	2.0	14,680	14,680
DeSoto, MS	STATE	00000302	8.397	38,380	3,749	1.6	14,676	14,676
Napa, CA	STATE	00000029	6.987	67,000	3,166	1.3	14,588	22,991
San Diego, CA	(NOT SIGNED)	00000000	0.000	22,045	2,406	2.4	14,536	142,567
Denton, TX	STATE	_SL0288_	9.631	25,000	2,500	6.2	14,454	22,779
Mobile, AL	MUNICIPAL	07500	3.830	45,050	2,749	4.0	14,444	14,444
Hood, TX	U.S.	_US0377_	126.610	32,000	1,920	4.8	14,378	107,564
St. Marys, MD	STATE	00000005	44.640	38,510	3,335	1.7	14,308	95,452
Nueces, TX	(NOT SIGNED)	00000000	19.800	37,430	1,123	2.9	14,304	15,477
Montgomery, MD	STATE	00000028	25.210	49,580	3,471	0.6	14,162	107,518
Los Angeles, CA	STATE	00000001	34.877	76,000	2,901	1.2	14,054	45,605
Fairfax, VA	U.S.	US00001	176.730	42,580	3,440	1.2	14,004	125,507
Franklin, NC	U.S.	00000401	11.350	21,000	2,100	2.1	13,990	39,074
Ada, ID	(NOT SIGNED)	00000000	1.662	40,074	2,621	1.0	13,982	17,631
Maricopa, AZ	(NOT SIGNED)	90000000	58.356	42,305	2,293	2.0	13,915	128,630

Appendix D: Signal Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Horry, SC	U.S.	00000017	16.910	33,300	2,664	4.1	13,860	34,179
El Paso, TX	(NOT SIGNED)	00000000	25.600	46,450	1,394	1.2	13,823	23,334
District of Columbia	U.S.	50	0.000	56,374	8,456	1.2	13,813	23,649
Maricopa, AZ	(NOT SIGNED)	90000000	60.853	32,631	2,360	1.2	13,806	115,764
Jefferson, AL	U.S.	00280	0.000	63,051	3,669	1.7	13,714	27,839
Bucks, PA	STATE	PA309	5.125	36,568	3,046	2.4	13,692	34,053
Russell, KY	U.S.	0000127	18.354	12,600	2,016	3.6	13,669	33,463
Lubbock, TX	(NOT SIGNED)	00000000	10.272	26,150	785	1.1	13,603	36,892
Lehigh, PA	STATE	PA309	0.000	38,480	3,667	2.0	13,601	33,825
Lafayette, LA	STATE	182	2.820	51,300	1,539	3.4	13,531	13,531
Baldwin, AL	STATE	00059	4.410	36,120	2,109	2.1	13,514	42,611
Florence, SC	U.S.	00000348	29.980	25,000	3,210	1.7	13,505	40,947
Harlan, KY	U.S.	0000421	13.938	20,055	1,203	1.2	13,400	13,400
St. Tammany, LA	U.S.	190	7.145	50,900	640	4.3	13,353	15,396
Harlan, KY	U.S.	0000421	17.124	19,686	1,575	4.1	13,284	184,034
Travis, TX	STATE	_FM0969_	2.340	21,900	1,314	1.7	13,007	34,052
Denton, TX	U.S.	_US0380_	367.149	20,000	3,600	1.3	13,001	16,525
Warren, NJ	U.S.	US 22	4.350	40,264	3,450	1.4	12,860	13,619
Calhoun, AL	U.S.	00431	7.340	39,030	3,007	1.3	12,821	14,078
Monroe, NY	STATE	00001040	4.430	41,484	1,783	1.2	12,732	27,565
Monroe, NY	STATE	00000015	11.230	34,543	1,382	3.3	12,722	52,147
Atlantic, NJ	U.S.	US 30	47.630	56,302	1,858	1.2	12,647	12,647
DeSoto, MS	STATE	00000302	11.885	37,630	2,863	1.0	12,614	12,614
Cameron, TX	STATE	_SH0004_	1.587	31,000	2,170	2.6	12,600	14,276
Harrison, MS	U.S.	00000049	0.000	64,640	2,808	2.5	12,557	13,084
York, VA	U.S.	US00017	60.120	52,337	1,808	3.2	12,544	32,476
Onondaga, NY	STATE	00000005	24.960	55,452	2,773	1.4	12,490	12,490
McLennan, TX	U.S.	_US0084_	428.564	45,000	2,250	3.3	12,453	12,453
Collin, TX	(NOT SIGNED)	00000000	19.985	51,400	1,542	4.1	12,411	36,611
Smith, TX	U.S.	_US0069_	141.635	23,000	920	3.4	12,324	23,736
Henderson, KY	U.S.	0000041A	2.962	26,444	907	2.9	12,292	12,292
Chesapeake, VA	U.S.	US00013	35.880	19,329	3,083	1.0	12,285	164,829
Nash, NC	U.S.	00000301	14.350	38,000	3,847	1.2	12,269	23,054
Butler, OH	STATE	SR000128	9.850	35,415	4,738	1.6	12,207	80,911
San Diego, CA	(NOT SIGNED)	00000000	0.330	35,506	2,272	1.1	12,206	17,601
Midland, TX	(NOT SIGNED)	00000000	4.504	27,570	827	2.5	12,159	12,159
Dallas, TX	STATE	_SL0012_	21.805	45,000	2,250	1.6	12,108	35,720
Caddo, LA	STATE	511	3.610	34,600	979	2.9	11,961	41,539
Dallas, TX	STATE	_SH0289_	47.044	58,000	3,480	2.1	11,826	23,546
Clark, WA	STATE	00000503	0.060	31,536	1,958	1.4	11,791	17,664
Bernalillo, NM	MUNICIPAL	00004065	2.296	35,793	4,653	1.0	11,723	214,113
Pierce, WA	(NOT SIGNED)	00000000	8.860	29,953	2,184	3.7	11,651	61,914
King, WA	TOWNSHIP	00000000	0.000	29,474	1,768	10.0	11,525	61,241
Harrison, MS	U.S.	00000090	25.090	51,523	1,858	1.9	11,473	13,206
Ouachita, LA	U.S.	165	4.980	46,100	1,626	1.1	11,419	11,419
Middlesex, NJ	U.S.	US 130	79.130	41,176	2,059	0.8	11,363	105,320
Morris, NJ	STATE	NJ 15	3.110	50,787	3,974	3.2	11,308	85,464
Bexar, TX	(NOT SIGNED)	00000000	20.998	38,780	1,163	4.7	11,306	22,307
Marion, IN	COUNTY	00CR4240	0.170	26,496	2,120	3.8	11,268	80,339
Russell, KY	U.S.	0000127	17.872	16,637	2,662	2.1	11,253	26,017
Larimer, CO	MUNICIPAL	TIMBERRD	2.571	33,130	1,325	2.0	11,233	46,045
Adams, MS	U.S.	00000061	13.967	30,300	1,214	1.8	11,232	11,232
Prince Georges, MD	U.S.	00000001	3.830	55,611	1,983	5.7	11,157	44,529
Ouachita, LA	U.S.	165	2.730	33,100	966	4.1	11,108	52,654
Travis, TX	(NOT SIGNED)	00000000	17.049	35,740	1,072	4.2	11,029	63,618
East Baton Rouge, LA	STATE	67	4.950	33,800	1,682	2.3	11,019	23,569
Burnet, TX	U.S.	_US0281_	249.120	29,000	4,060	1.5	11,017	43,154
Natrona, WY	STATE	00WYO258	17.813	28,000	2,192	4.9	10,992	10,992
Marion, OR	STATE	00000022	25.900	36,900	2,464	2.7	10,988	50,173
11002	(NOT SIGNED)	00000000	0.000	35,725	2,501	0.7	10,946	49,661
Leon, FL	STATE	SR 366	2.913	38,500	1,531	4.7	10,872	32,540
Mecklenburg, NC	U.S.	00000521	0.000	24,000	1,501	2.1	10,809	30,189
Ventura, CA	STATE	00000232	0.000	53,000	2,120	4.5	10,747	15,325
Leon, FL	U.S.	US 27	6.766	47,500	1,911	3.0	10,715	19,716
Coryell, TX	U.S.	_US0190_	275.441	34,000	3,740	2.7	10,707	10,879

Appendix D: Signal Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Pike, KY	U.S.	0000460	0.481	12,216	977	0.5	10,677	26,138
Jefferson, KY	U.S.	0000031E	13.620	40,200	2,994	2.3	10,487	20,020
Martin, FL	U.S.	US 1	0.000	61,050	2,442	0.9	10,474	14,685
Harris, TX	STATE	_SH0146_	77.413	38,000	3,040	1.7	10,393	54,273
Mercer, NJ	STATE	NJ 33	0.000	32,987	1,562	2.5	10,355	23,629
Monmouth, NJ	STATE	NJ 34	6.000	37,515	1,343	1.2	10,279	10,279
Dallas, TX	STATE	_SH0352_	12.647	19,900	1,592	2.5	10,273	77,357
Kern, CA	STATE	00000178	0.000	59,000	2,205	1.0	10,272	28,074
Richland, SC	U.S.	00000001	10.870	37,000	3,408	2.6	10,181	32,641
Kalamazoo, MI	(NOT SIGNED)	00000000	2.347	36,680	1,406	1.6	10,175	16,850
Williamson, TX	STATE	_RM0620_	24.697	53,000	1,060	2.7	10,154	13,596
Terrebonne, LA	STATE	3040	0.430	34,500	3,105	3.1	10,144	25,167
Vanderburgh, IN	STATE	00000062	24.430	41,920	1,905	0.8	10,114	18,438
Nueces, TX	STATE	_SH0357_	7.291	27,000	2,430	1.0	10,083	30,662
Lee, MS	U.S.	00000006	0.000	23,758	856	3.4	9,896	40,285
Middlesex, NJ	U.S.	US 1	15.840	47,344	2,367	1.6	9,852	74,464
Horry, SC	U.S.	00000501	3.170	21,900	1,926	2.9	9,825	48,162
Florence, SC	U.S.	00000052	23.300	23,100	3,170	2.7	9,807	23,547
Spartanburg, SC	U.S.	00000221	28.110	19,100	1,339	1.4	9,754	30,941
Kershaw, SC	INTERSTATE	00000001	9.820	24,700	2,714	2.7	9,704	60,206
Ventura, CA	(NOT SIGNED)	00000000	0.170	43,900	2,665	2.7	9,693	16,381
Pickens, SC	U.S.	00000123	7.450	35,451	907	1.7	9,590	13,790
Ventura, CA	(NOT SIGNED)	00000000	3.450	37,300	2,879	2.2	9,579	18,487
Lucas, OH	U.S.	US000020	10.050	25,996	2,312	1.7	9,497	87,021
Brevard, FL	STATE	SR A1A	35.776	41,000	2,109	5.4	9,442	51,358
Adams, MS	U.S.	00000061	14.573	30,300	1,934	4.5	9,427	9,427
Horry, SC	U.S.	00000501	15.480	53,600	2,331	0.4	9,417	15,679
Hamblen, TN	U.S.	0000011E	5.660	33,110	662	2.3	9,401	26,116
District of Columbia	U.S.	29	0.253	29,616	2,962	1.7	9,327	28,232
Yakima, WA	TOWNSHIP	00000000	4.270	25,412	2,261	1.7	9,287	15,510
Sussex, DE	STATE	0000DEL1	2.150	52,593	2,366	0.9	9,269	9,269
Travis, TX	STATE	_SH0071_	108.933	43,000	2,150	1.6	9,251	17,836
Ada, ID	(NOT SIGNED)	00000000	8.892	38,000	1,616	3.0	9,187	11,585
Boulder, CO	STATE	0000119B	49.809	28,500	1,533	3.9	9,177	23,134
San Bernardino, CA	(NOT SIGNED)	00000000	0.500	43,200	841	3.3	9,130	9,130
Douglas, NV	U.S.	00000395	31.000	35,500	710	1.4	9,030	9,030
Calcasieu, LA	U.S.	171	0.000	29,500	2,461	2.4	8,836	13,245
Kenosha, WI	STATE	031N	5.630	28,187	2,166	2.0	8,835	21,063
New Hanover, NC	U.S.	00000017	0.300	34,000	1,883	1.1	8,833	29,528
Cameron, TX	(NOT SIGNED)	00000000	3.500	25,251	758	3.3	8,829	10,003
Ventura, CA	(NOT SIGNED)	00000000	1.145	43,900	2,426	2.7	8,824	14,912
Montgomery, TN	U.S.	0000041A	19.760	34,720	1,021	1.0	8,788	15,677
New York, NY	STATE	0000907P	0.000	27,833	2,096	1.0	8,727	190,560
Dane, WI	U.S.	051N	54.880	34,918	1,711	4.0	8,721	18,593
Cameron, TX	STATE	_SH0048_	3.509	25,000	1,000	2.6	8,690	9,845
Erie, NY	STATE	00000005	37.870	36,798	1,472	3.3	8,660	47,805
Midland, TX	(NOT SIGNED)	00000000	3.526	29,850	896	4.1	8,563	8,563
Bernalillo, NM	MUNICIPAL	00004061	0.000	51,449	3,545	1.0	8,562	56,212
East Baton Rouge, LA	U.S.	61	0.000	44,500	2,290	1.6	8,529	14,584
Sevier, TN	U.S.	00000321	17.540	27,170	1,273	2.4	8,426	69,062
Bexar, TX	STATE	_SH0016_	355.119	54,000	1,620	4.6	8,409	13,026
Harrison, MS	U.S.	00000090	17.521	33,509	1,858	2.0	8,405	21,694
Volusia, FL	U.S.	US 1	30.763	33,500	2,383	1.5	8,359	36,797
Brazoria, TX	STATE	_FM0518_	2.341	30,000	1,200	1.8	8,356	39,040
Pierce, WA	(NOT SIGNED)	00000000	8.860	29,953	2,184	1.8	8,348	44,361
Dearborn, IN	U.S.	00000050	163.160	28,800	1,554	4.1	8,327	19,177
Marion, OR	STATE	0000099E	24.870	17,000	1,460	1.2	8,296	65,456
Jasper, MO	STATE	FF	0.694	26,798	1,876	2.5	8,260	18,064
Monmouth, NJ	STATE	NJ 34	11.520	32,220	2,624	2.6	8,242	235,416
Craighead, AR	U.S.	00000049	11.900	32,601	1,195	2.4	8,219	10,504
New Castle, DE	STATE	0000DEL7	3.320	62,668	2,377	3.0	8,189	19,703
Mercer, NJ	U.S.	US 130	63.700	38,665	1,933	0.9	8,094	8,166
Aiken, SC	U.S.	00000025	3.710	29,000	2,320	1.6	8,090	29,982
Bossier, LA	STATE	3105	0.530	25,200	1,764	1.6	8,043	27,933
Fayette, KY	U.S.	0000068	5.401	44,100	882	3.8	8,035	18,175

Appendix D: Signal Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Pierce, WA	STATE	00000007	49.860	40,911	1,833	0.7	7,972	25,024
Weld, CO	STATE	0000119C	61.016	34,500	1,432	0.5	7,936	12,595
Brazos, TX	STATE	_FM0158_	2.553	36,000	2,160	1.8	7,916	8,707
Santa Clara, CA	(NOT SIGNED)	00000000	4.220	37,497	1,500	5.0	7,881	65,741
Vermilion, LA	U.S.	167	0.000	22,000	1,320	3.3	7,812	15,819
Brevard, FL	STATE	SR A1A	1.050	39,000	2,109	1.9	7,756	42,183
Williamson, TX	STATE	_RM0620_	23.556	53,000	1,060	1.8	7,710	8,604
Orange, NY	STATE	00000300	7.840	64,017	3,201	1.2	7,703	7,703
Racine, WI	STATE	020E	37.910	26,876	1,933	1.0	7,657	43,298
Albemarle, VA	U.S.	US00029	134.040	34,938	1,398	0.6	7,615	20,736
Sussex, DE	U.S.	000US113	28.960	23,649	2,269	1.8	7,587	17,374
Travis, TX	STATE	_FM1325_	2.338	55,000	1,650	2.0	7,499	8,691
Ada, ID	(NOT SIGNED)	00000000	25.938	32,000	1,943	1.3	7,477	11,807
Montgomery, MD	STATE	00000187	1.180	42,100	2,105	1.7	7,474	86,636
Williamson, TX	U.S.	_US0183_	302.077	35,000	1,400	3.3	7,435	42,884
Fauquier, VA	U.S.	6US00017	2.690	39,520	1,186	1.6	7,428	40,198
Waukesha, WI	STATE	L016E	3.680	18,075	1,446	4.2	7,367	161,782
Jackson, MS	U.S.	00000090	6.277	43,430	763	1.3	7,305	9,840
Adams, MS	U.S.	00000061	13.967	30,300	1,593	1.5	7,211	7,211
Leon, FL	U.S.	US 27	2.015	41,000	1,911	1.3	7,207	21,570
Ada, ID	U.S.	000US020	40.229	29,740	1,745	0.7	7,198	11,365
Gloucester, NJ	COUNTY	CO689	4.880	24,807	1,985	2.5	7,064	64,577
Dallas, TX	(NOT SIGNED)	00000000	34.815	31,760	953	1.6	7,053	43,305
Randall, TX	(NOT SIGNED)	00000000	12.078	33,690	1,011	1.3	7,045	9,158
Lafayette, LA	STATE	3095	4.530	35,000	2,100	2.9	7,002	9,887
Lubbock, TX	(NOT SIGNED)	00000000	16.544	36,560	1,097	1.0	6,921	8,817
Henderson, KY	U.S.	0000041A	4.357	30,200	907	1.9	6,918	6,918
Utah, UT	STATE	00000265	0.530	46,385	1,383	1.3	6,888	16,234
Johnson, KS	U.S.	00000056	10.195	35,000	854	2.3	6,886	15,245
Washington, MS	U.S.	00000082	10.222	25,250	2,273	3.3	6,835	21,879
Linn, OR	STATE	00000034	0.420	34,000	1,484	1.2	6,811	14,350
Pima, AZ	(NOT SIGNED)	90000000	12.018	51,012	1,356	1.1	6,785	29,751
Georgetown, SC	U.S.	00000017	23.990	31,357	1,514	2.9	6,780	18,415
Clark, NV	(NOT SIGNED)	00000000	4.643	57,500	3,126	1.1	6,759	24,237
Webb, TX	STATE	_SL0020_	9.183	28,000	1,680	0.6	6,736	11,728
Jackson, MS	U.S.	00000090	4.108	31,039	763	4.5	6,706	10,267
Lubbock, TX	(NOT SIGNED)	00000000	16.963	36,650	1,100	1.1	6,680	8,510
Denton, TX	STATE	_FM2499_	2.748	35,000	1,050	2.8	6,651	7,782
Horry, SC	U.S.	00000501	10.600	33,800	1,596	5.6	6,635	16,362
Rowan, NC	U.S.	00000070	0.000	13,000	1,692	1.1	6,629	17,607
Sussex, DE	U.S.	00000US9	28.000	16,110	1,539	1.4	6,558	21,379
Anderson, TN	STATE	00000061	5.021	23,660	1,942	1.7	6,533	53,544
Volusia, FL	U.S.	US 17	0.176	36,500	1,804	1.4	6,519	10,209
Denver, CO	U.S.	0000285D	255.753	72,300	2,075	1.1	6,489	18,670
Chittenden, VT	U.S.	00007	11.930	28,400	2,143	1.6	6,398	10,173
Sebastian, AR	STATE	00000022	0.070	28,460	959	2.9	6,396	17,466
Chattooga, GA	STATE	00000100	14.180	12,890	1,289	1.5	6,355	74,821
Faulkner, AR	U.S.	00000065	17.080	31,600	1,810	1.9	6,328	25,192
Sebastian, AR	STATE	00000022	0.070	30,780	507	3.6	6,321	17,261
Suffolk, MA	(NOT SIGNED)	00000000	4.530	40,700	1,722	1.7	6,227	52,204
Genesee, MI	(NOT SIGNED)	00000000	0.000	64,640	1,243	3.1	6,190	6,190
Charleston, SC	U.S.	00000052	7.880	69,800	1,808	1.8	6,188	14,715
District of Columbia	(NOT SIGNED)	00000000	0.816	53,295	2,580	1.0	6,132	9,382
Spokane, WA	(NOT SIGNED)	00000000	0.100	25,749	1,802	2.4	6,046	17,401
Lubbock, TX	(NOT SIGNED)	00000000	16.963	46,510	1,395	1.2	6,026	6,026
Dane, WI	U.S.	051N	53.120	47,834	1,711	1.6	5,958	30,740
Whitfield, GA	U.S.	00000076	6.480	30,390	1,216	1.3	5,884	5,884
Sedgwick, KS	(NOT SIGNED)	00000000	7.890	27,585	828	2.0	5,828	17,723
Camden, NJ	U.S.	US 30	4.260	31,938	1,597	2.6	5,768	65,541
Adams, MS	U.S.	00000061	13.600	30,300	1,515	1.5	5,751	5,751
Alameda, CA	(NOT SIGNED)	00000000	0.000	27,780	1,667	1.4	5,708	10,646
Milwaukee, WI	STATE	100N	3.890	34,045	1,758	2.6	5,701	29,423
Pitt, NC	U.S.	00000264	20.600	28,000	1,414	2.4	5,640	8,804
Smith, TX	STATE	_SH0155_	76.612	32,000	960	3.7	5,570	8,978
Johnson, KS	(NOT SIGNED)	00000000	1.535	31,118	934	4.2	5,523	25,551

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Ada, ID	STATE	000SH055	12.000	41,640	1,475	1.3	5,502	6,938
York, ME	STATE	00000111	2.950	18,127	1,269	1.8	5,491	48,057
Montgomery, MD	STATE	00000185	2.830	47,172	2,359	1.0	5,484	41,633
Independence, AR	U.S.	00000167	13.080	23,600	1,608	1.8	5,479	18,442
Pima, AZ	(NOT SIGNED)	90000000	0.861	57,045	1,356	1.9	5,456	14,754
Clackamas, OR	STATE	0000099E	8.440	23,900	1,709	2.6	5,434	18,548
Stanislaus, CA	STATE	00000108	4.605	31,500	1,260	0.9	5,325	8,281
Riverside, CA	(NOT SIGNED)	00000000	1.220	44,901	929	2.9	5,298	6,315
Hall, GA	U.S.	00000129	8.060	38,250	2,295	1.1	5,294	5,294
Shelby, TN	U.S.	00000072	7.100	37,500	1,762	2.9	5,283	41,406
Lane, OR	(NOT SIGNED)	00000000	8.470	42,060	1,374	1.7	5,259	12,391
St. Bernard, LA	STATE	47	0.410	30,600	394	2.8	5,245	16,984
Johnson, KS	U.S.	00000169	6.365	28,830	1,136	0.6	5,198	24,044
Pickens, SC	U.S.	00000123	2.240	38,800	819	1.9	5,167	7,431
Randall, TX	(NOT SIGNED)	00000000	1.735	22,750	683	2.0	5,009	6,682
Pulaski, AR	MUNICIPAL	UNIVERSI	1.980	35,700	1,071	5.0	5,003	8,060
Williamson, TX	U.S.	_US0183_	305.876	55,000	1,650	2.6	4,940	5,725
Washington, AR	U.S.	00000071	3.380	35,900	723	1.8	4,824	8,669
Utah, UT	STATE	00000265	0.530	35,015	1,383	2.3	4,680	12,158
Pueblo, CO	STATE	0000096A	54.266	21,500	645	4.0	4,651	8,399
Whitfield, GA	(NOT SIGNED)	00000000	0.920	26,560	1,859	1.4	4,635	7,403
East Baton Rouge, LA	U.S.	61	5.600	49,800	1,051	1.9	4,613	6,408
Snohomish, WA	TOWNSHIP	00000000	0.000	29,475	464	4.6	4,579	24,333
El Paso, CO	MUNICIPAL	CONSTIAV	3.623	15,944	638	2.0	4,498	29,857
11002	U.S.	50	2.116	67,830	1,104	0.7	4,370	7,481
Hamilton, TN	(NOT SIGNED)	00000000	1.870	36,330	1,189	1.2	4,289	15,034
Kenosha, WI	STATE	031N	8.210	31,247	1,073	2.0	4,283	10,211
McLennan, TX	U.S.	_US0084_	432.114	27,000	1,350	1.6	4,211	6,325
Jefferson, LA	STATE	45	9.720	48,300	443	1.4	4,199	13,167
Douglas, NV	U.S.	00050	13.214	31,000	891	5.5	4,176	11,926
Bradley, TN	STATE	00000060	10.348	24,460	1,065	1.8	4,071	7,173
New Haven, CT	STATE	00000010	1.870	34,500	2,018	1.5	4,034	9,400
Baldwin, AL	U.S.	00098	8.210	29,336	188	1.5	4,012	7,058
Multnomah, OR	U.S.	000030BY	9.890	29,100	1,225	2.0	3,996	43,441
Ward, ND	U.S.	00000083	197.326	27,486	1,695	1.6	3,991	3,991
Travis, TX	STATE	_FM1825_	0.750	36,000	1,080	1.3	3,937	22,710
Pearl River, MS	STATE	00000043	7.411	39,466	349	1.9	3,897	3,897
Hamilton, TN	(NOT SIGNED)	00000000	1.870	36,940	1,101	1.8	3,896	13,655
Bexar, TX	(NOT SIGNED)	00000000	20.089	44,781	1,343	1.2	3,893	7,681
Ontario, NY	STATE	00000332	0.950	26,966	1,348	2.9	3,886	10,690
Harris, TX	STATE	_FM2351_	4.910	33,000	990	1.0	3,839	17,935
Genesee, MI	(NOT SIGNED)	00000000	14.833	24,512	640	0.5	3,831	12,229
Spokane, WA	TOWNSHIP	00000000	4.710	33,123	794	1.5	3,805	10,950
Kenosha, WI	STATE	031N	11.720	27,239	1,048	1.9	3,803	9,065
Anderson, SC	STATE	00000028	0.000	20,600	1,218	2.4	3,747	6,973
Berks, PA	U.S.	US422	11.917	36,252	1,327	1.0	3,742	5,078
Crow Wing, MN	STATE	00000210	136.307	24,614	1,221	2.2	3,720	21,743
Garrett, MD	U.S.	00000219	45.860	4,212	422	0.4	3,708	4,743
Marion, OR	(NOT SIGNED)	00000000	0.000	46,080	1,766	1.1	3,680	4,129
Pennington, SD	U.S.	00000016	69.000	22,927	917	9.9	3,620	4,514
Johnson, KY	STATE	0000321	7.660	15,866	793	1.1	3,596	49,824
Dutchess, NY	U.S.	00000090	4.460	41,499	1,194	3.2	3,582	10,889
Pueblo, CO	STATE	0000096A	53.756	22,121	664	1.8	3,445	6,221
Jackson, MS	U.S.	00000090	18.080	32,714	1,002	2.0	3,421	5,238
Hartford, CT	STATE	00000004	32.220	12,600	756	0.8	3,387	7,824
Cache, UT	U.S.	00000091	32.530	23,895	855	0.7	3,375	5,338
Salt Lake, UT	STATE	00000154	0.000	51,985	1,090	2.8	3,285	83,864
Volusia, FL	STATE	SR 40	25.565	35,500	945	1.9	3,158	30,858
Sauk, WI	U.S.	012E	203.800	26,244	571	4.1	3,119	15,406
Carson City city, NV	U.S.	00395	34.212	46,000	1,931	1.2	3,070	7,253
Cache, UT	U.S.	00000091	30.810	29,885	855	2.0	3,040	5,065
Montgomery, TN	U.S.	0000041A	16.470	41,580	1,021	3.0	3,010	8,360
Pearl River, MS	STATE	00000043	7.411	39,466	488	1.3	2,973	2,973
Sedgwick, KS	(NOT SIGNED)	00000000	9.900	23,685	711	1.3	2,972	12,520
Weld, CO	U.S.	0000034A	102.476	34,400	562	0.5	2,954	4,687

Appendix D: Signal Bottlenecks

County/State	Signing	Route No.	Begin Mile Point	AADT	Truck AADT	Signals/Mile	Annual Truck Delay (Hours)	Annual Truck Delay Expanded (Hours)
Wichita, TX	(NOT SIGNED)	00000000	9.004	33,091	993	1.4	2,921	2,921
Sedgwick, KS	(NOT SIGNED)	00000000	5.990	27,166	815	1.8	2,906	8,837
Brazos, TX	STATE	_BS0006R	4.604	32,000	320	2.6	2,893	4,332
Clark, WA	(NOT SIGNED)	00000000	0.000	48,889	628	5.7	2,877	2,877
Sussex, DE	U.S.	00000US9	5.380	16,445	526	0.6	2,790	9,095
Washington, AR	U.S.	00000071	2.310	38,820	723	1.6	2,756	4,953
Tarrant, TX	(NOT SIGNED)	00000000	24.498	29,900	897	2.9	2,653	16,292
Garrard, KY	STATE	0000034	0.000	9,581	479	0.6	2,638	5,031
Todd, MN	U.S.	00000010	103.020	10,600	776	1.6	2,613	11,167
Dutchess, NY	U.S.	00000090	16.370	47,697	817	2.9	2,596	5,249
Lehigh, PA	STATE	PA145	5.148	28,950	869	1.5	2,588	32,669
Hamilton, OH	U.S.	US000042	1.760	21,427	429	6.7	2,578	20,141
Cache, UT	U.S.	00000091	28.936	28,920	855	3.2	2,515	4,189
Washington, AR	U.S.	00000071	1.450	32,500	723	2.2	2,496	9,928
Washington, AR	U.S.	00000071	5.880	33,700	723	2.0	2,429	9,662
Clark, NV	STATE	00000599	4.659	41,000	820	0.9	2,424	9,471
Washington, AR	U.S.	00000071	4.820	26,900	723	1.9	2,356	9,369
Catawba, NC	STATE	00000127	10.070	39,000	276	1.3	2,144	3,940
Potter, TX	BUSINESS	_BI0040D	8.242	19,600	588	1.0	2,121	3,680
Washington, AR	U.S.	00000071	22.390	29,900	641	2.6	2,013	8,008
Genesee, MI	(NOT SIGNED)	00000000	6.441	38,472	1,243	1.2	1,980	2,199
Salt Lake, UT	STATE	00000071	11.170	41,260	718	3.2	1,928	14,075
New Haven, CT	STATE	00000073	3.020	25,900	777	1.1	1,828	2,432
Jackson, FL	U.S.	US 90	0.000	22,000	226	1.1	1,714	5,774
Salt Lake, UT	STATE	00000071	10.450	40,065	490	1.8	1,663	12,145
Walton, FL	U.S.	US 331	16.762	13,900	362	0.6	1,546	14,651
Fauquier, VA	U.S.	6US00017	0.890	14,332	287	1.2	1,388	11,604
Lawrence, SD	U.S.	00000085	27.220	6,289	402	2.3	1,251	1,609
Livingston, NY	U.S.	0000020A	0.000	9,831	314	0.6	1,232	30,254
Marion, OR	STATE	00000022	6.390	33,900	562	1.1	1,185	11,013
Hubbard, MN	STATE	00000034	93.475	21,100	339	2.0	1,119	2,082
Jefferson, LA	U.S.	61	1.580	31,000	100	5.1	1,086	3,517
Eaton, MI	STATE	00000043	8.270	33,679	342	3.3	1,056	5,540
Canyon, ID	STATE	000SH045	26.109	28,297	283	1.5	999	1,393
Jackson, OR	(NOT SIGNED)	00000000	1.674	15,660	176	0.9	991	7,819
Ada, ID	(NOT SIGNED)	00000000	1.000	41,000	151	2.9	899	1,134
Fall River, SD	U.S.	00000385	35.640	7,145	225	1.1	860	1,107
Stark, OH	STATE	SR000172	7.600	19,760	395	1.0	757	3,166
Marion, OR	(NOT SIGNED)	00000000	11.660	46,640	147	1.4	335	376

Appendix E

Congestion Maps from Caltrans 2006 HICOMP Report

EXHIBIT 3-7
DISTRICT 4
SAN FRANCISCO BAY AREA
2006 MORNING CONGESTION MAP

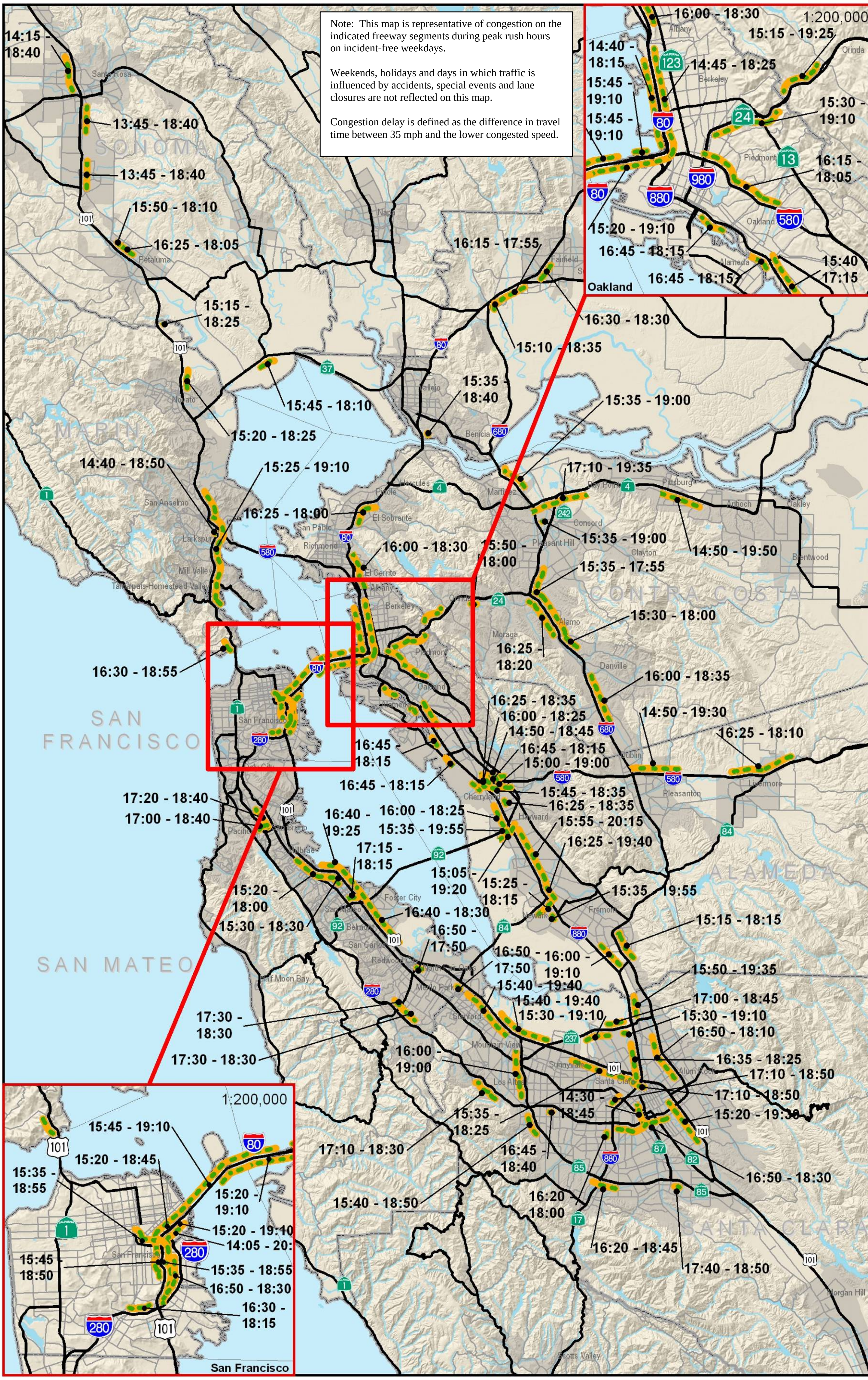


EXHIBIT 3-8
DISTRICT 4
SAN FRANCISCO BAY AREA
2006 EVENING CONGESTION MAP

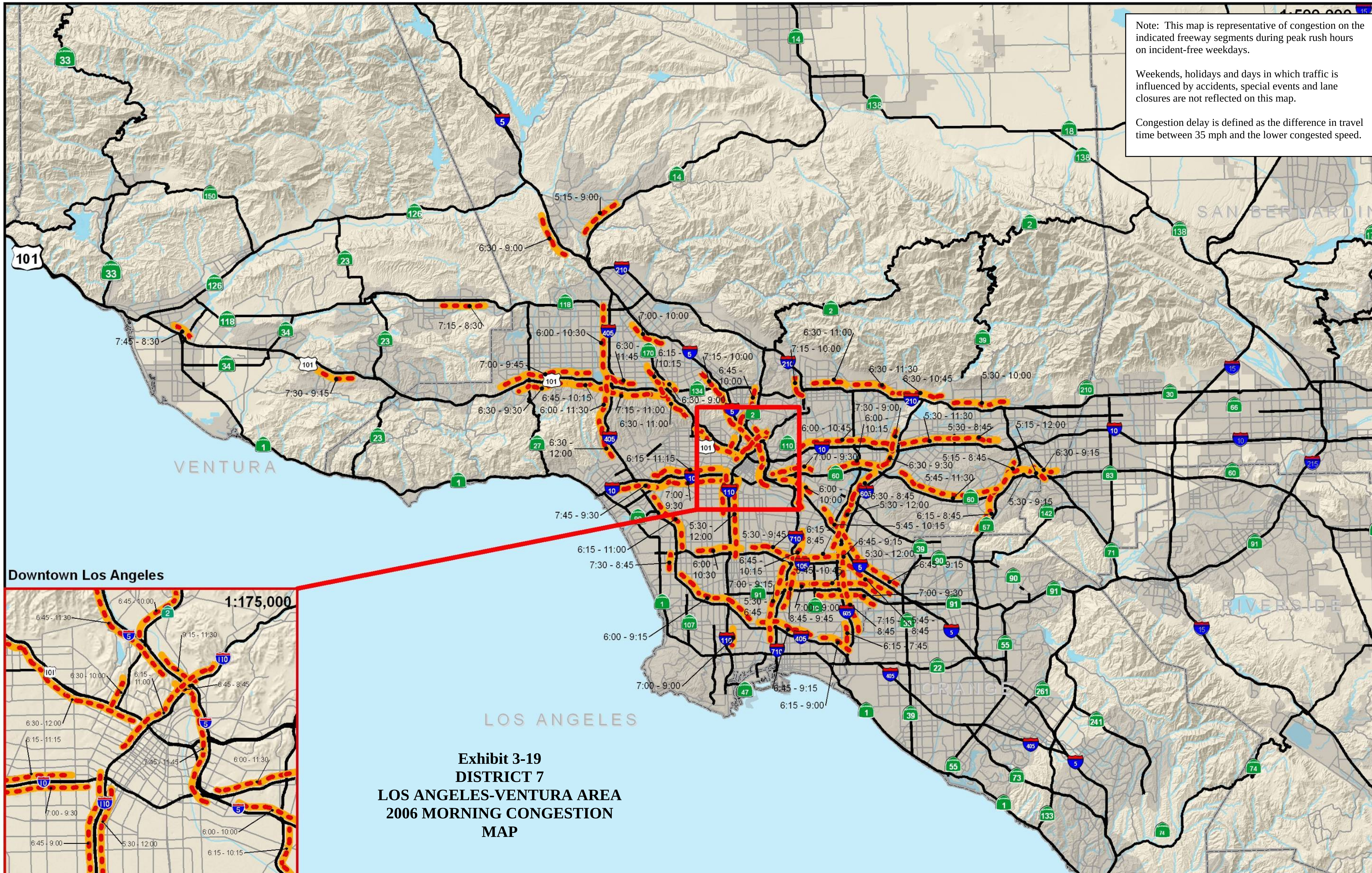


Exhibit 3-19
DISTRICT 7
LOS ANGELES-VENTURA AREA
2006 MORNING CONGESTION MAP

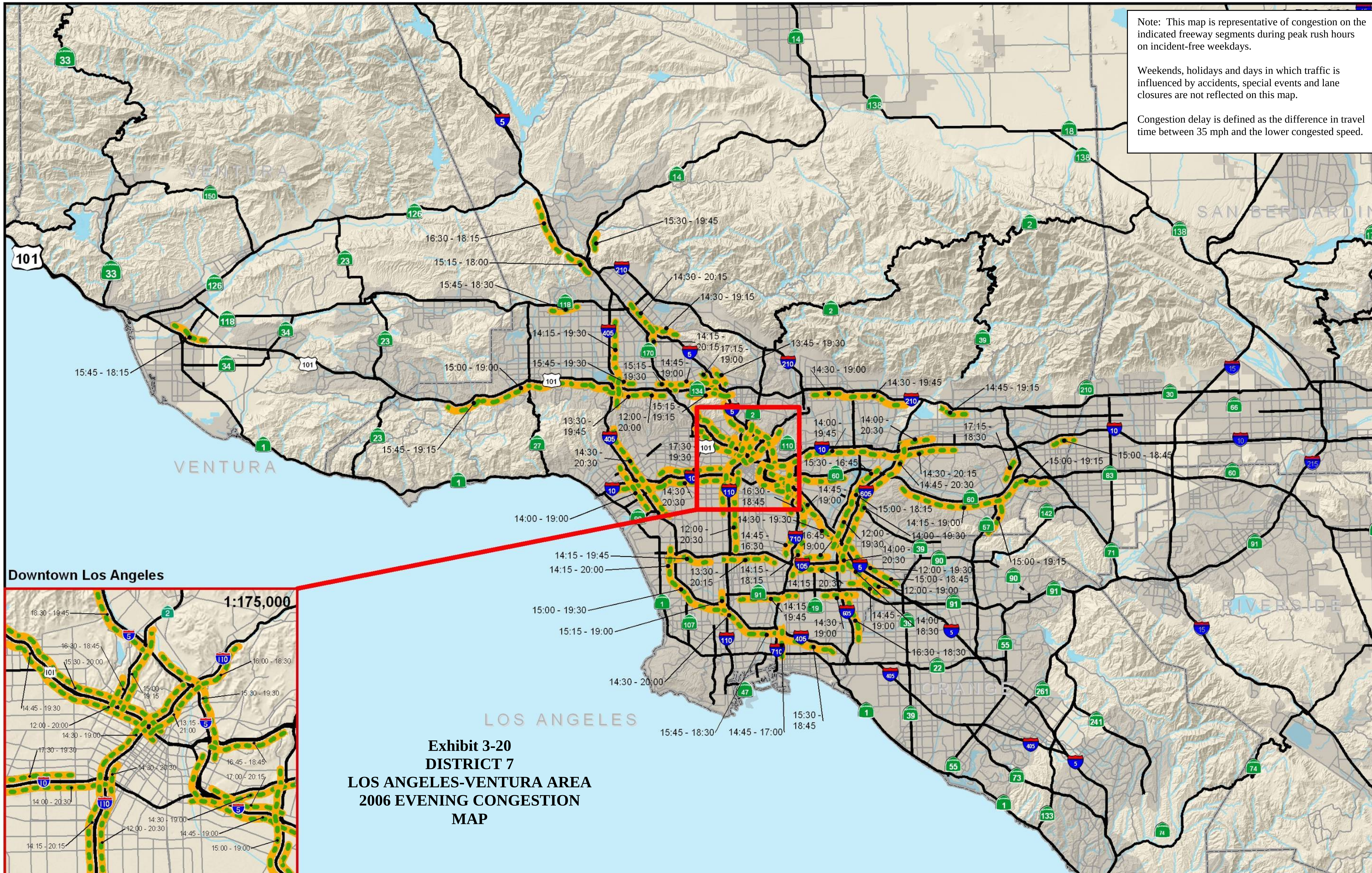


Exhibit 3-20
DISTRICT 7
LOS ANGELES-VENTURA AREA
2006 EVENING CONGESTION
MAP

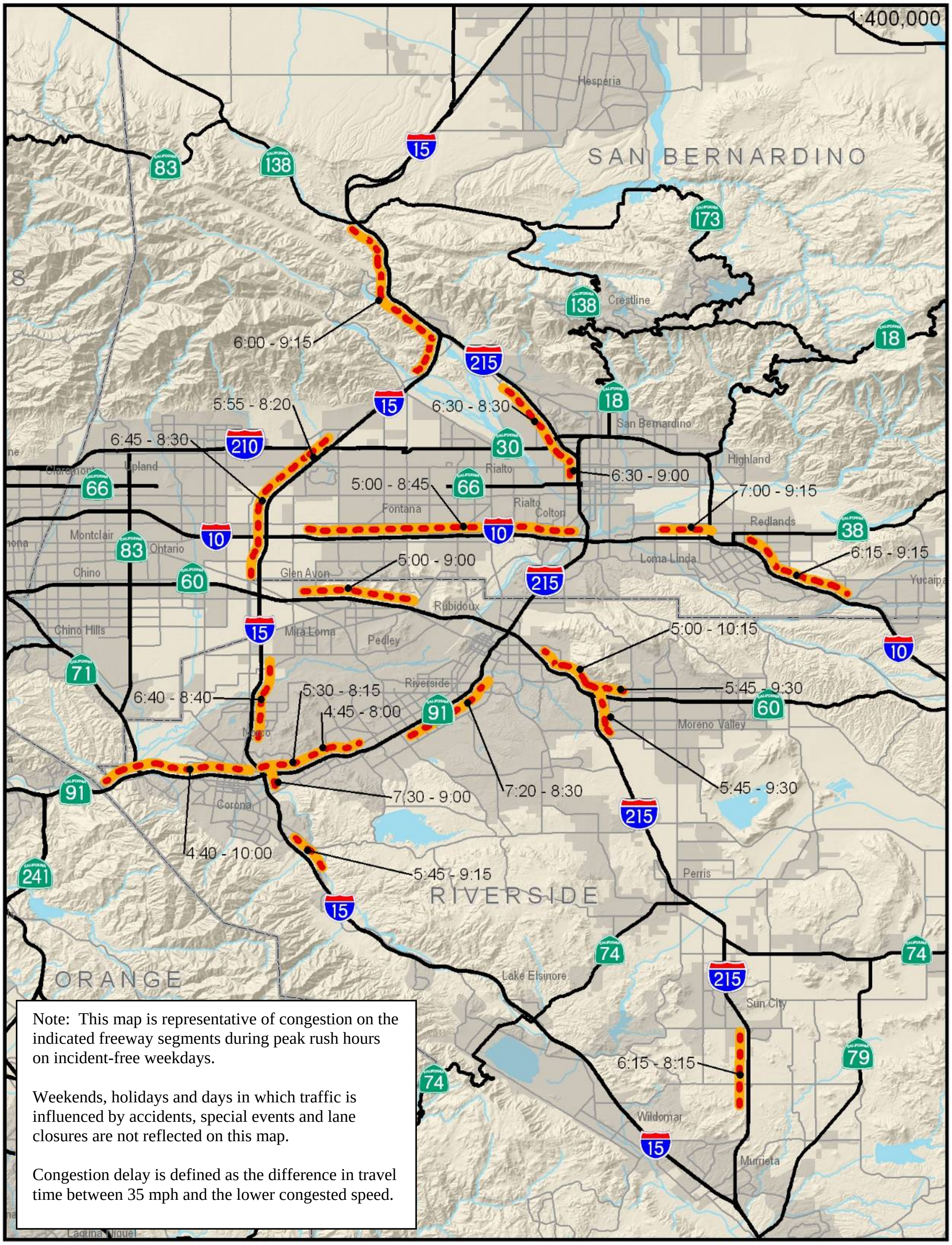


EXHIBIT 3-23
DISTRICT 8
SAN BERNARDINO-RIVERSIDE AREA
2006 MORNING CONGESTION MAP

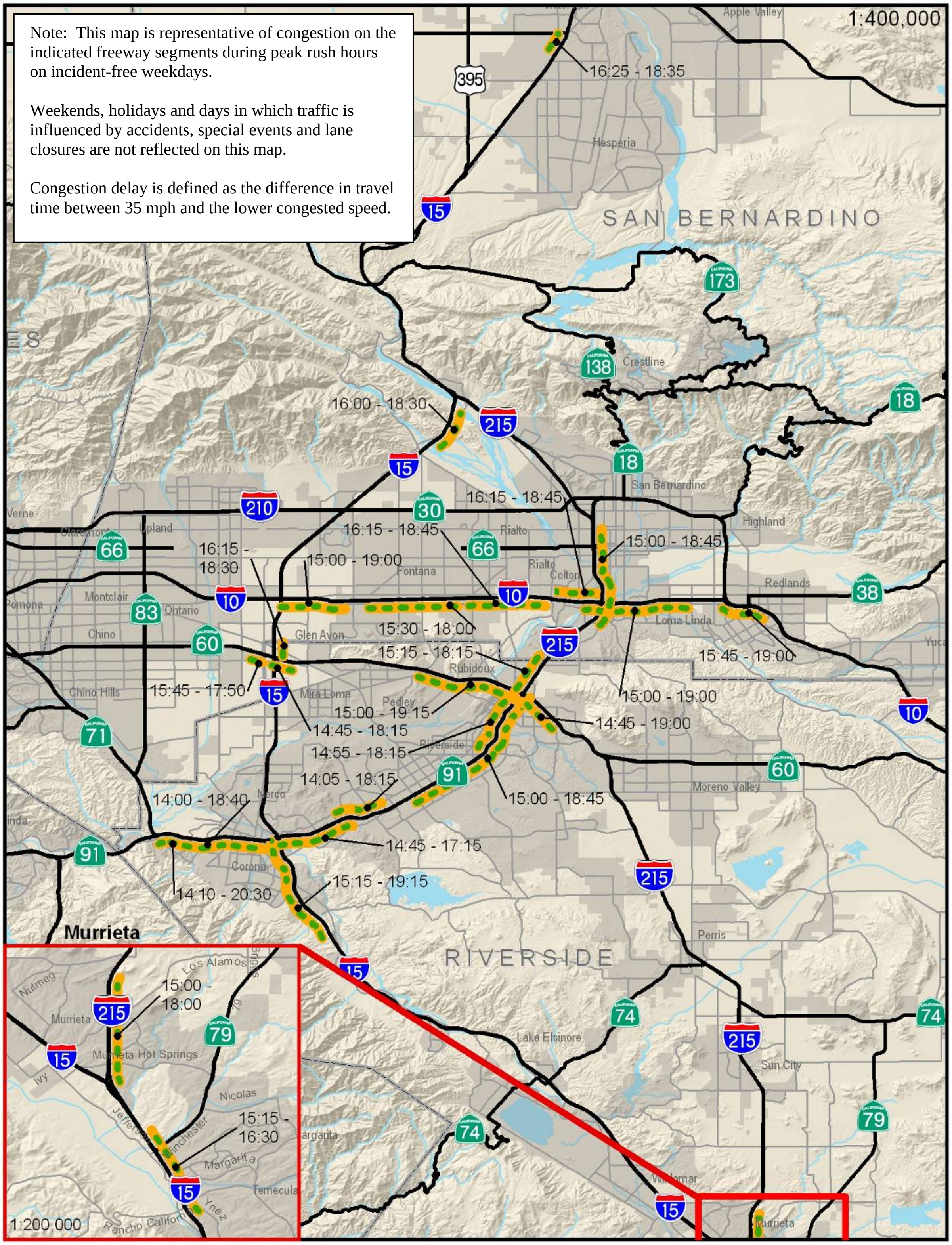


EXHIBIT 3-24
DISTRICT 8
SAN BERNARDINO-RIVERSIDE AREA
2006 EVENING CONGESTION MAP

Appendix F

Truck Travel Time Data Supplied by ATRI

Figure F.1 Interchange Bottlenecks Identified with HPMS Scan Method and National Truck Speeds, 2006
North and East Directions

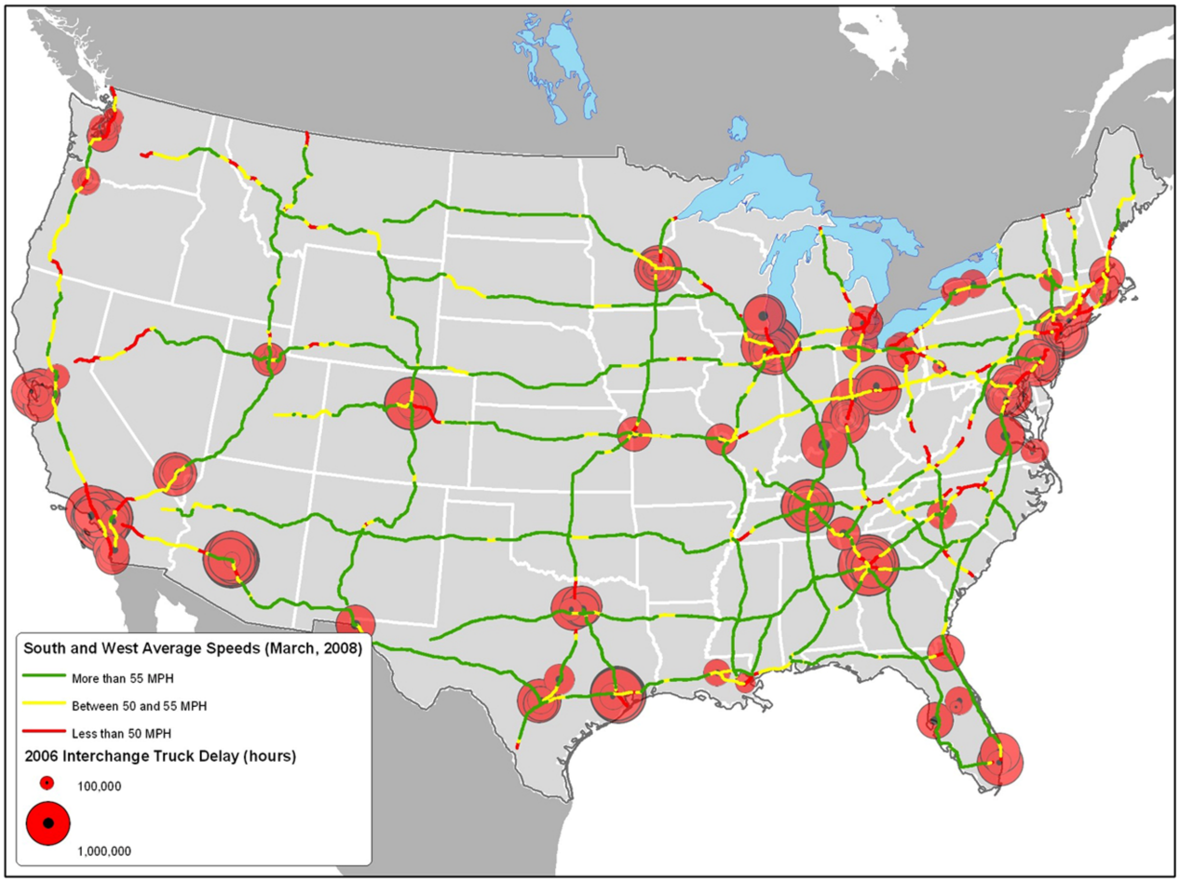
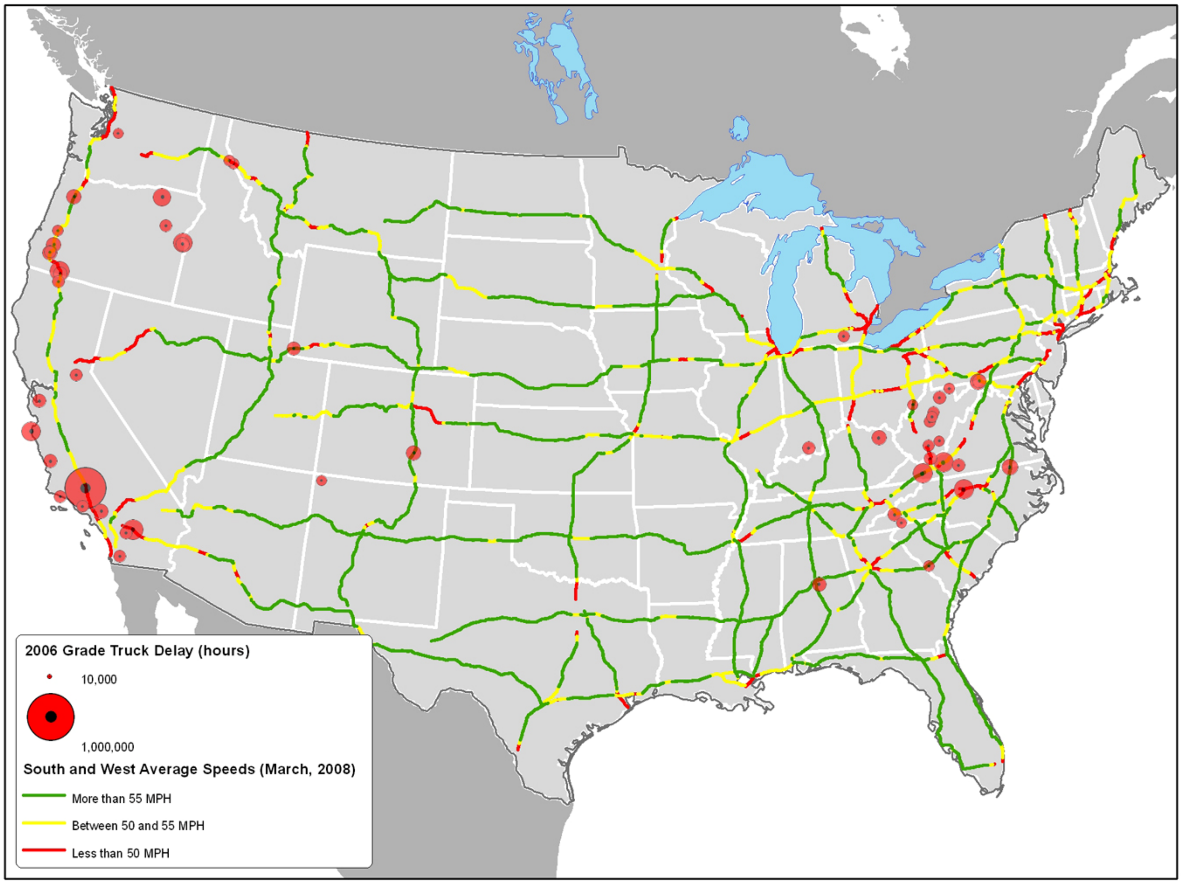
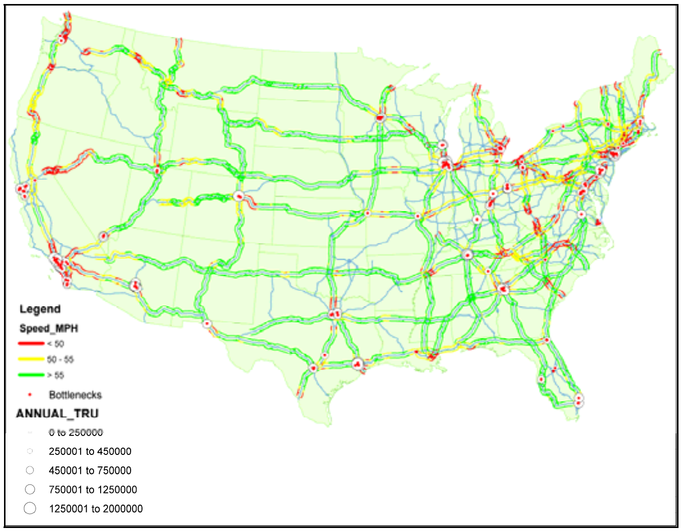


Figure F.2 Grade Bottlenecks Identified with HPMS Scan Method and National Truck Speeds, 2006

North and East Directions



DRAFT: FREIGHT PERFORMANCE MEASURES ANALYSIS OF 30 FREIGHT BOTTLENECKS



Submitted to
Federal Highway Administration,
Office of Freight Management and Operations

by
American Transportation Research Institute

October 1, 2008

List of Worst U.S. Freight Bottlenecks (by Rank)

No.	Bottleneck Name	County/State
1	I-710 @I-105 Interchange	Los Angeles, CA
2	I-17 (Black Canyon Fwy): I-10 Interchange (the "Stack")	Maricopa, AZ
3	I - 285 @ I - 85 Interchange ("Spaghetti Junction")	Dekalb, GA
4	I-20 @ I-75/I-85 Interchange	Fulton, GA
5	I-80 @ I-94 split in Chicago, IL	Cook, IL
6	SR-60 @ SR-57 Interchange	Los Angeles, CA
7	I-80 @ I-580/I-880 in Oakland, CA	Alameda, CA
8	I-405 (San Diego Fwy) @ I-605 Interchange	Orange, CA
9	I-90 @I-94 Interchange ("Edens Interchange")	Cook, IL
10	I-40 @ I-65 Interchange (east)	Davidson, TN
11	I-290 @ I-355 Interchange	DuPage, IL
12	I - 75 @ I - 85 Interchange	Fulton, GA
13	I-95 @SR-9A (Westside Hwy)	New York, NY
14	I-71 @ I-70 Interchange	Franklin, OH
15	I-880 @ I-238	Alameda, CA
16	SR-91 @ SR-55 Interchange	Orange, CA
17	I - 285 @ I - 75 Interchange	Cobb, GA
18	I-695/I-70 and I-95 exit 11 (note: I-70 N. of here)	Baltimore, MD
19	I-95 @ SR-4	Bergen, NJ
20	I-10 @ I-110/US-54 Interchange	El Paso, TX
21	I-45 (Gulf Freeway) @ US-59 Interchange	Harris, TX
22	SR-134 @ SR-2 Interchange	Los Angeles, CA
23	I-10 @ SR-51/SR-202 Interchange ("Mini-Stack")	Maricopa, AZ
24	I-10 @ I-15 Interchange	San Bernardino, CA
25	I-95/I-495	Prince Georges, MD
26	I-45 @ I-610 Interchange	Harris, TX
27	I-10 @ I-410 Loop North Interchange	Bexar, TX
28	I-110 @ I-105 Interchange	Los Angeles, CA
29	I-95 @ I-595 Interchange	Broward, FL
30	I-25 @ I-76 Interchange	Adams, CO

Source: Federal Highway Administration, 2008

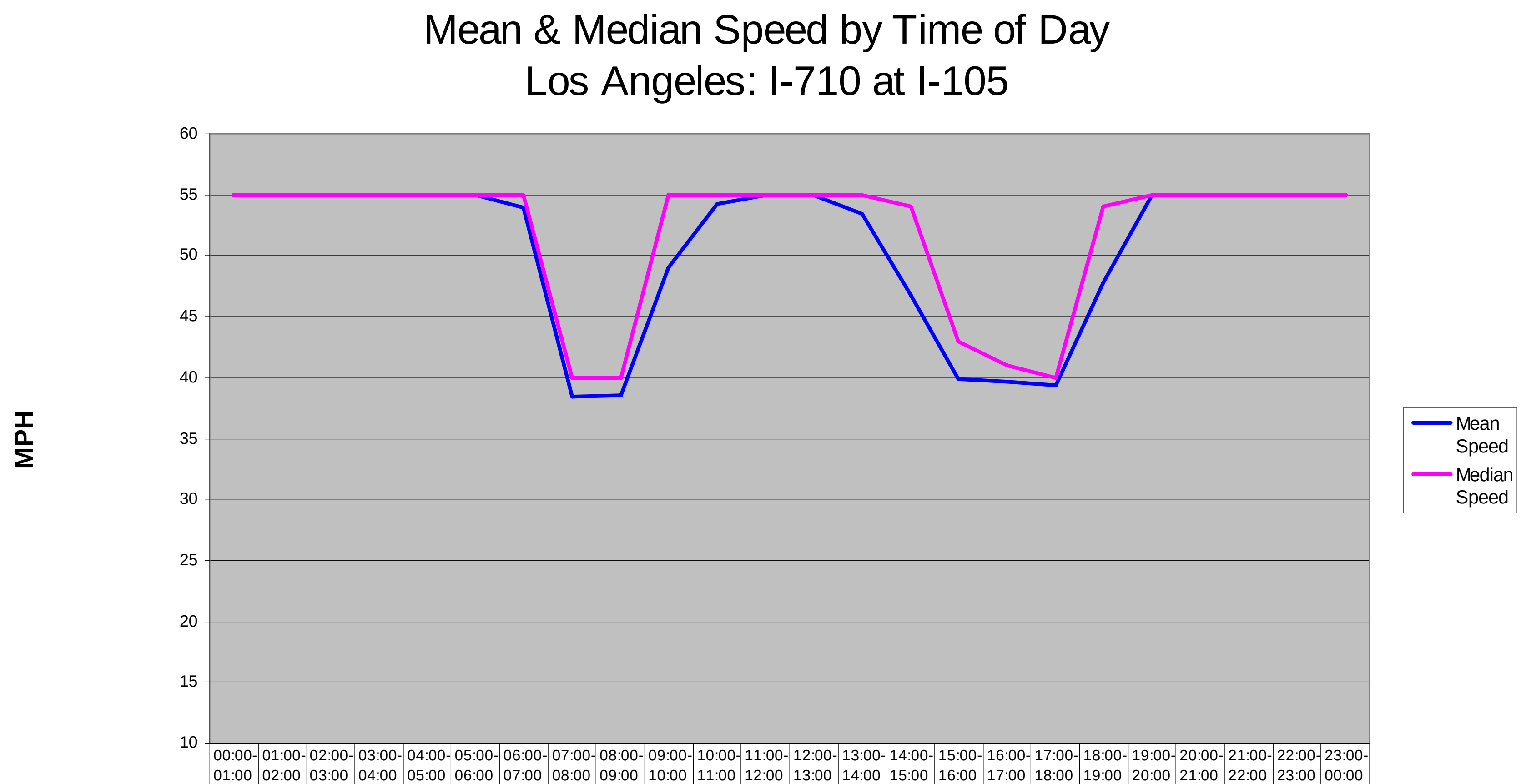
Bottleneck 01: Los Angeles, California

Bottleneck Location: Los Angeles, California, Interstate 710 and Interstate 105

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 8 miles in the study area.

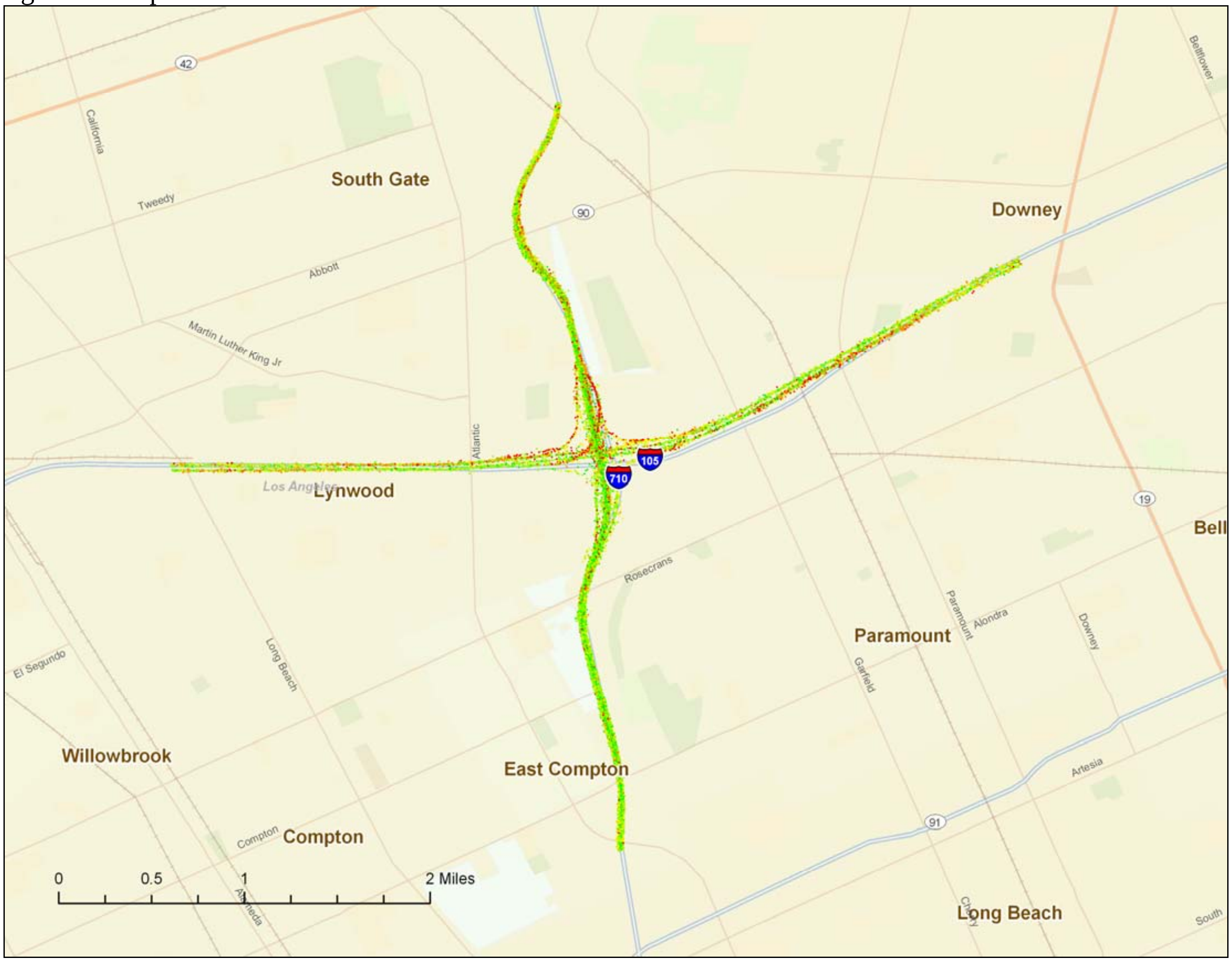
Positions: There were approximately 27,488 truck position reads used in this analysis.



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	53.98	38.48	38.59	49.06	54.27	55	55	53.44	46.8	39.85	39.68	39.36	47.76	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	40	40	55	55	55	55	55	54	43	41	40	54	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 02: Phoenix, Arizona

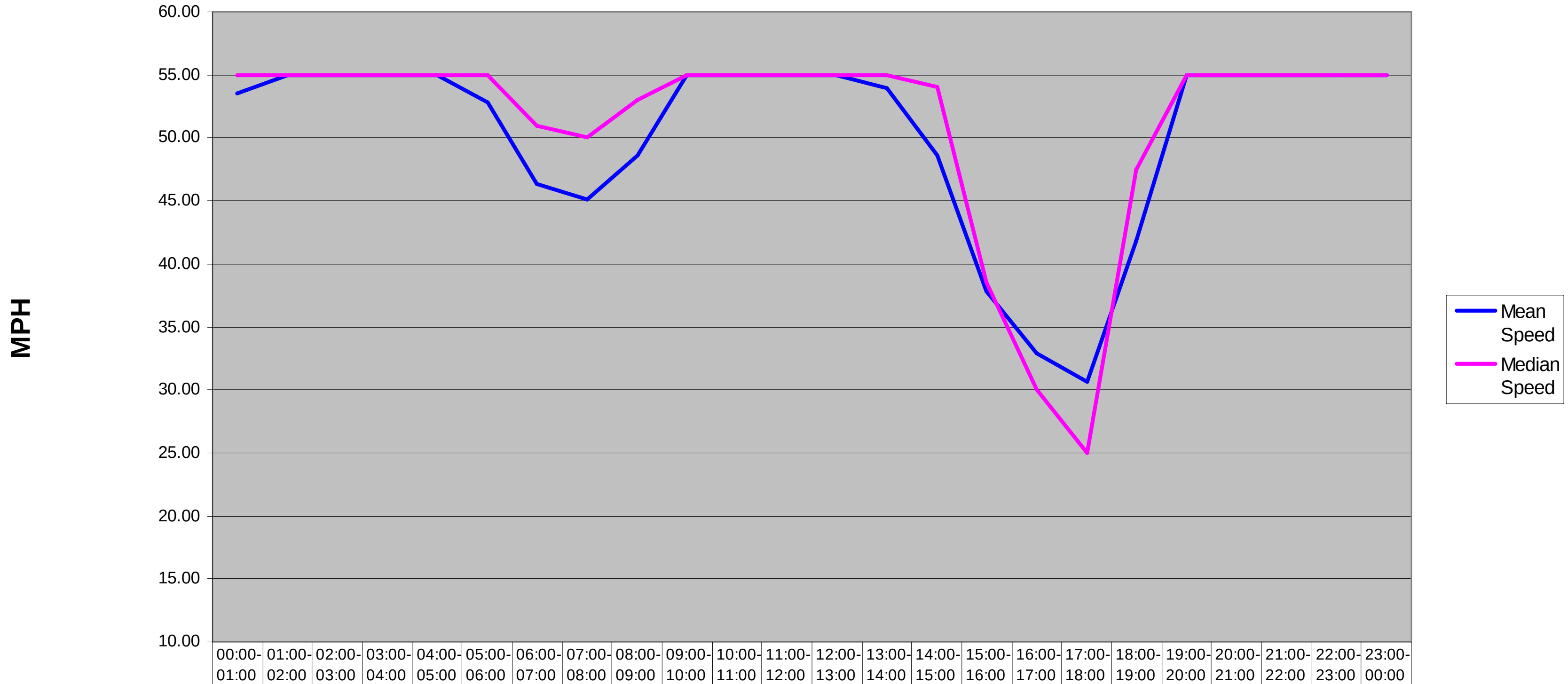
Bottleneck Location: Phoenix, Arizona, Interstate 10 and 17, "The Stack"

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 8 miles in the study area.

Positions: There were approximately 42,395 truck position reads used in this analysis.

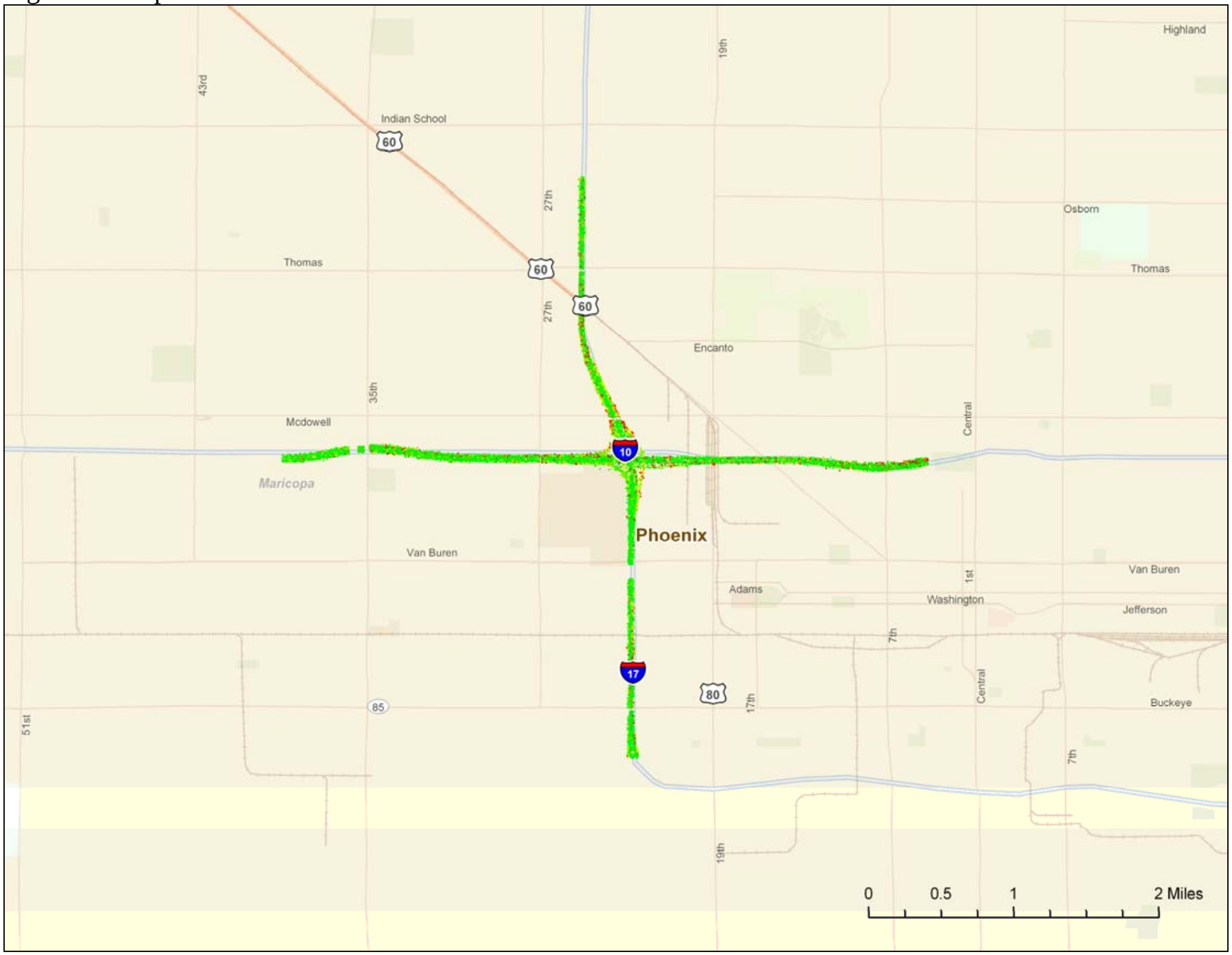
Mean & Median Speed by Time of Day
Phoenix: I-10 at I-17 (The Stack)



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	53.57	55.00	55.00	55.00	55.00	52.83	46.36	45.14	48.65	55.00	55.00	55.00	55.00	53.94	48.65	37.78	32.92	30.63	41.81	55.00	55.00	55.00	55.00	55.00
Median Speed	55	55	55	55	55	55	51	50	53	55	55	55	55	55	54	38.5	30	25	47.5	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 03: Atlanta, Georgia

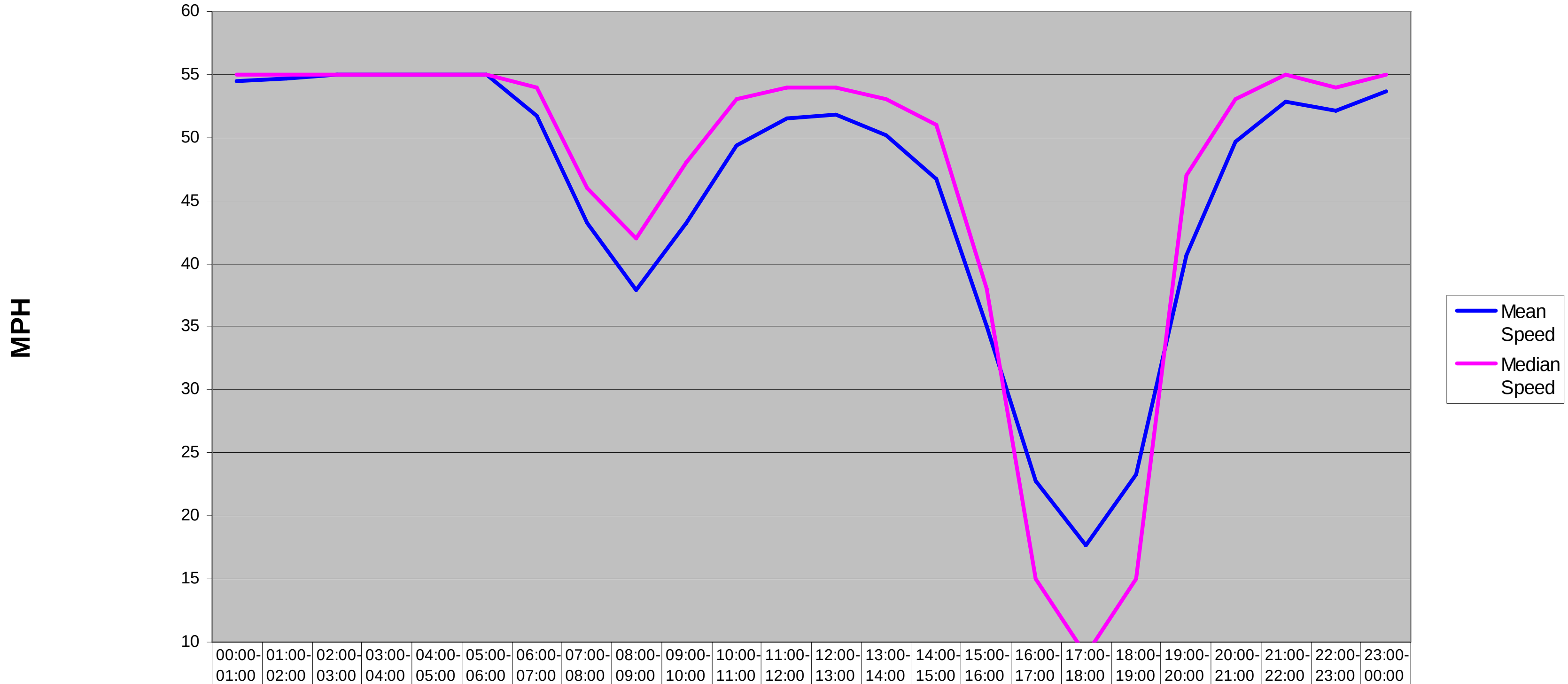
Bottleneck Location: Atlanta, Georgia; Interstates 85 and 285; “Spaghetti Junction”

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 1 mile in each direction for a total of approximately 3 miles in the study area.

Positions: There were approximately 71,865 truck position reads used in this analysis.

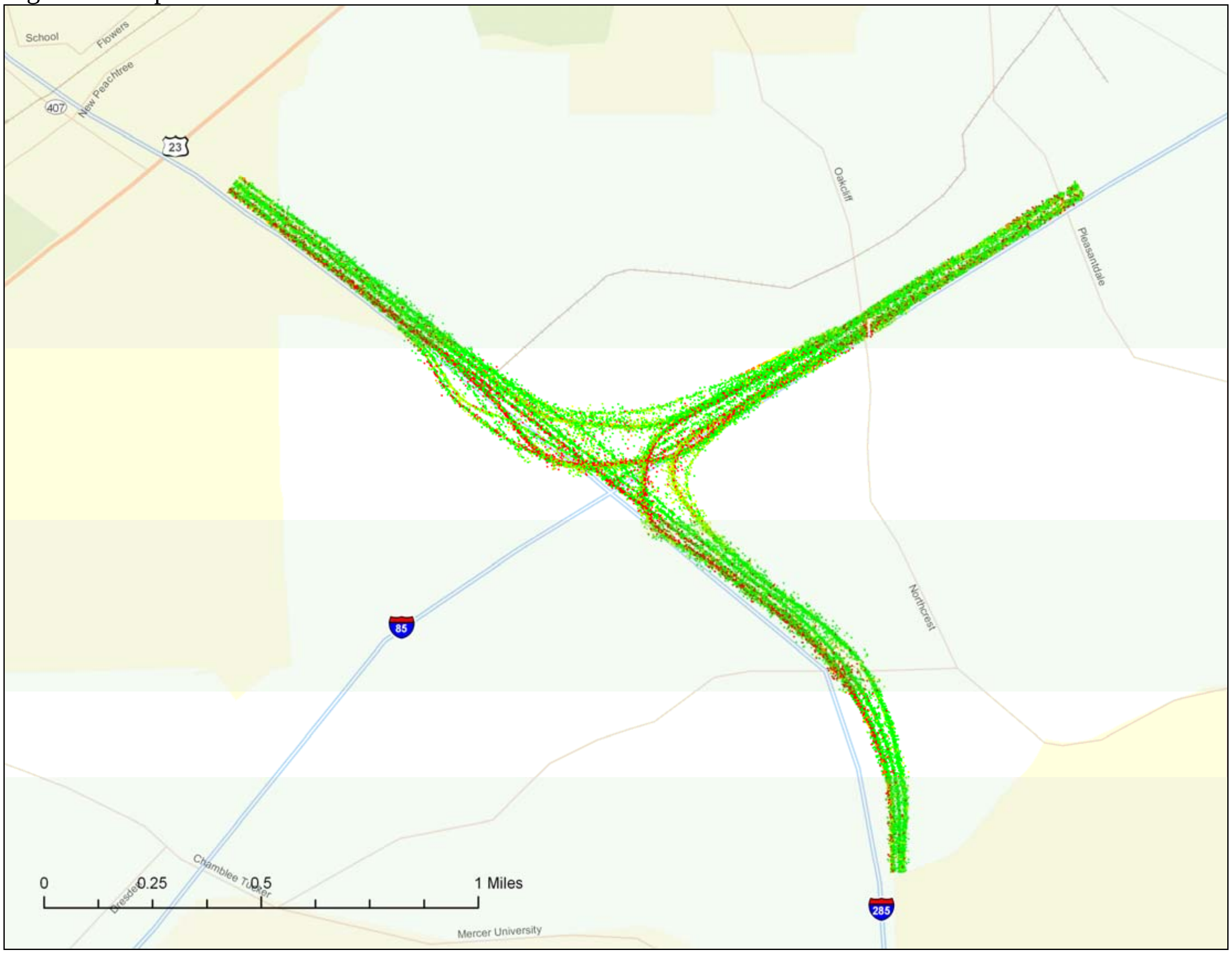
Mean & Median Speed by Time of Day
Atlanta: I-85 at I-285



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	54.48	54.68	55	55	55	55	51.74	43.23	37.95	43.21	49.39	51.51	51.83	50.2	46.71	35.1	22.82	17.69	23.26	40.63	49.68	52.88	52.16	53.71
Median Speed	55	55	55	55	55	55	54	46	42	48	53	54	54	53	51	38	15	9	15	47	53	55	54	55

Time of Day

Figure 1: Map of Location



Bottleneck 04: Atlanta, Georgia

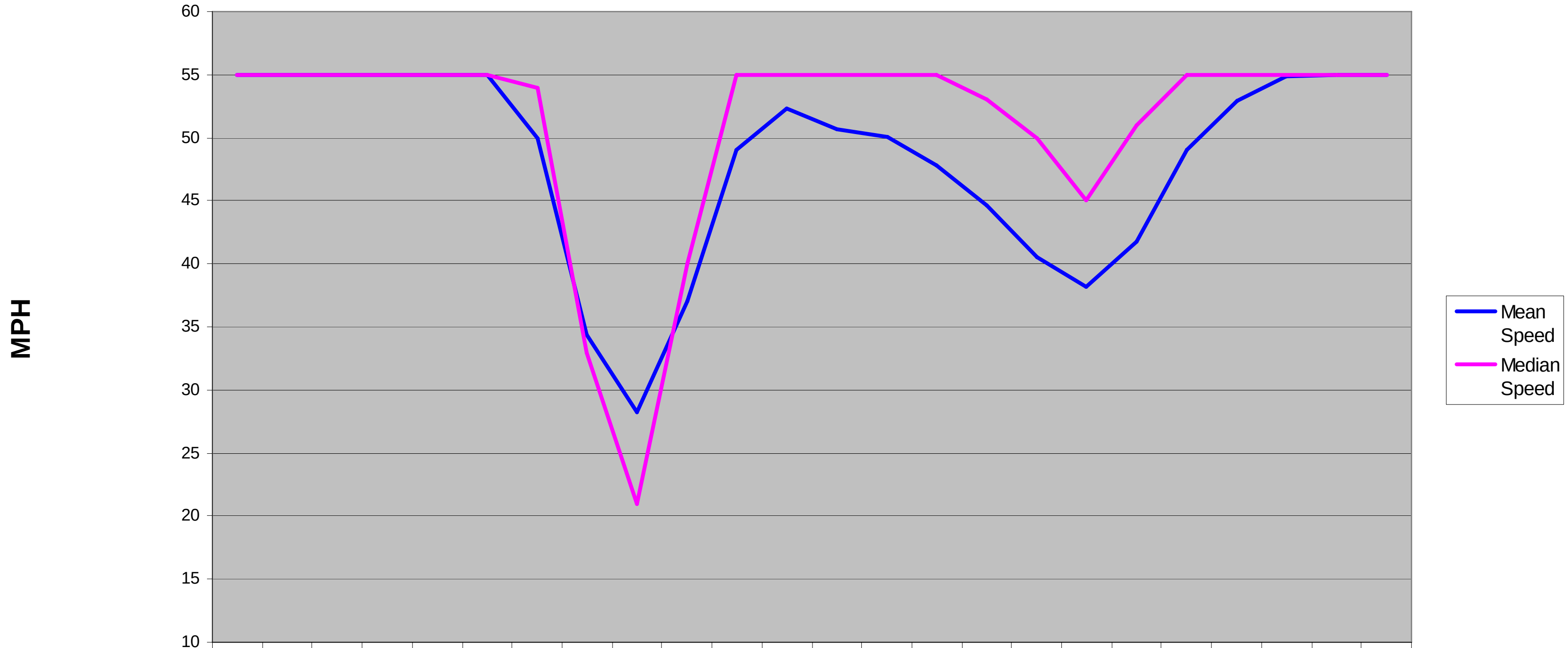
Bottleneck Location: Atlanta, Georgia, Interstate 20 at Interstate 85/75

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 8 miles in the study area.

Positions: There were approximately 27,537 truck position reads used in this analysis.

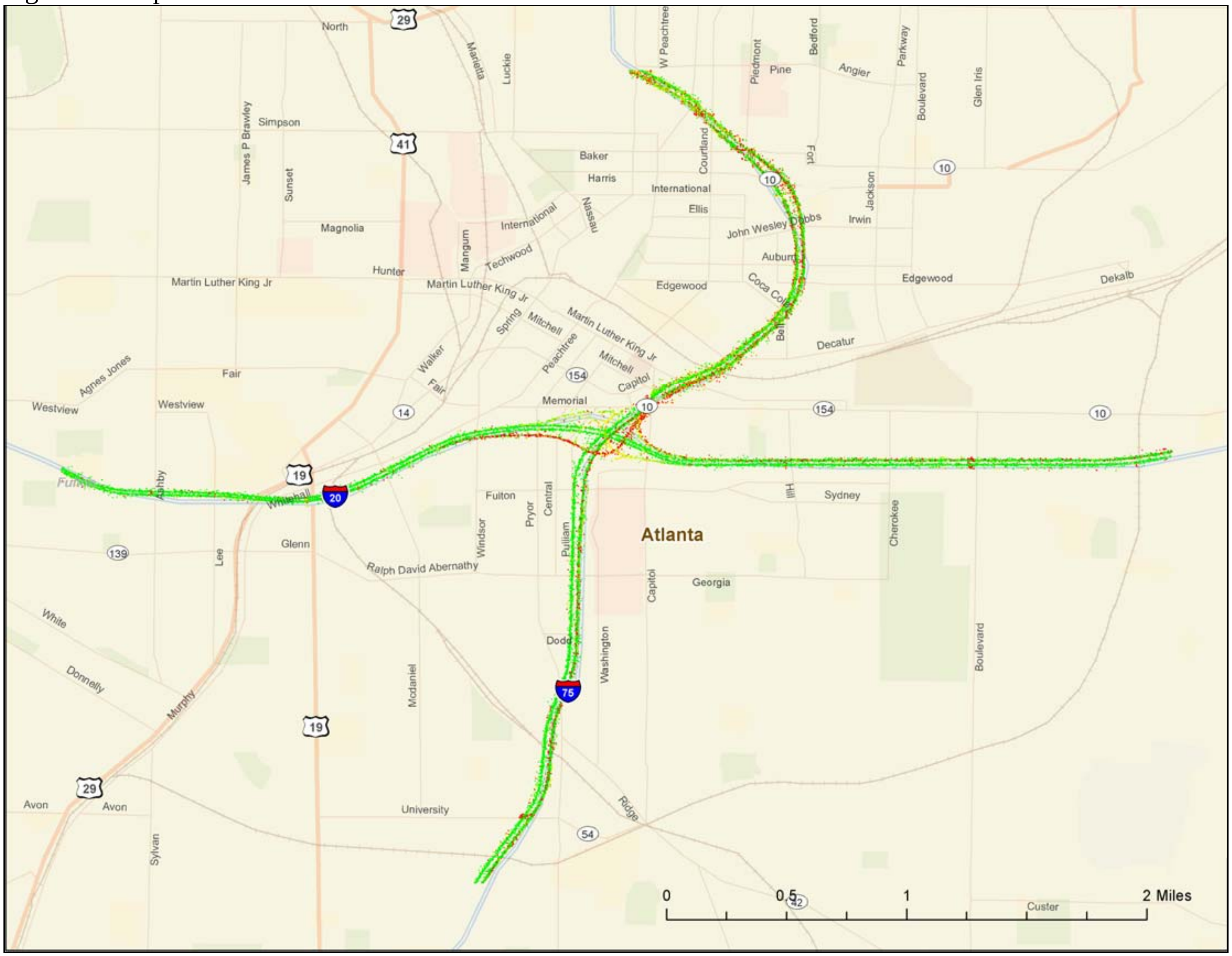
Mean & Median Speed by Time of Day
Atlanta: I-20 at I-85/75



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	49.91	34.4	28.28	37.06	49.06	52.31	50.69	50.02	47.84	44.58	40.49	38.14	41.81	49.06	52.95	54.85	55	55
Median Speed	55	55	55	55	55	55	54	33	21	40	55	55	55	55	55	53	50	45	51	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 05: Chicago, Illinois

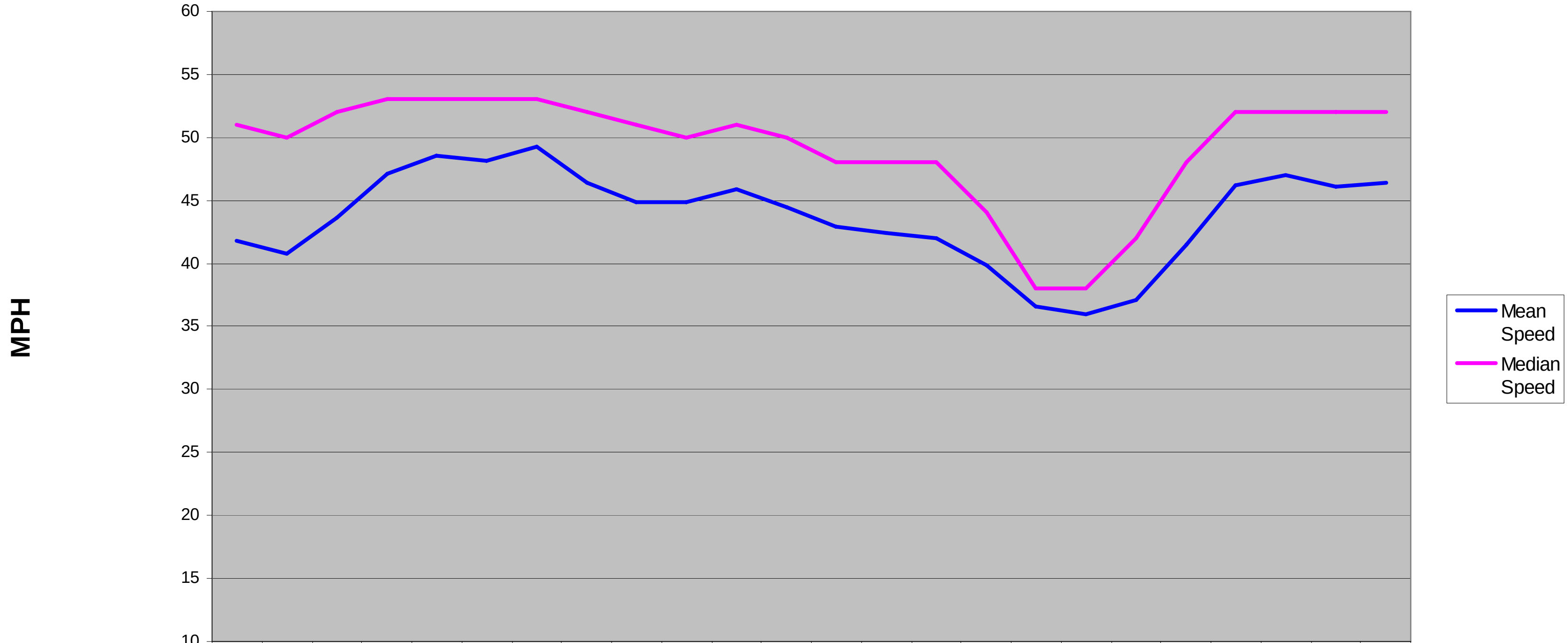
Bottleneck Location: Chicago, Illinois, Interstate 80 at Interstate 94.

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 8 miles in the study area.

Positions: There were approximately 227,478 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Chicago: I-80 at I-94

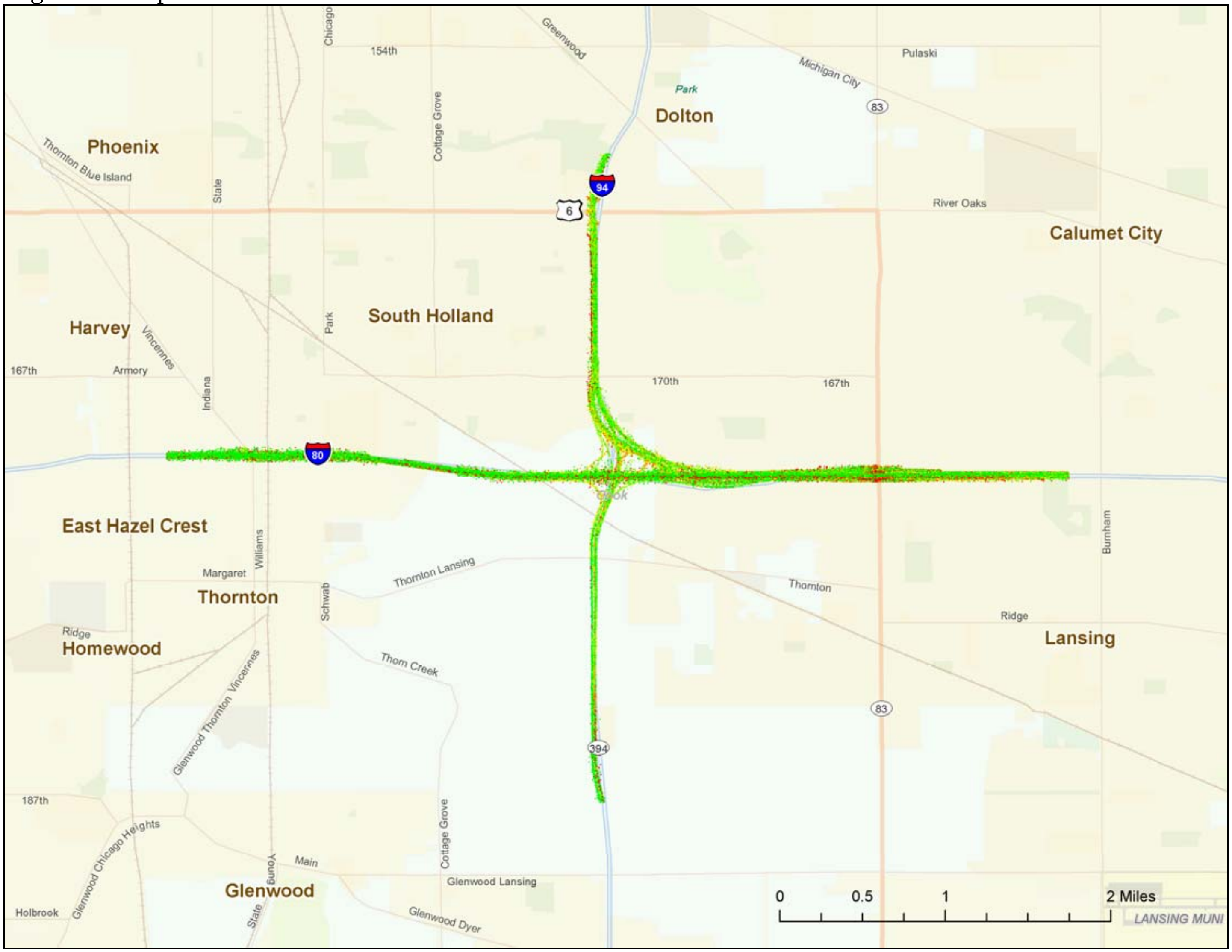


	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00
Mean Speed	41.84	40.78	43.63	47.15	48.54	48.15	49.24	46.43	44.89	44.84	45.87	44.47
Median Speed	51	50	52	53	53	53	53	52	51	50	51	50

	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	42.94	42.45	41.96	39.85	36.62	36.02	37.09	41.49	46.24	47.04	46.1	46.36
Median Speed	48	48	48	44	38	38	42	48	52	52	52	52

Time of Day

Figure 1: Map of Location



Bottleneck 06: Industry, California

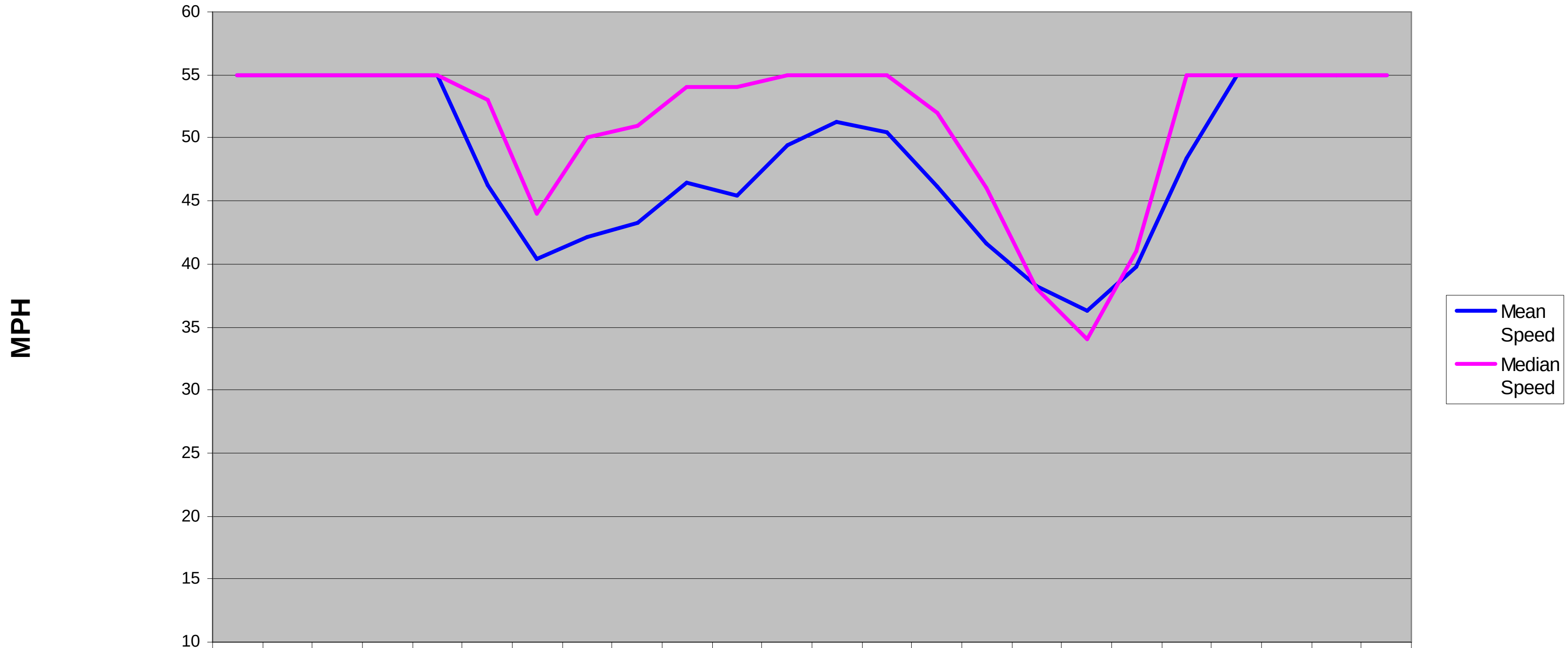
Bottleneck Location: Industry, California, Highways 60 and 57 (near Los Angeles)

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: The study area covers approximately 10 miles.

Positions: There were approximately 52,140 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Industry, CA: SR-60/57 Interchange



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	46.23	40.41	42.19	43.3	46.46	45.46	49.41	51.26	50.49	46.18	41.61	38.2	36.27	39.82	48.42	55	55	55	55
Median Speed	55	55	55	55	55	53	44	50	51	54	54	55	55	55	52	46	38	34	41	55	55	55	55	55

Time of Day

Figure 1: Map of Location

Bottleneck 07: Oakland, California

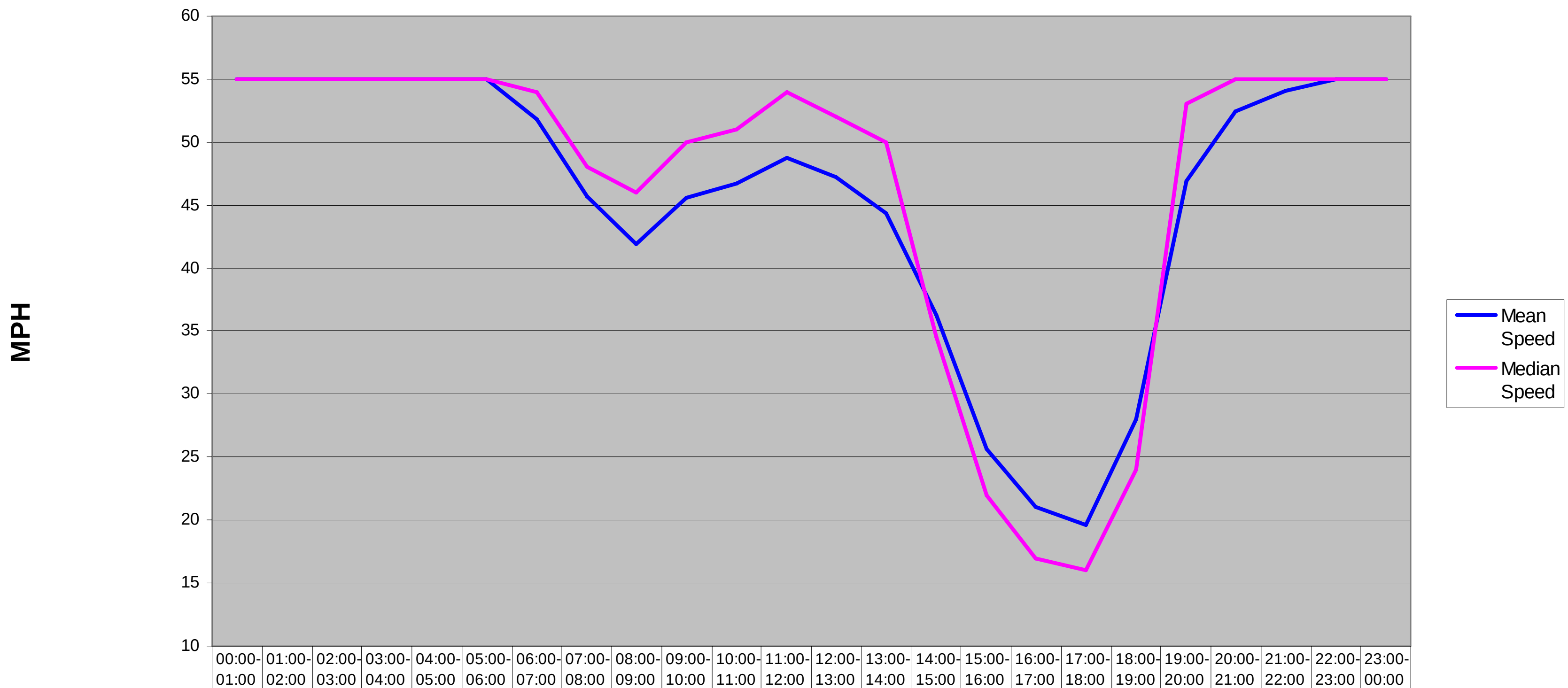
Bottleneck Location: Oakland, California, Interstate 80 at Interstate 580

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 4 miles in the study area.

Positions: There were approximately 10,347 truck position reads used in this analysis.

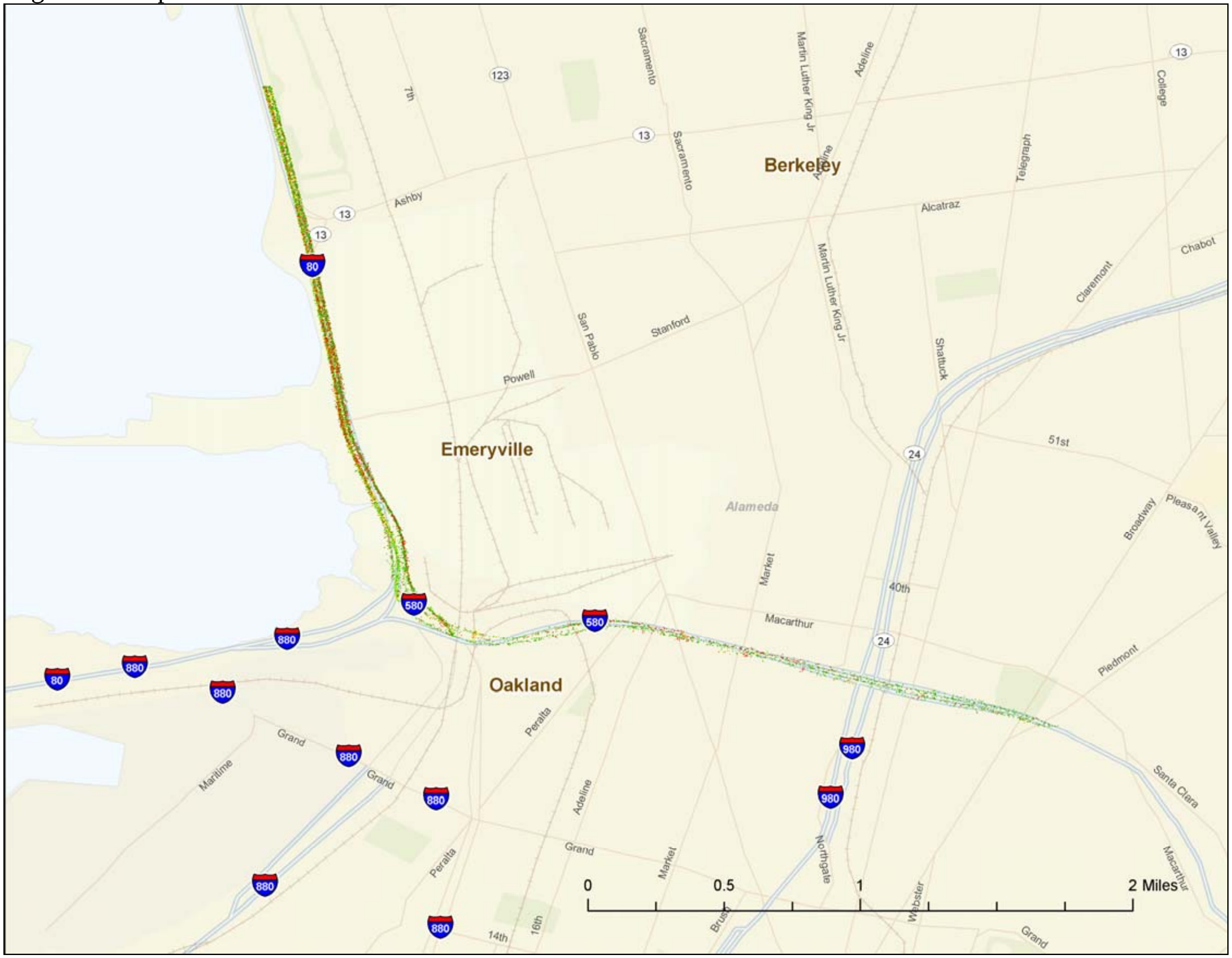
Mean & Median Speed by Time of Day
Oakland: I-80 at I-580



Time of Day	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	51.78	45.67	41.95	45.56	46.68	48.79	47.21	44.34	36.3	25.69	21.05	19.6	28.03	46.9	52.46	54.06	55	55
Median Speed	55	55	55	55	55	55	54	48	46	50	51	54	52	50	34.5	22	17	16	24	53	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 08: Long Beach, California

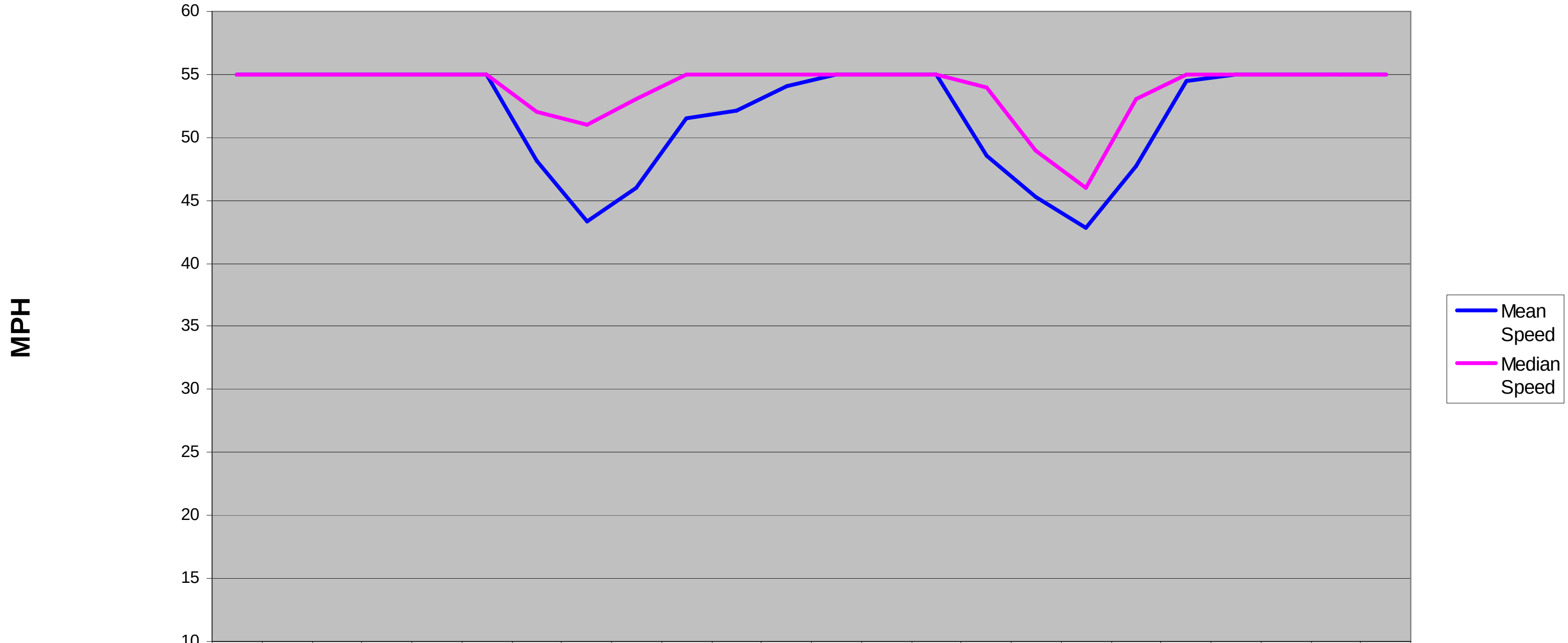
Bottleneck Location: Long Beach, California, Interstate 405 at Interstate 605

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 4,426 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Long Beach:I-405 at I-605



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	48.17	43.29	46.01	51.48	52.16	54.03	55	54.95	55	48.57	45.26	42.78	47.75	54.49	55	55	55	55
Median Speed	55	55	55	55	55	55	52	51	53	55	55	55	55	55	55	54	49	46	53	55	55	55	55	55

Time of Day

Figure 1: Map of Location

Bottleneck 09: Chicago, Illinois

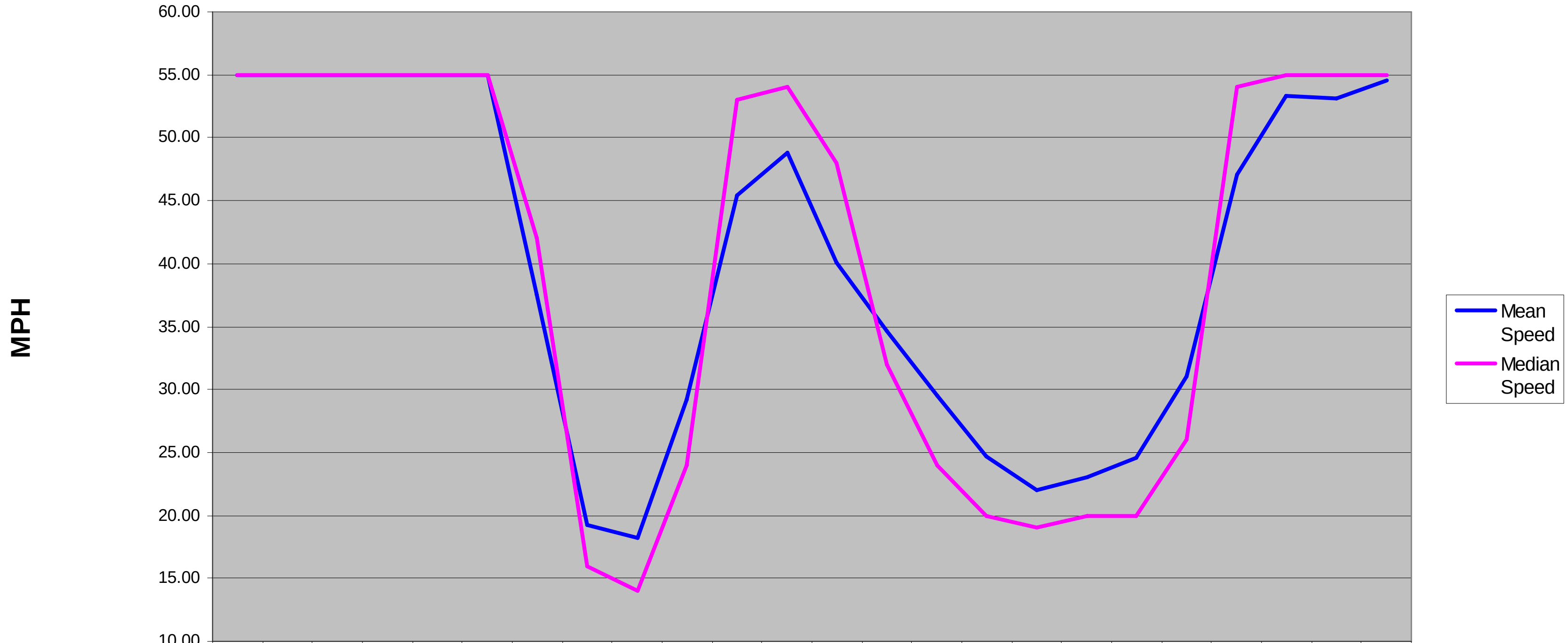
Bottleneck Location: Chicago, Illinois , Interstate 94/90 Interchange (Edens)

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 6 miles.

Positions: There were approximately 49,923 truck position reads used in this analysis.

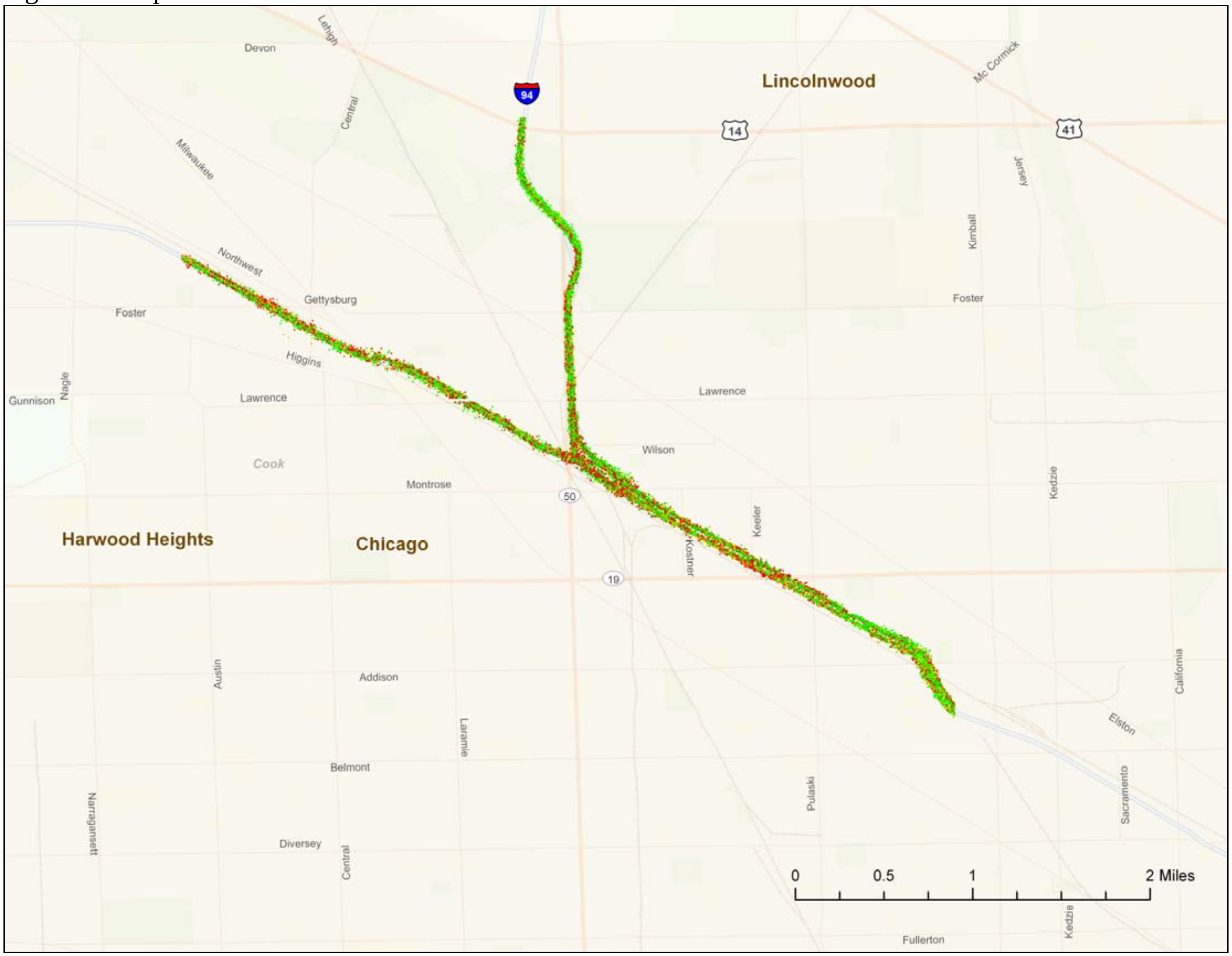
Mean & Median Speed by Time of Day
Chicago: I-90/I-94 (Edens Interchange)



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55.00	55.00	55.00	55.00	55.00	55.00	37.50	19.24	18.21	29.22	45.39	48.77	40.07	34.62	29.56	24.70	22.06	22.99	24.60	31.02	47.03	53.28	53.13	54.59
Median Speed	55	55	55	55	55	55	42	16	14	24	53	54	48	32	24	20	19	20	20	26	54	55	55	55

Time of Day

Figure 1: Map of Location



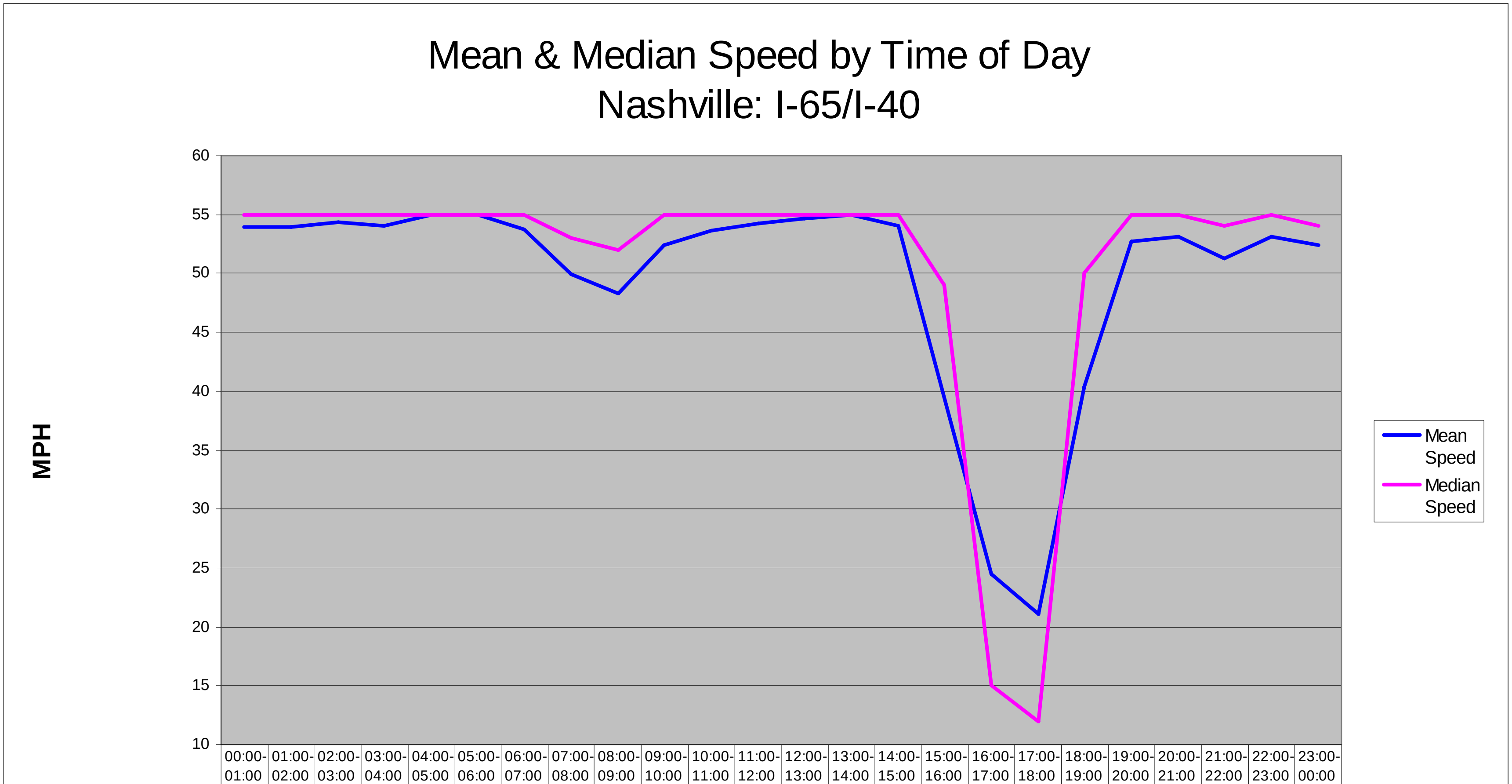
Bottleneck 10: Nashville, Tennessee

Bottleneck Location: Nashville, Tennessee, Interstates 65 and 40

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

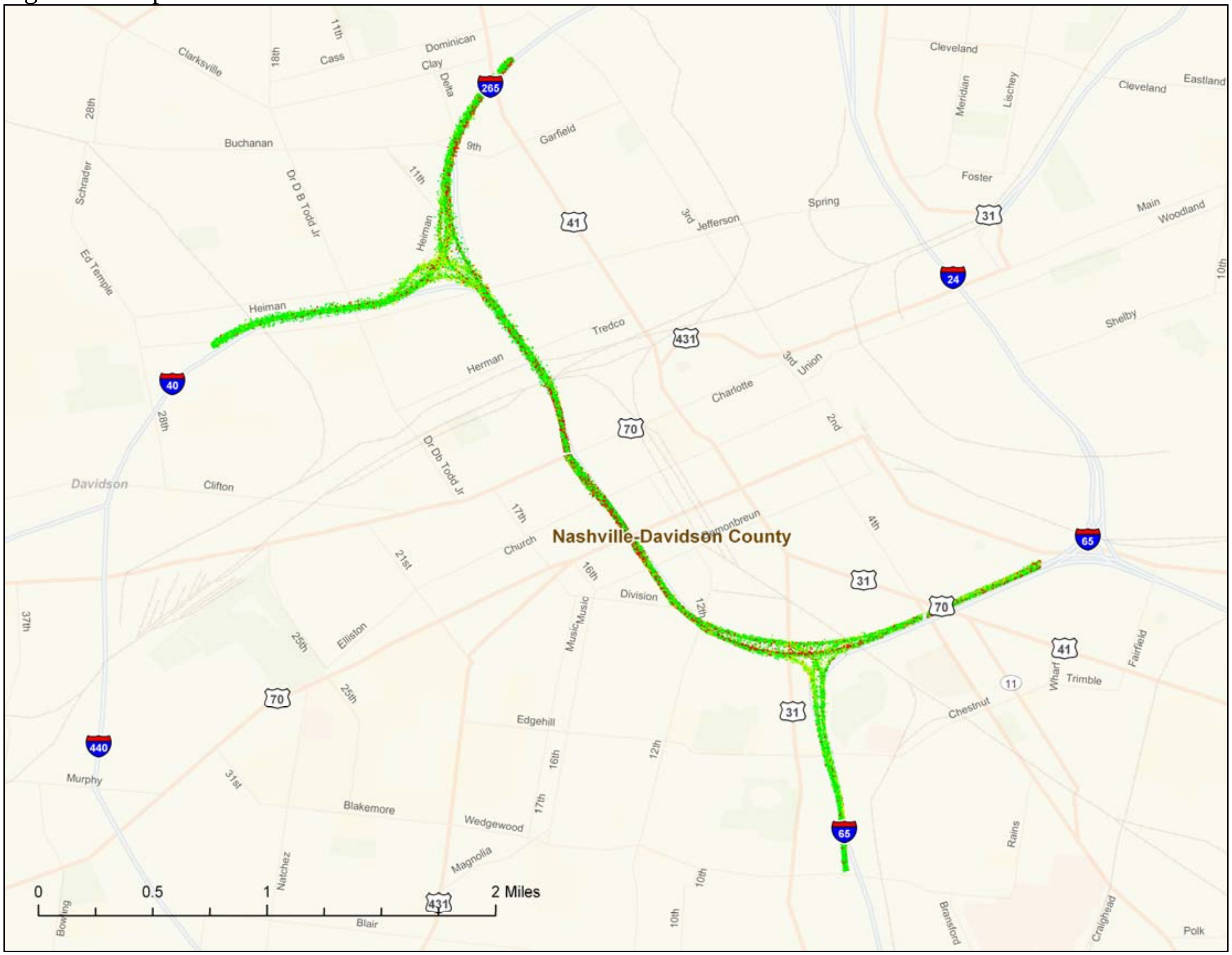
Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 51,313 truck position reads used in this analysis.



Time of Day	Mean Speed	Median Speed
00:00-01:00	53.93	55
01:00-02:00	53.96	55
02:00-03:00	54.4	55
03:00-04:00	54.08	55
04:00-05:00	55	55
05:00-06:00	55	55
06:00-07:00	53.77	55
07:00-08:00	49.9	53
08:00-09:00	48.25	52
09:00-10:00	52.4	55
10:00-11:00	53.58	55
11:00-12:00	54.25	55
12:00-13:00	54.66	55
13:00-14:00	55	55
14:00-15:00	54.05	55
15:00-16:00	39.43	49
16:00-17:00	24.52	15
17:00-18:00	21.05	12
18:00-19:00	40.36	50
19:00-20:00	52.76	55
20:00-21:00	53.08	55
21:00-22:00	51.31	54
22:00-23:00	53.16	55
23:00-00:00	52.38	54

Figure 1: Map of Location



Bottleneck 11: Chicago, Illinois

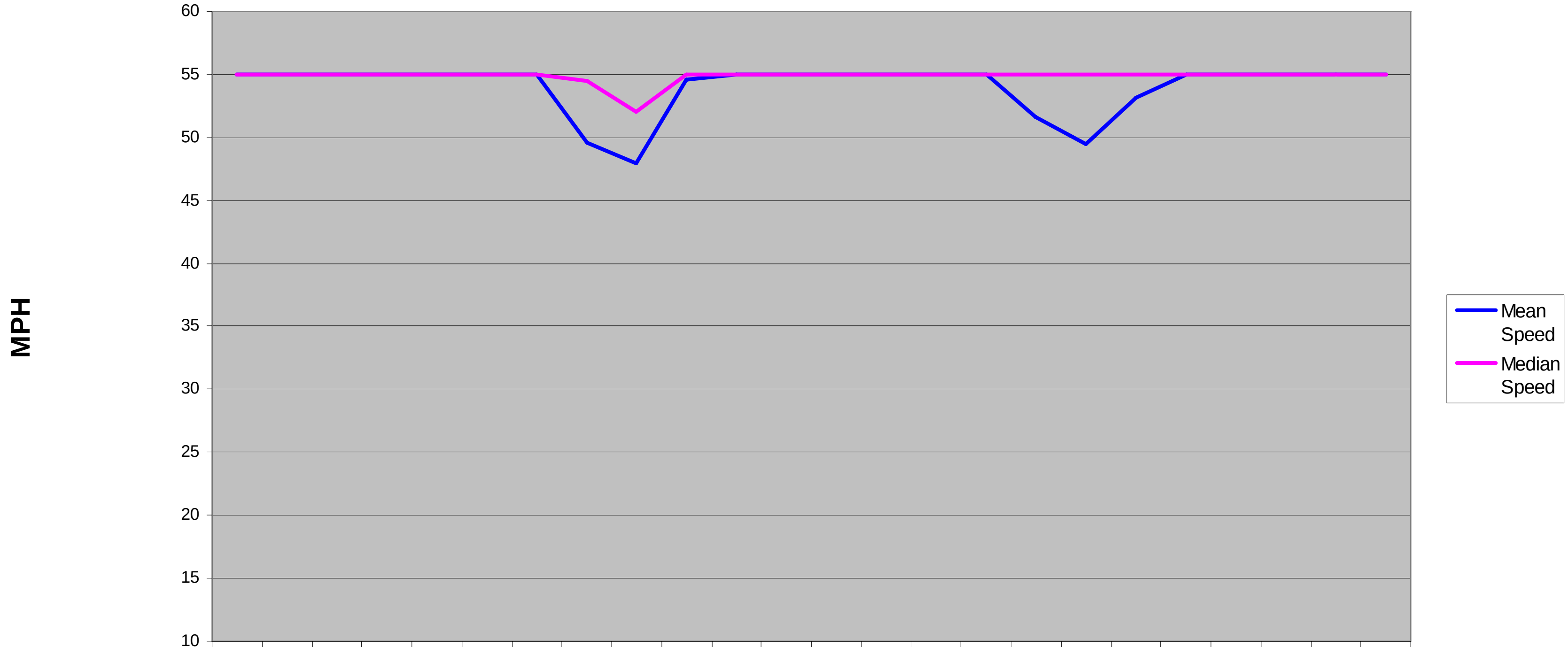
Bottleneck Location: Chicago, Illinois, Interstate 280 at Interstate 355

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 6 miles in the study area.

Positions: There were approximately 49,546 truck position reads used in this analysis.

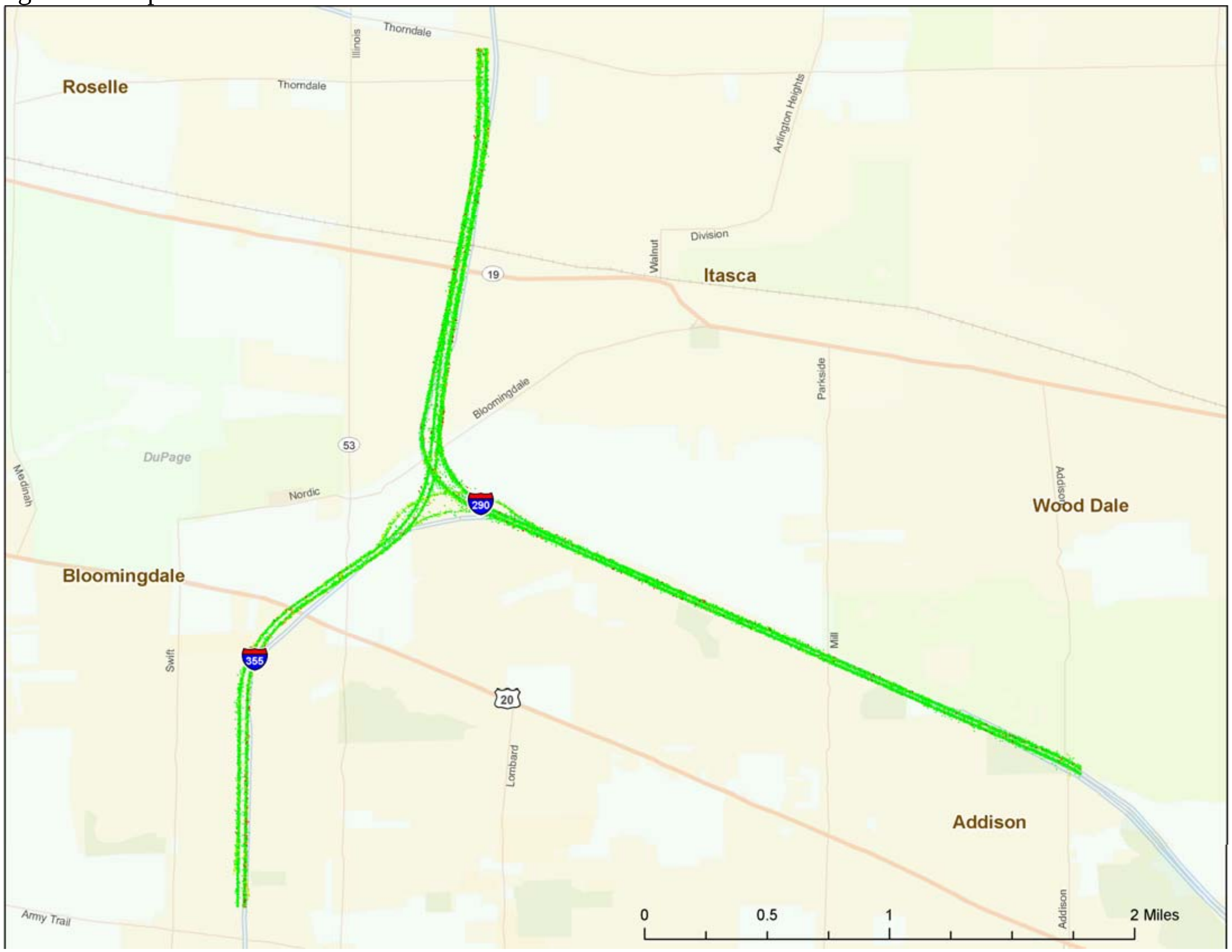
Mean & Median Speed by Time of Day
Chicago:I-280 at I-355



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	55	49.62	47.89	54.56	55	55	55	55	55	55	51.62	49.44	53.1	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	54.5	52	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 12: Atlanta, Georgia

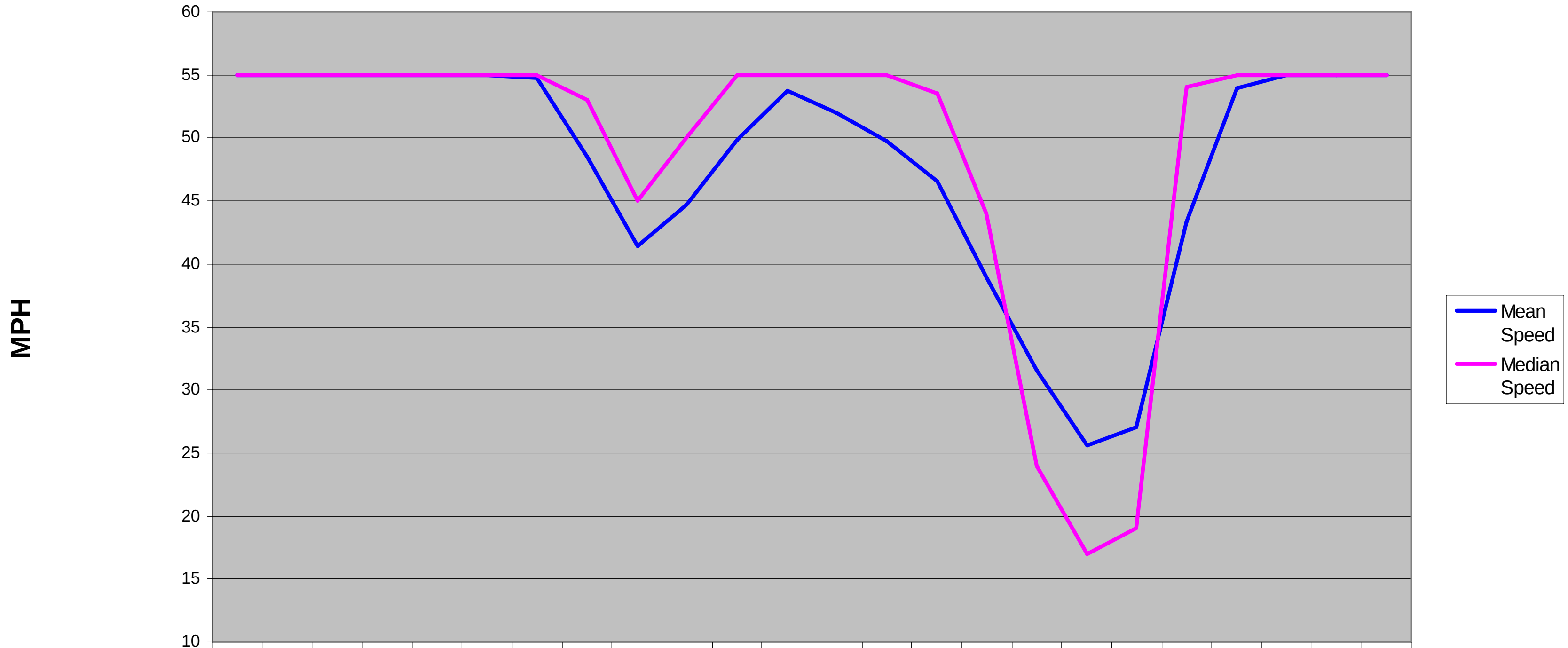
Bottleneck Location: Atlanta, Georgia, Interstate 75 and 85 Interchange (Brookwood) in Fulton County

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 6 miles.

Positions: There were approximately 18,270 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Atlanta: I-85/75 (Brookwood Interchange)



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	54.74	48.48	41.4	44.68	49.82	53.7	51.94	49.71	46.56	38.94	31.53	25.58	27.09	43.36	53.96	55	55	55
Median Speed	55	55	55	55	55	55	55	53	45	50	55	55	55	55	53.5	44	24	17	19	54	55	55	55	55

Time of Day

Figure 1: Map of Location

Bottleneck 13: New York, New York

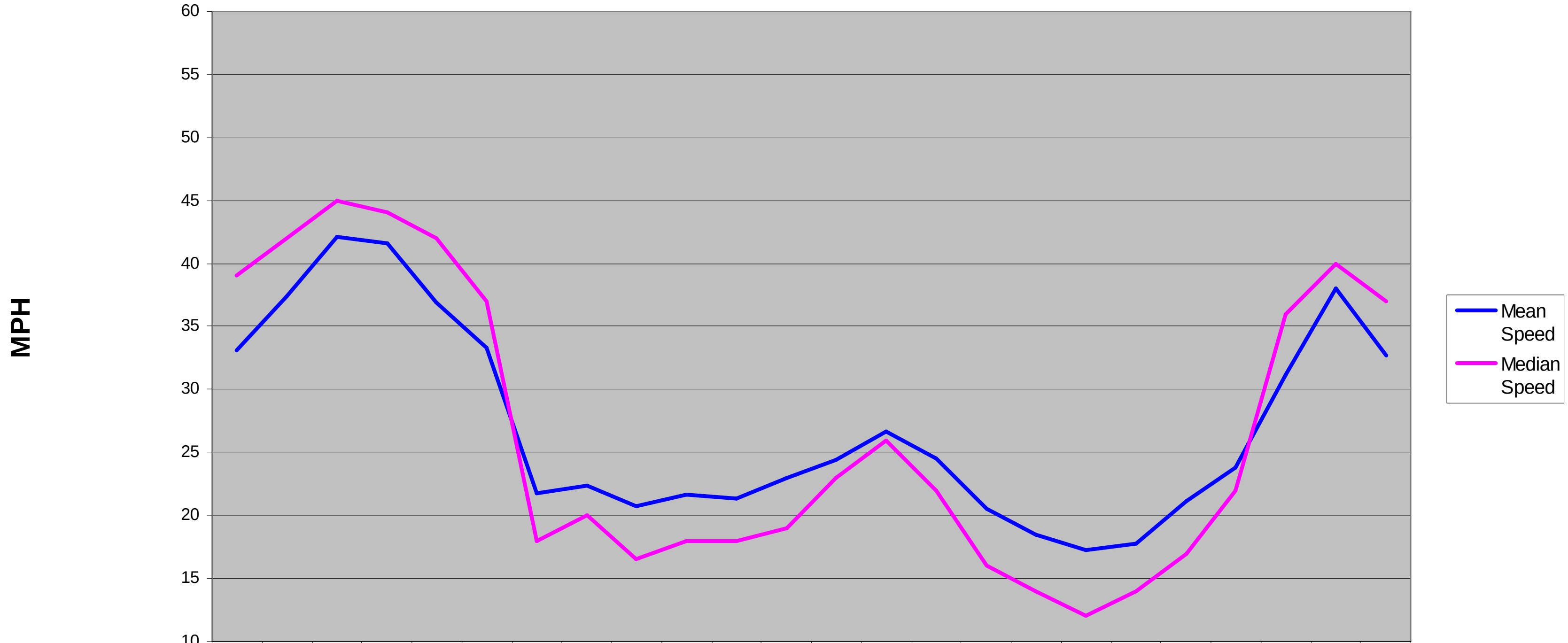
Bottleneck Location: New York, New York, Interstate 95 near SR-9A (Westside Highway)

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: The study area is approximately 2 miles.

Positions: There were approximately 21,896 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
New York City: I-95



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	33.14	37.38	42.11	41.64	36.93	33.34	21.74	22.41	20.71	21.68	21.36	22.95	24.46	26.7	24.51	20.52	18.54	17.23	17.8	21.18	23.76	31.15	37.99	32.68
Median Speed	39	42	45	44	42	37	18	20	16.5	18	18	19	23	26	22	16	14	12	14	17	22	36	40	37

Time of Day

Figure 1: Map of Location

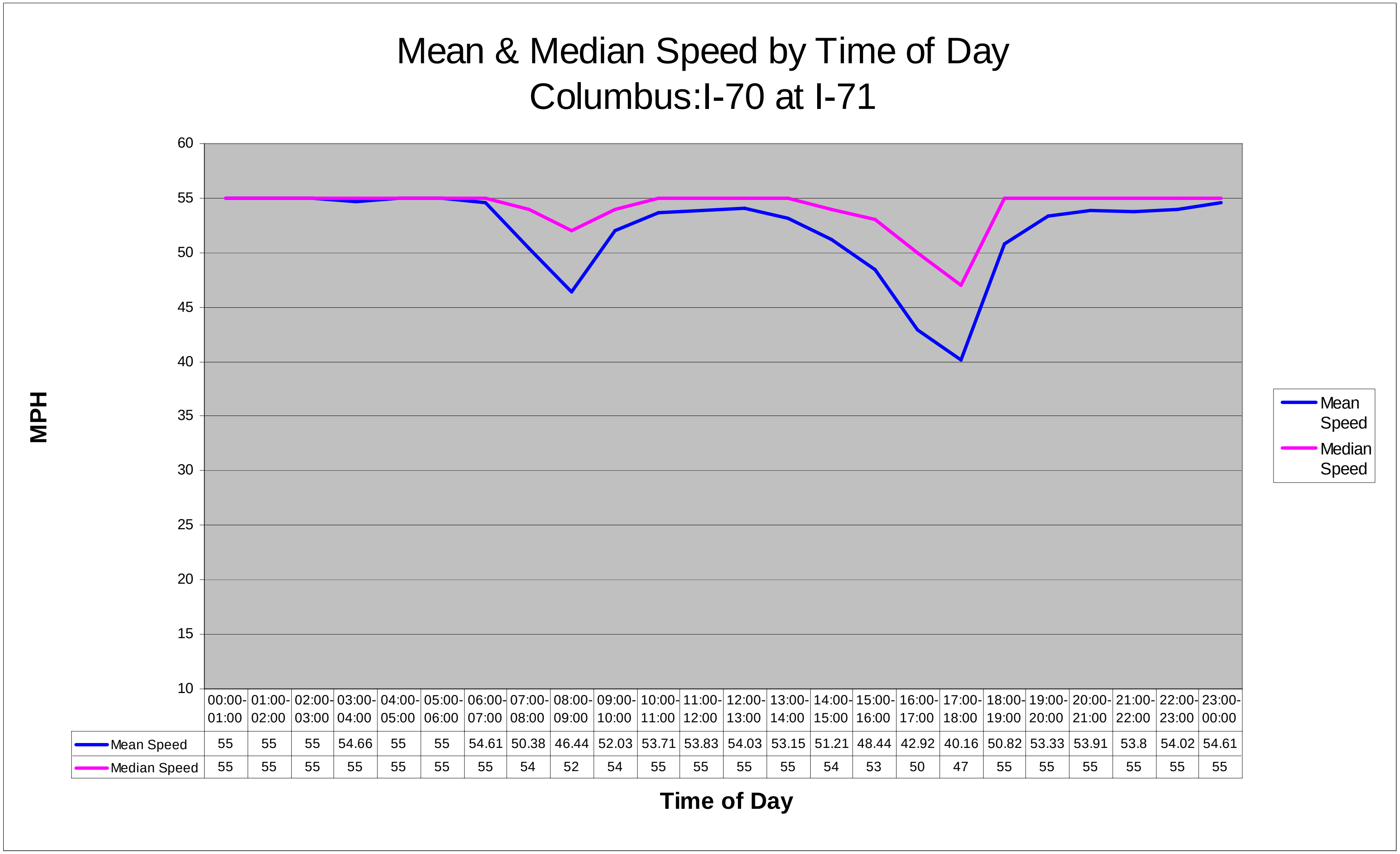
Bottleneck 14: Columbus, Ohio

Bottleneck Location: Columbus, Ohio, Interstate 70 at Interstate 71

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

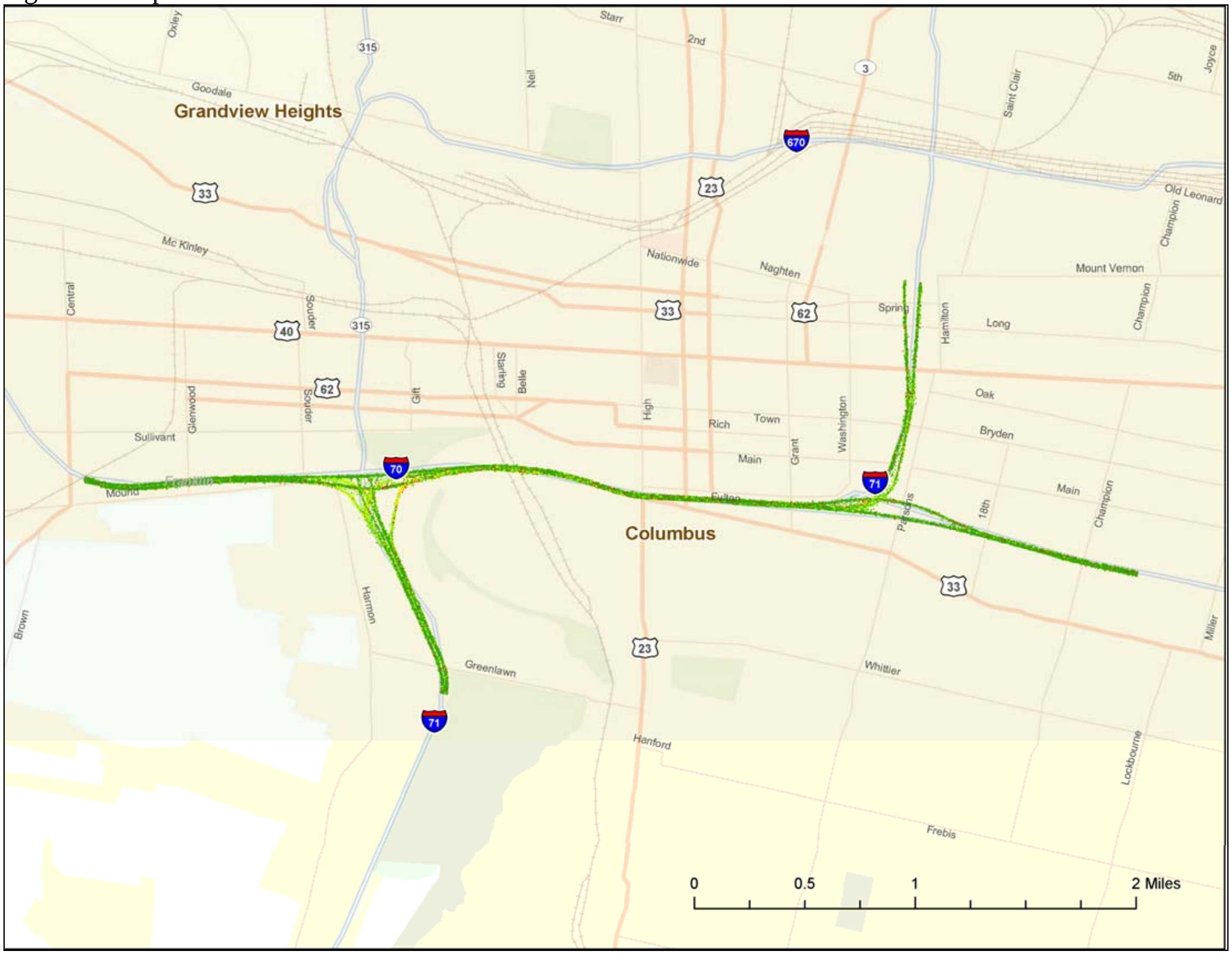
Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 40,718 truck position reads used in this analysis.



Time of Day	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	54.66	55	55	54.61	50.38	46.44	52.03	53.71	53.83	54.03	53.15	51.21	48.44	42.92	40.16	50.82	53.33	53.91	53.8	54.02	54.61
Median Speed	55	55	55	55	55	55	55	54	52	54	55	55	55	55	54	53	50	47	55	55	55	55	55	55

Figure 1: Map of Location



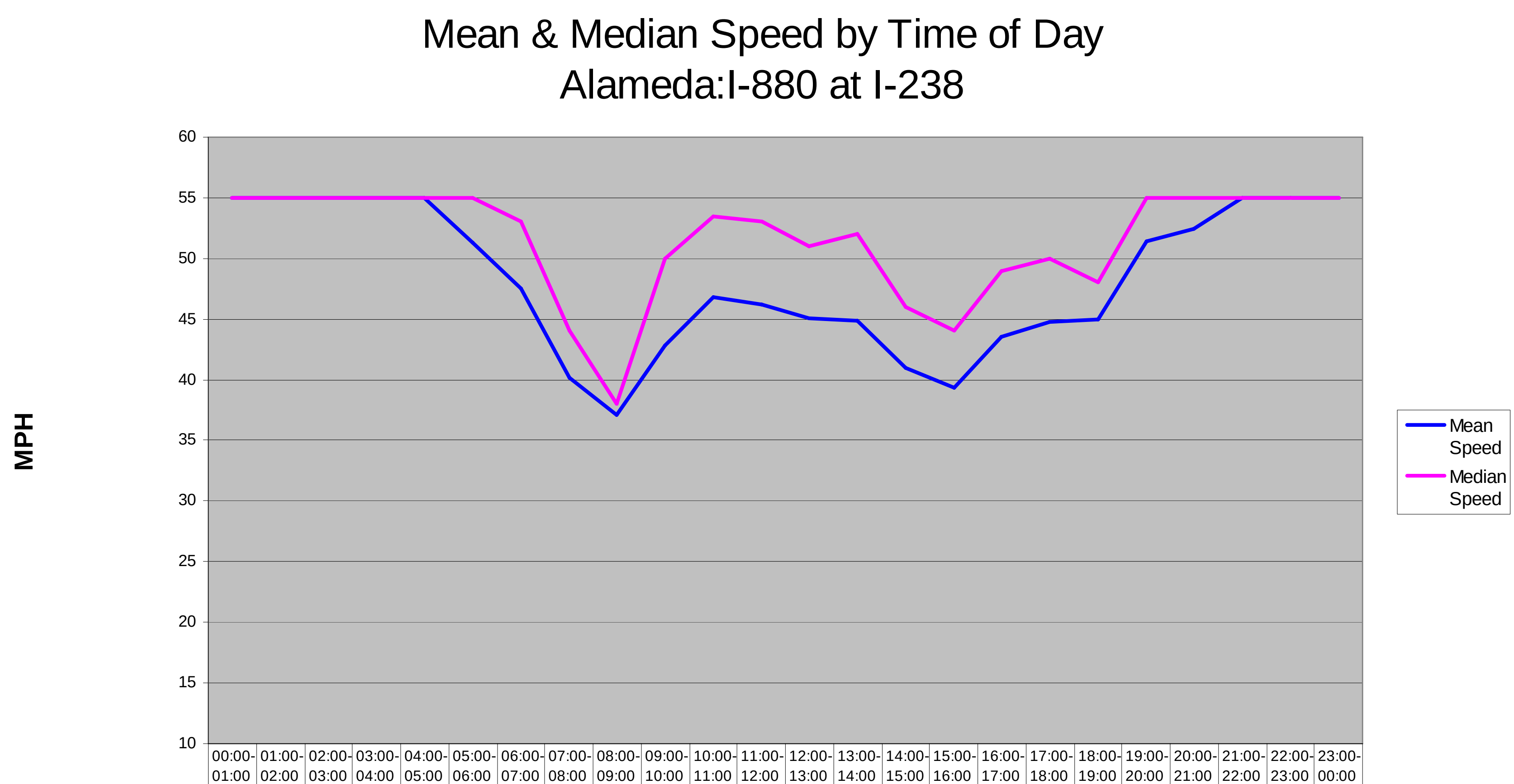
Bottleneck 15: Alameda, California

Bottleneck Location: Alameda, California, Interstate 880 at 238

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

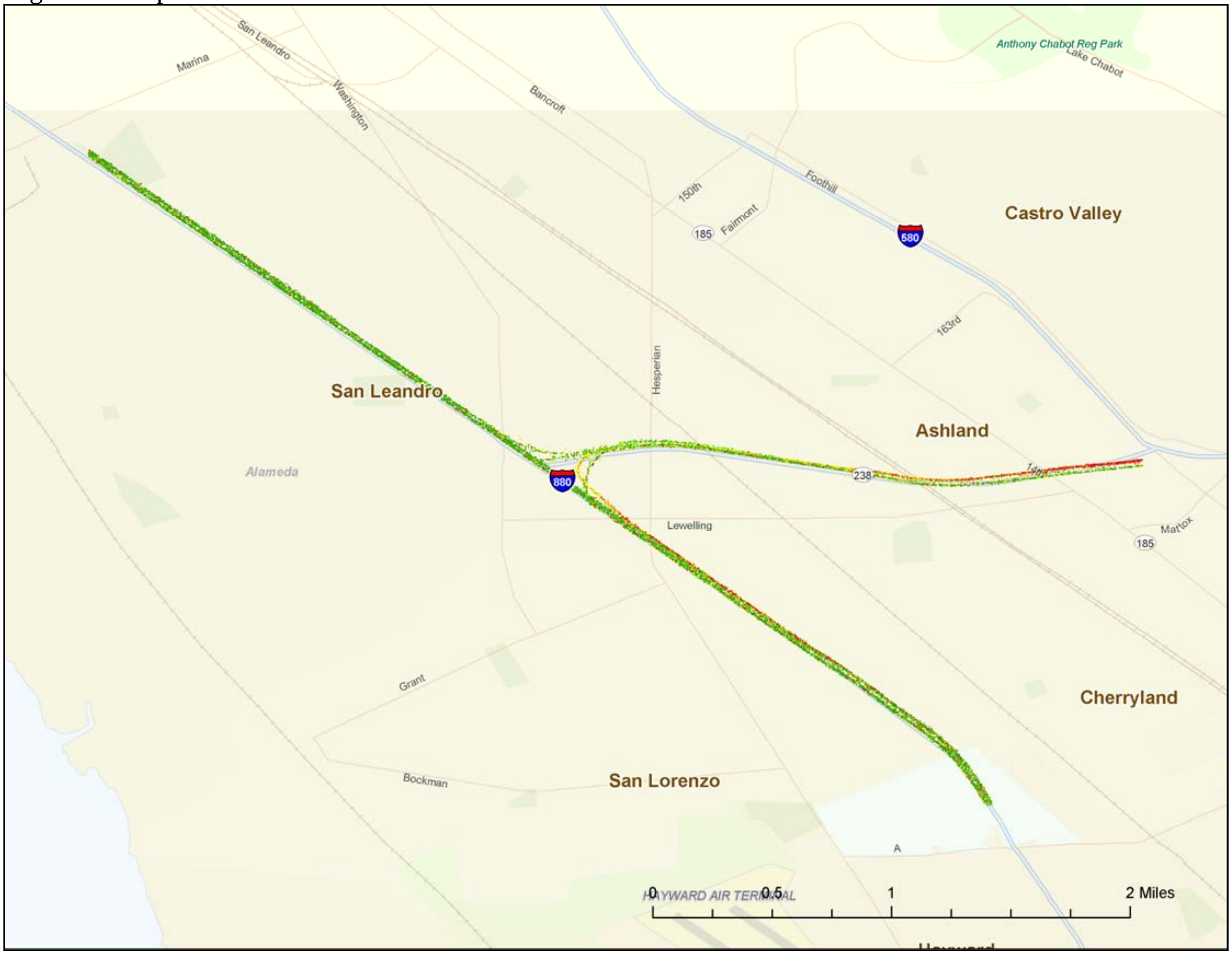
Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 13,550 truck position reads used in this analysis.



Time of Day	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	51.31	47.48	40.16	37.1	42.85	46.8	46.18	45.06	44.89	40.96	39.3	43.52	44.77	45	51.44	52.45	55	55	55
Median Speed	55	55	55	55	55	55	53	44	38	50	53.5	53	51	52	46	44	49	50	48	55	55	55	55	55

Figure 1: Map of Location



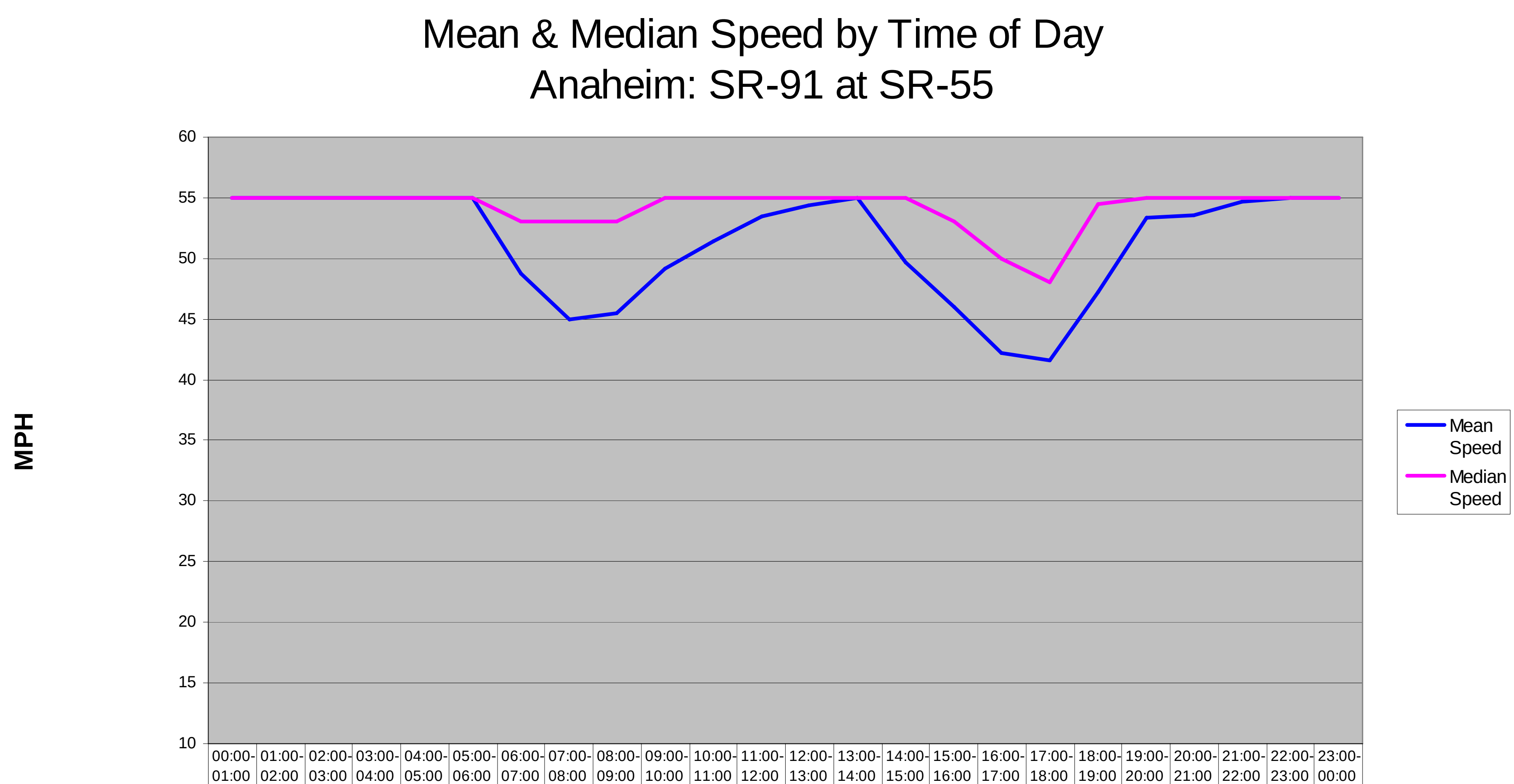
Bottleneck 16: Anaheim, California

Bottleneck Location: Anaheim, California, SR-91 at SR-55

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 8,163 truck position reads used in this analysis.



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	48.75	44.92	45.43	49.13	51.45	53.47	54.33	55	49.65	45.99	42.2	41.54	47.19	53.36	53.54	54.67	55	55
Median Speed	55	55	55	55	55	55	53	53	53	55	55	55	55	55	55	53	50	48	54.5	55	55	55	55	55

Figure 1: Map of Location

Bottleneck 17: Atlanta, Georgia (North)

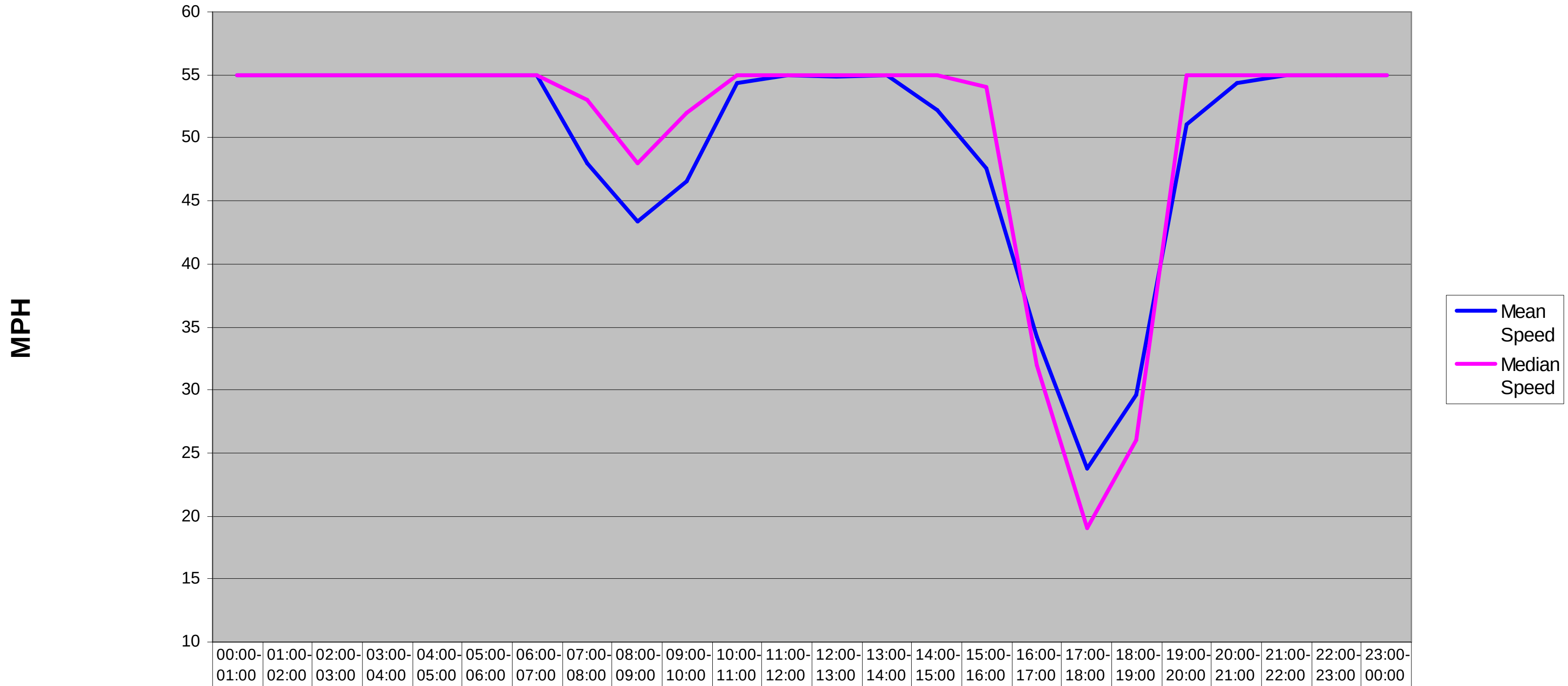
Bottleneck Location: Atlanta, Georgia, Interstate 285 at 75 Interchange in Cobb County

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 2 miles in each direction for a total of approximately 8 miles.

Positions: There were approximately 8,532 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Atlanta (North): I-285 at I-75



Time of Day	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	55	47.94	43.36	46.57	54.38	55	54.91	55	52.2	47.58	34.2	23.8	29.65	51.03	54.38	55	55	55
Median Speed	55	55	55	55	55	55	55	53	48	52	55	55	55	55	55	54	32	19	26	55	55	55	55	55

Time of Day

Figure 1: Map of Location

Bottleneck 18: Baltimore, Maryland

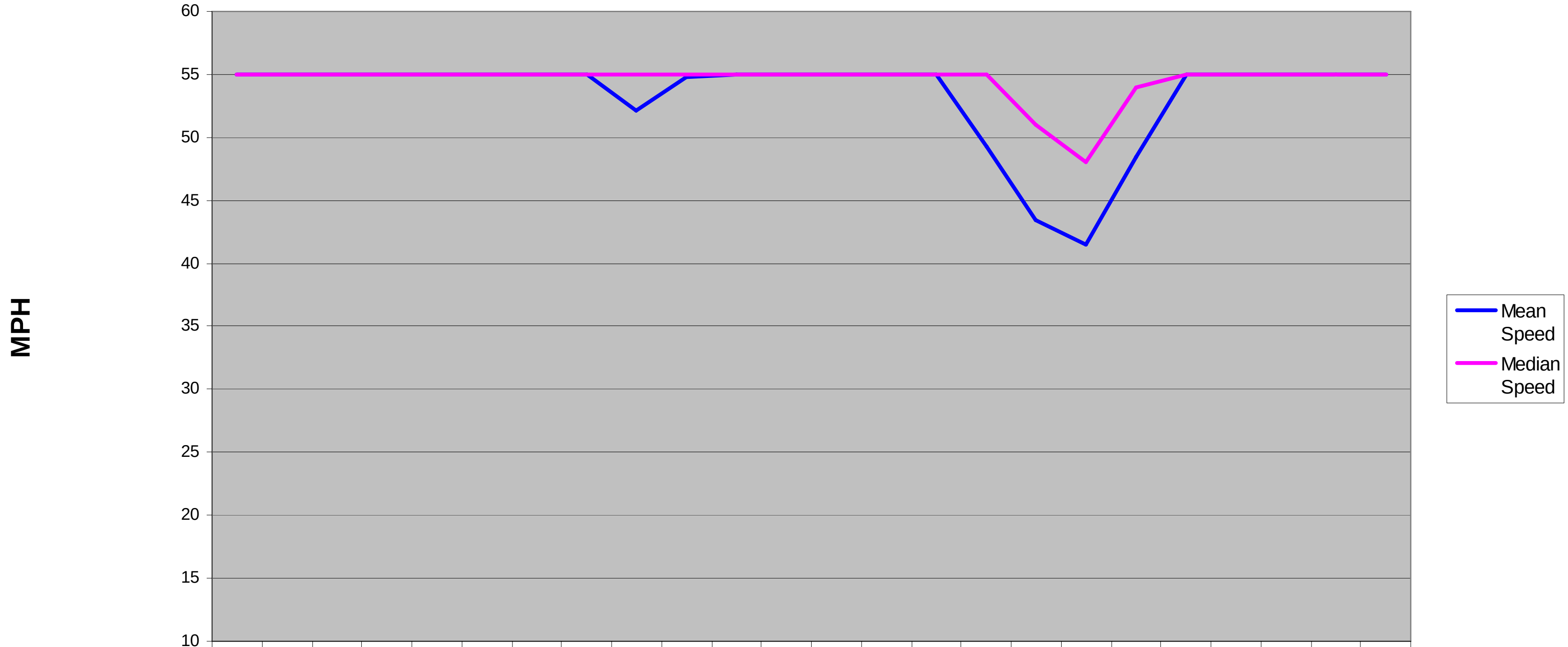
Bottleneck Location: Baltimore, Maryland, I-95 at I-695

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

Positions: There were approximately 59,523 truck position reads used in this analysis.

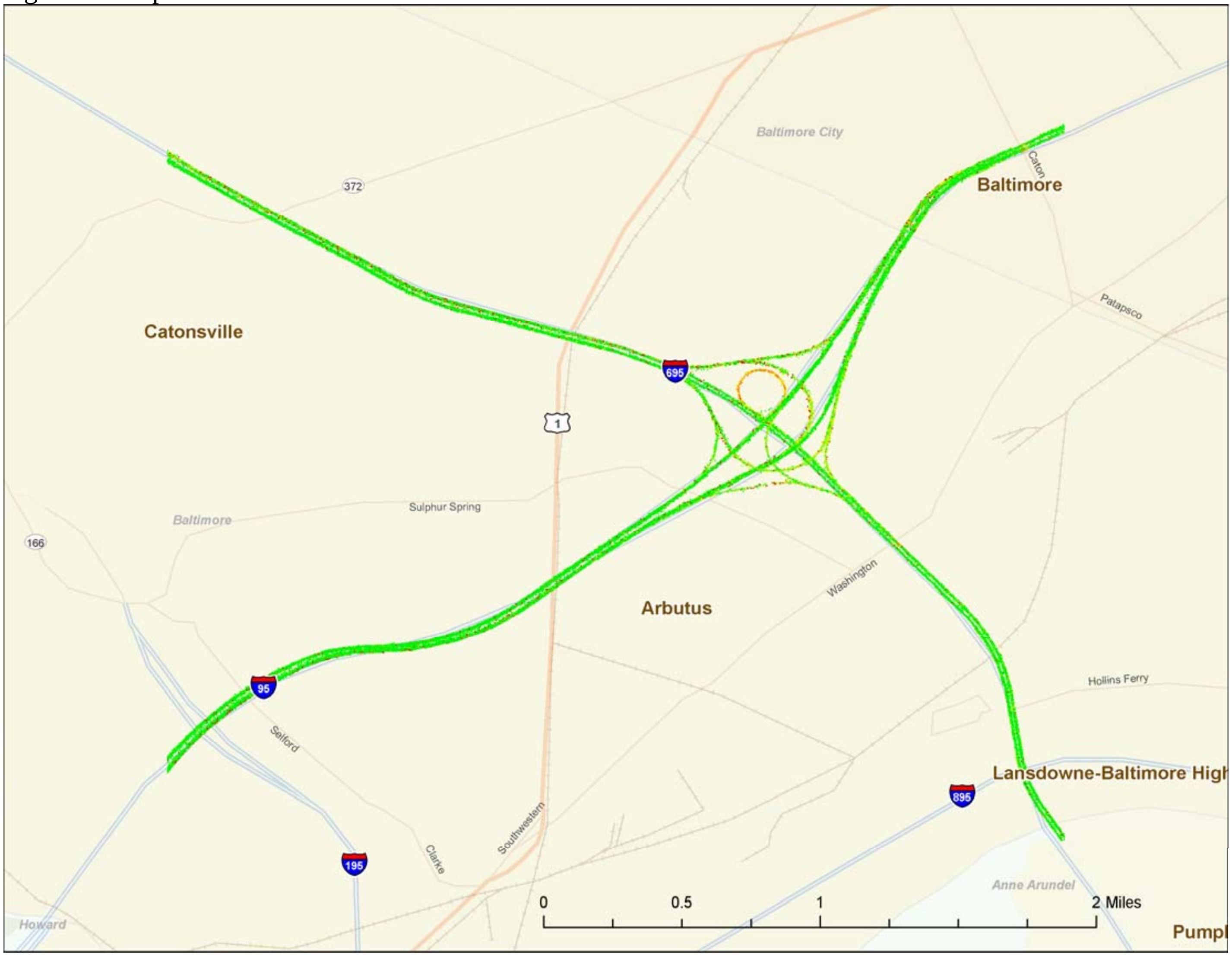
Mean & Median Speed by Time of Day
Baltimore: I-95 at I-695 (South)



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	55	55	52.09	54.84	55	55	55	55	55	49.24	43.46	41.47	48.43	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	51	48	54	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 19: Fort Lee, New Jersey

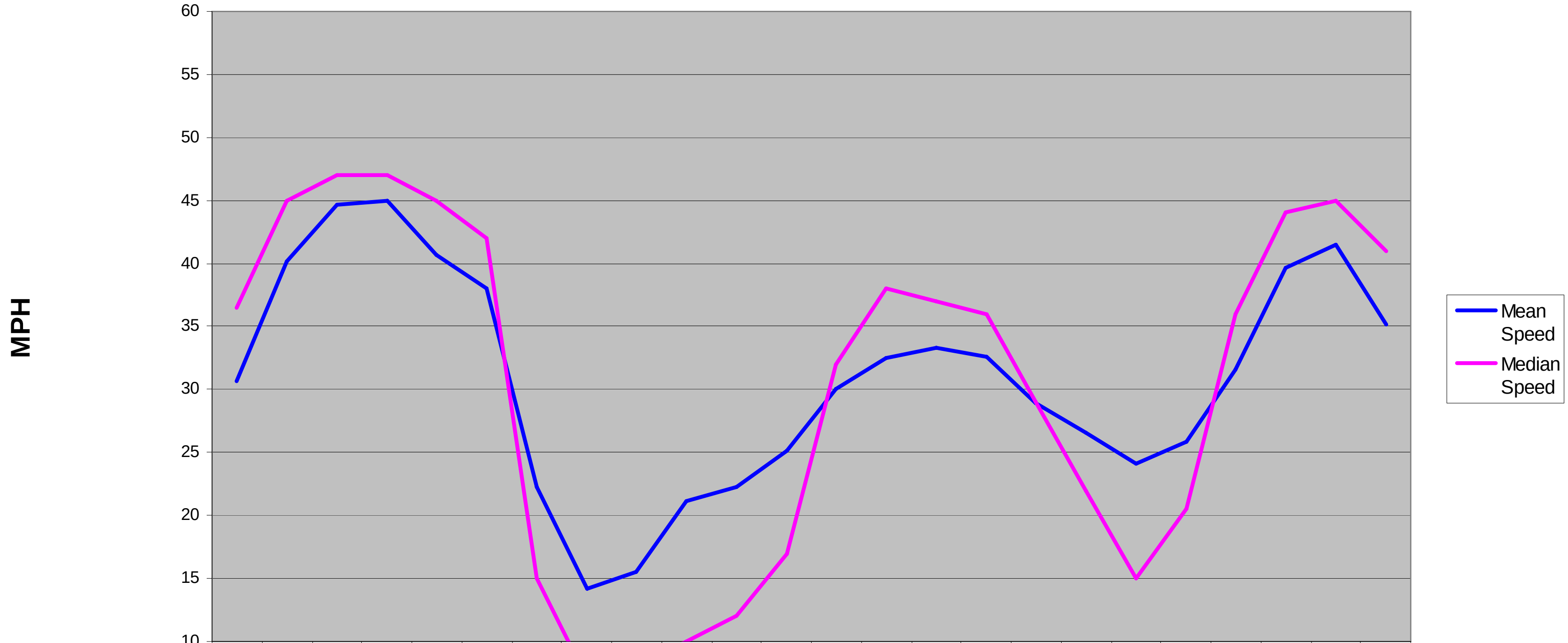
Bottleneck Location: Fort Lee, New Jersey, Interstate 95 at SR-4

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 4 miles of roadway were included in the study area.

Positions: There were approximately 51,257 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Fort Lee: Interstate 95 at SR-4

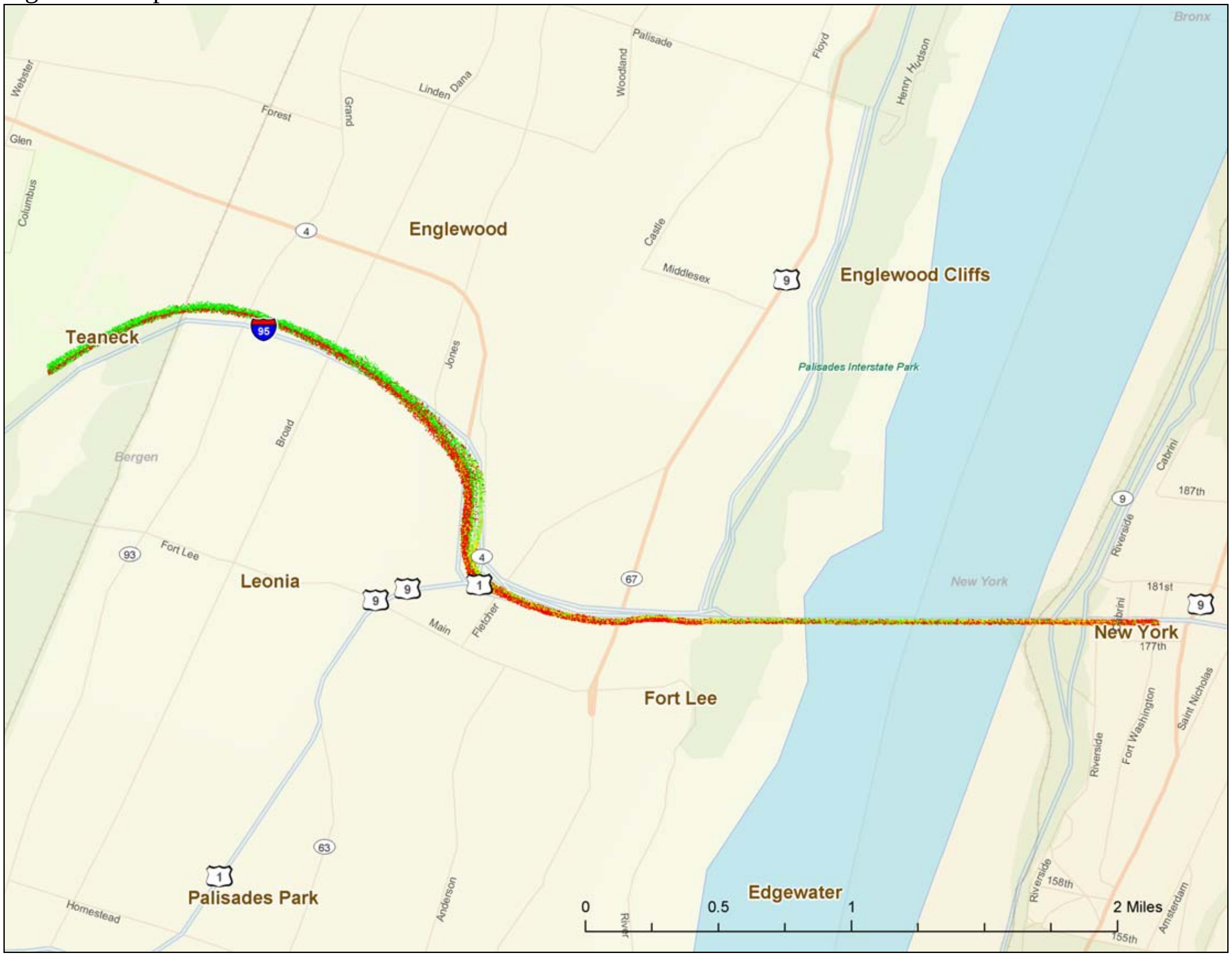


	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00
Mean Speed	30.66	40.13	44.71	44.94	40.69	38.07	22.24	14.19	15.48	21.11	22.31	25.15
Median Speed	36.5	45	47	47	45	42	15	7	8	10	12	17

	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	30.03	32.53	33.28	32.62	28.91	26.57	24.07	25.9	31.53	39.62	41.51	35.19
Median Speed	32	38	37	36	29	22	15	20.5	36	44	45	41

Time of Day

Figure 1: Map of Location



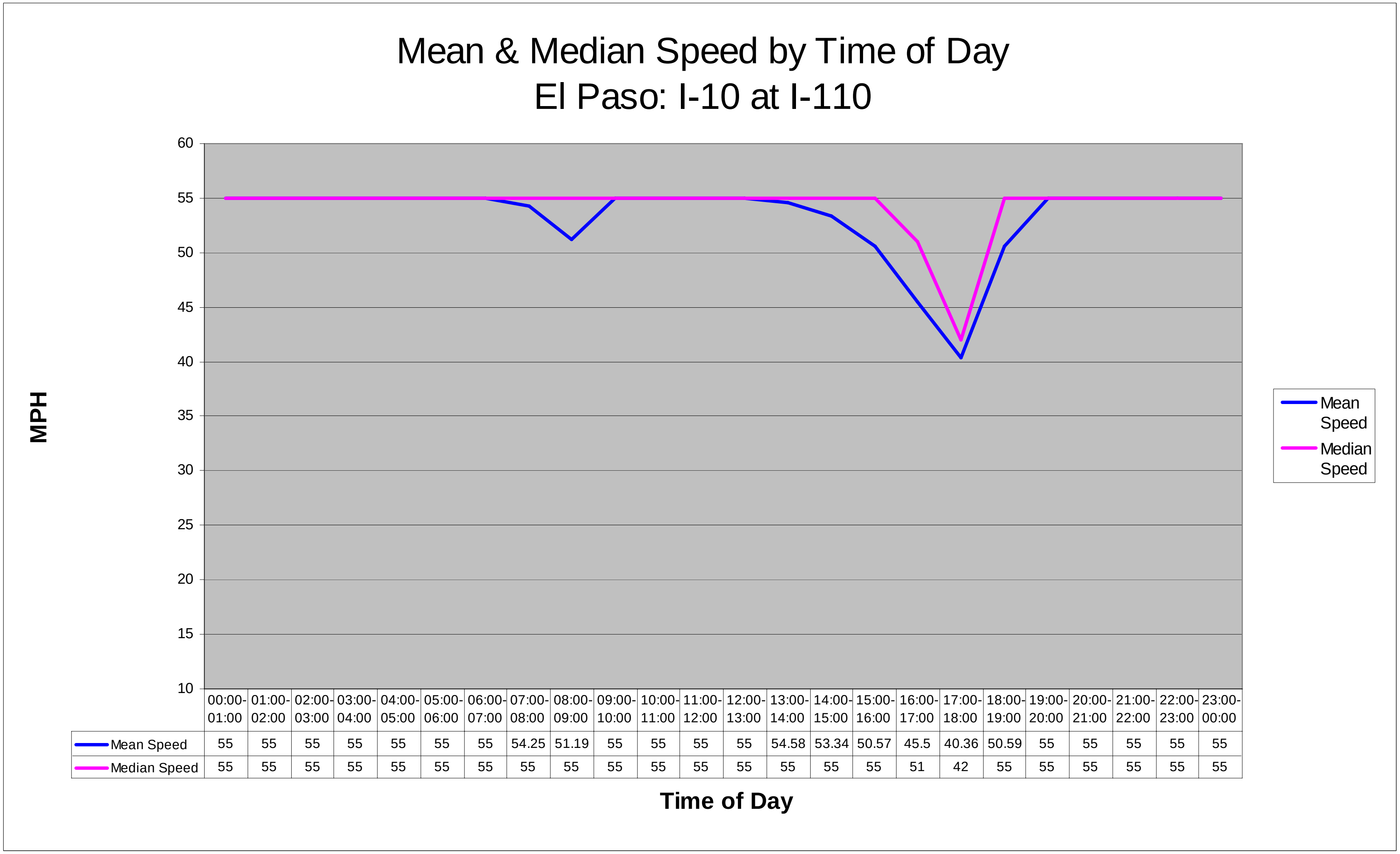
Bottleneck 20: El Paso, Texas

Bottleneck Location: El Paso, Texas, Interstate 10 at Interstate 110

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

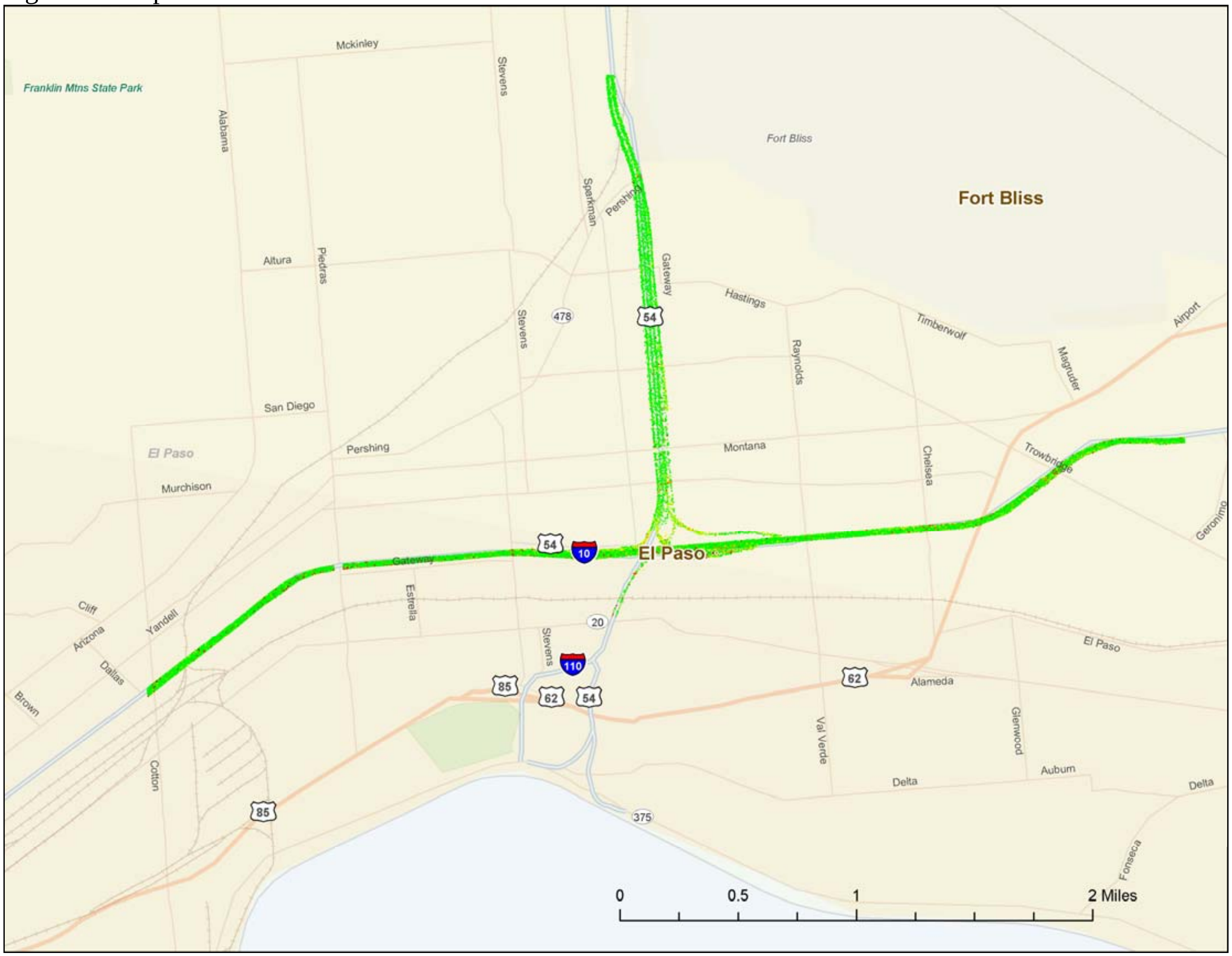
Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 49,672 truck position reads used in this analysis.



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	55	54.25	51.19	55	55	55	55	54.58	53.34	50.57	45.5	40.36	50.59	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	51	42	55	55	55	55	55	55

Figure 1: Map of Location



Bottleneck 21: Houston, Texas

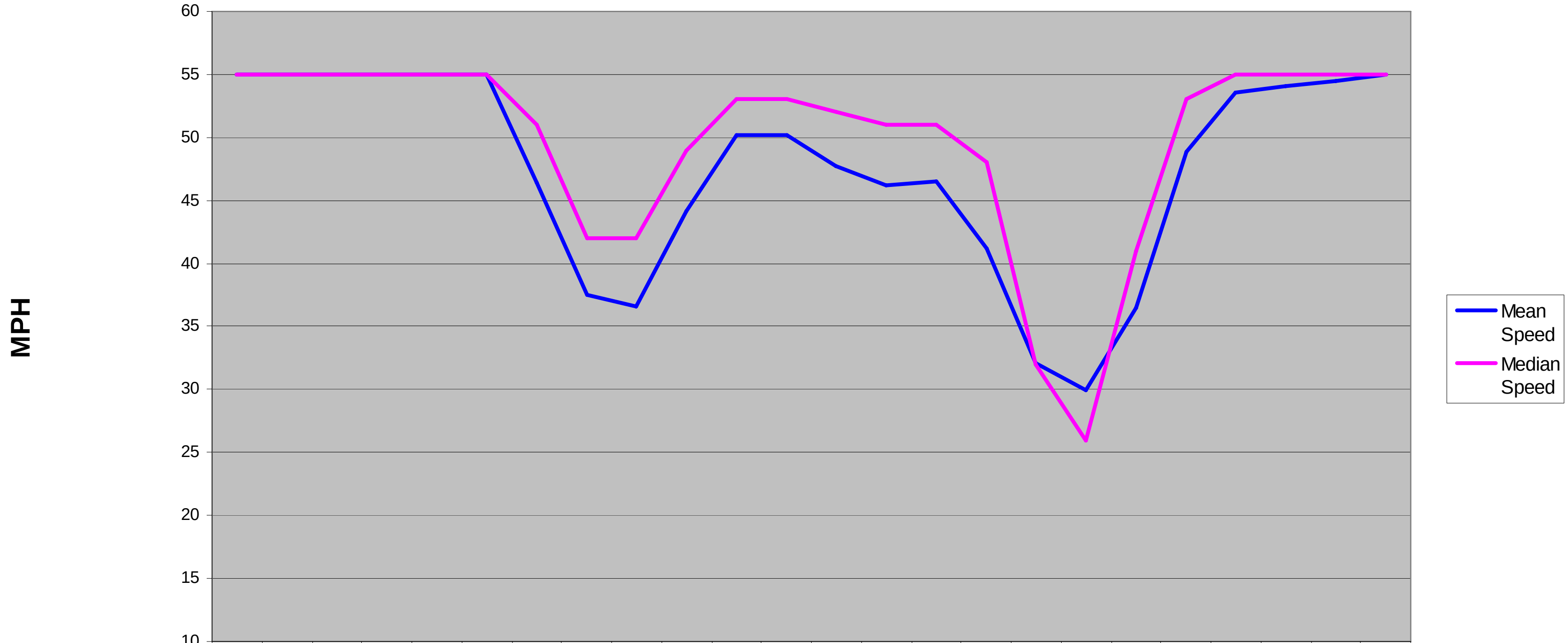
Bottleneck Location: Houston, Texas, Interstate 45 at US-59

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

Positions: There 32,627 were approximately truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Houston: I-45 at US-59



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	46.41	37.52	36.56	44.18	50.14	50.21	47.78	46.21	46.54	41.18	32.13	29.91	36.51	48.82	53.57	54.06	54.46	55
Median Speed	55	55	55	55	55	55	51	42	42	49	53	53	52	51	51	48	32	26	41	53	55	55	55	55

Time of Day

Figure 1: Map of Location

Bottleneck 22: Los Angeles, California

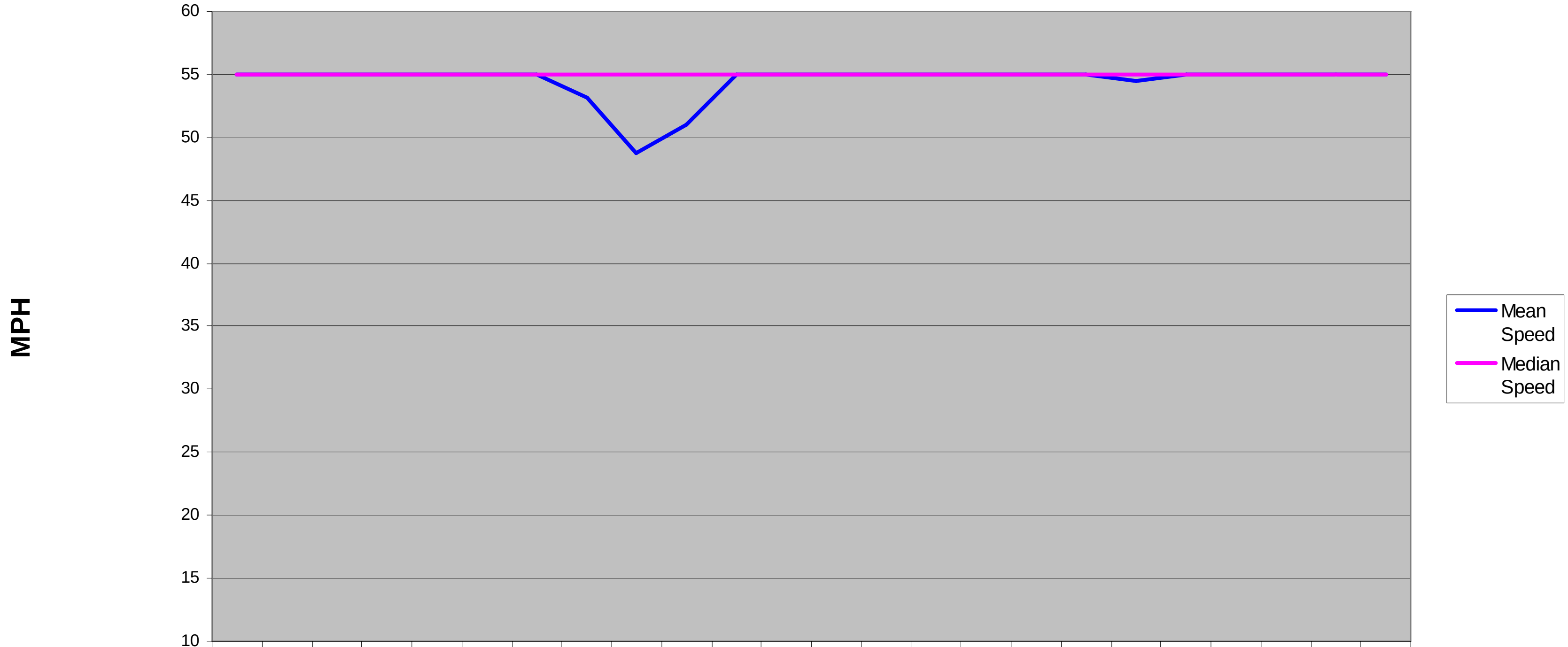
Bottleneck Location: Los Angeles, California, SR-134 at SR-2

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

Positions: There were approximately 4,603 truck position reads used in this analysis.

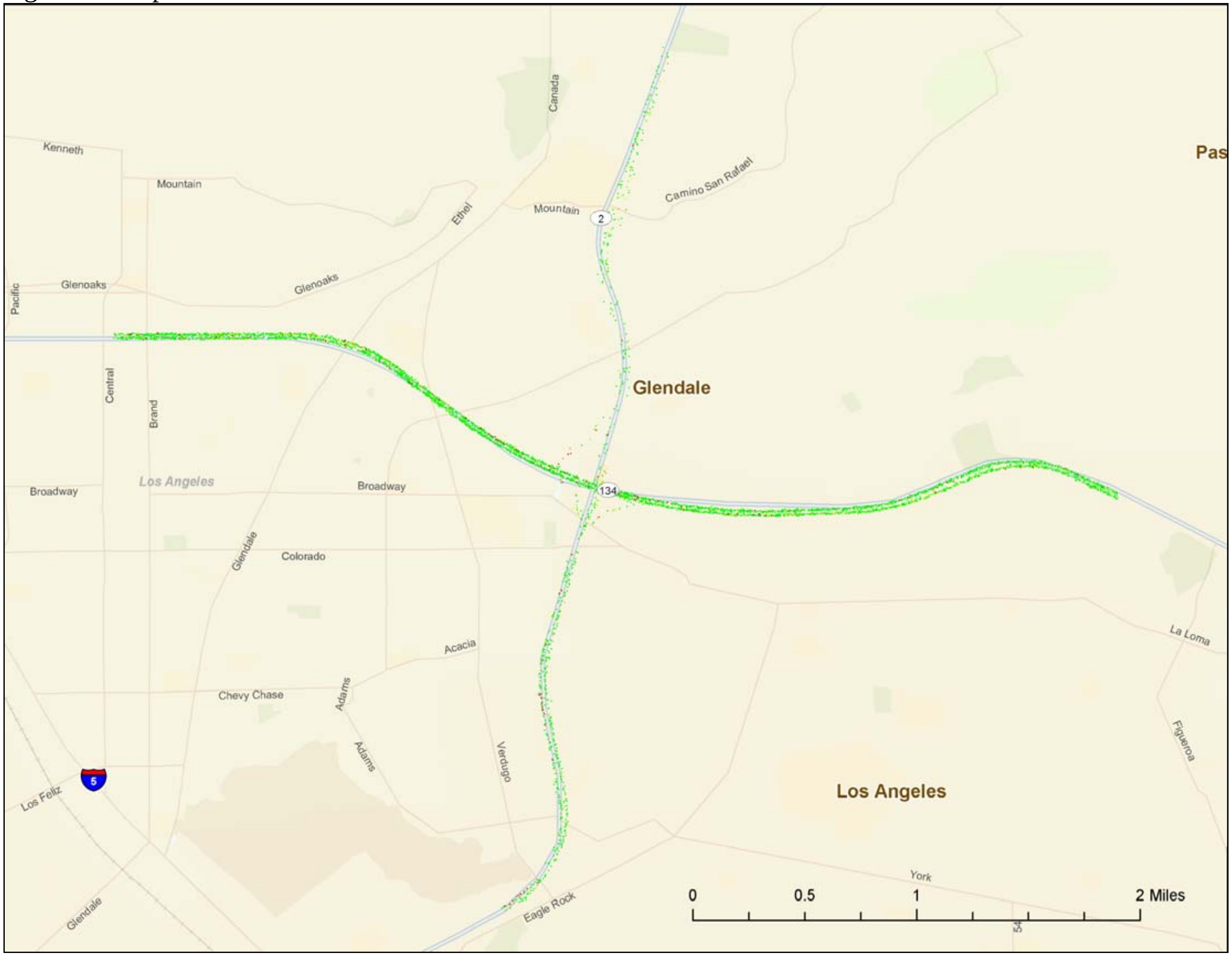
Mean & Median Speed by Time of Day
Los Angeles: SR-134 at SR-2



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	55	53.11	48.78	50.98	55	55	55	55	55	55	55	54.94	54.47	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 23: Phoenix, Arizona

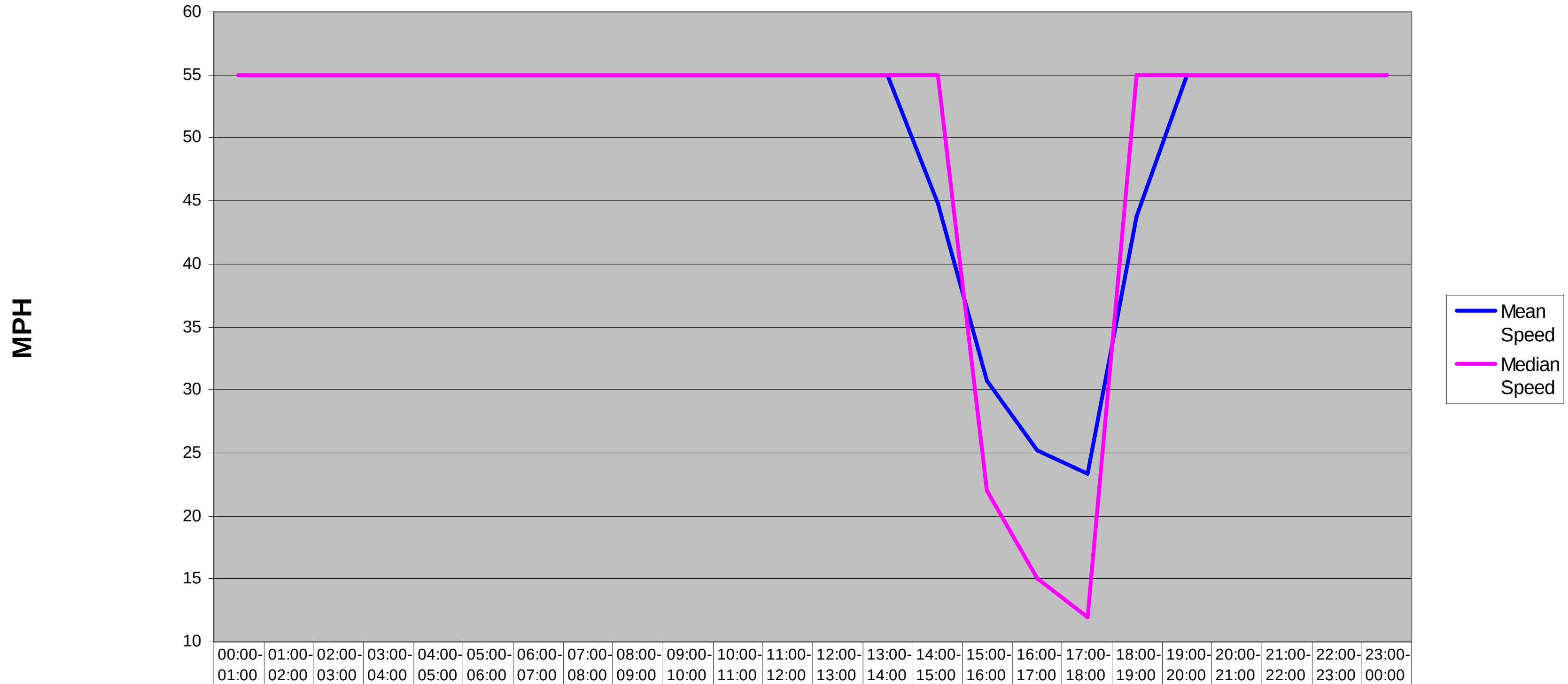
Bottleneck Location: Phoenix, Arizona, Interstate 10, Mini Stack

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 1 mile in each direction for a total of approximately 2 miles.

Positions: There were approximately 8,322 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
PHOENIX: I-10 (Mini-Stack)



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	55	55	55	55	55	55	55	55	44.77	30.75	25.22	23.39	43.76	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	22	15	12	55	55	55	55	55	55

Time of Day

Figure 1: Map of Location

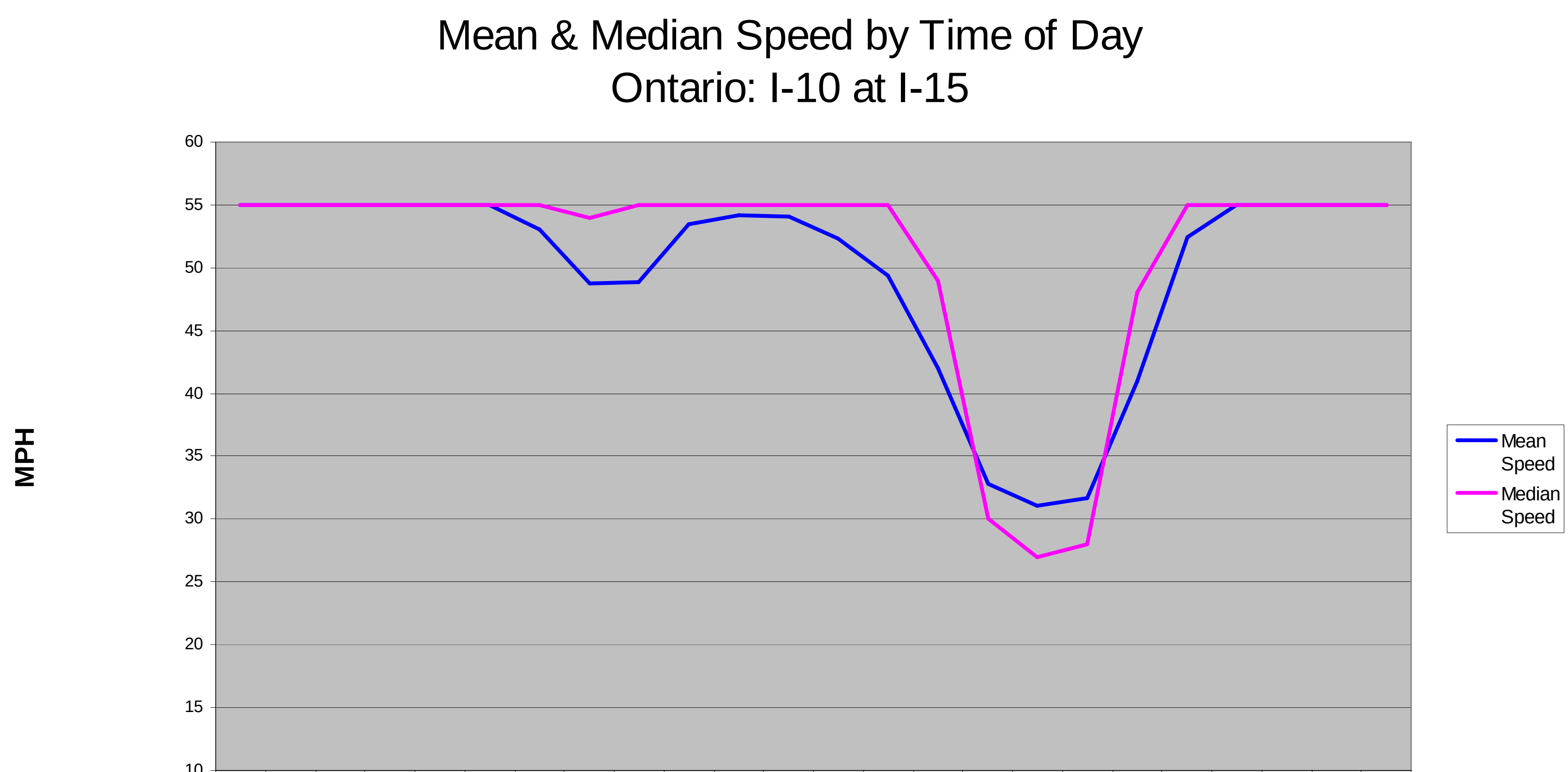
Bottleneck 24: Ontario, California

Bottleneck Location: Ontario, California, Interstate 10 at 15

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

Positions: There were 56,102 approximately truck position reads used in this analysis.



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	53.06	48.74	48.83	53.49	54.2	54.02	52.3	49.33	42.05	32.8	31.04	31.69	41	52.42	55	55	55	55
Median Speed	55	55	55	55	55	55	55	54	55	55	55	55	55	55	49	30	27	28	48	55	55	55	55	55

Time of Day

Figure 1: Map of Location

Bottleneck 25: Washington, DC

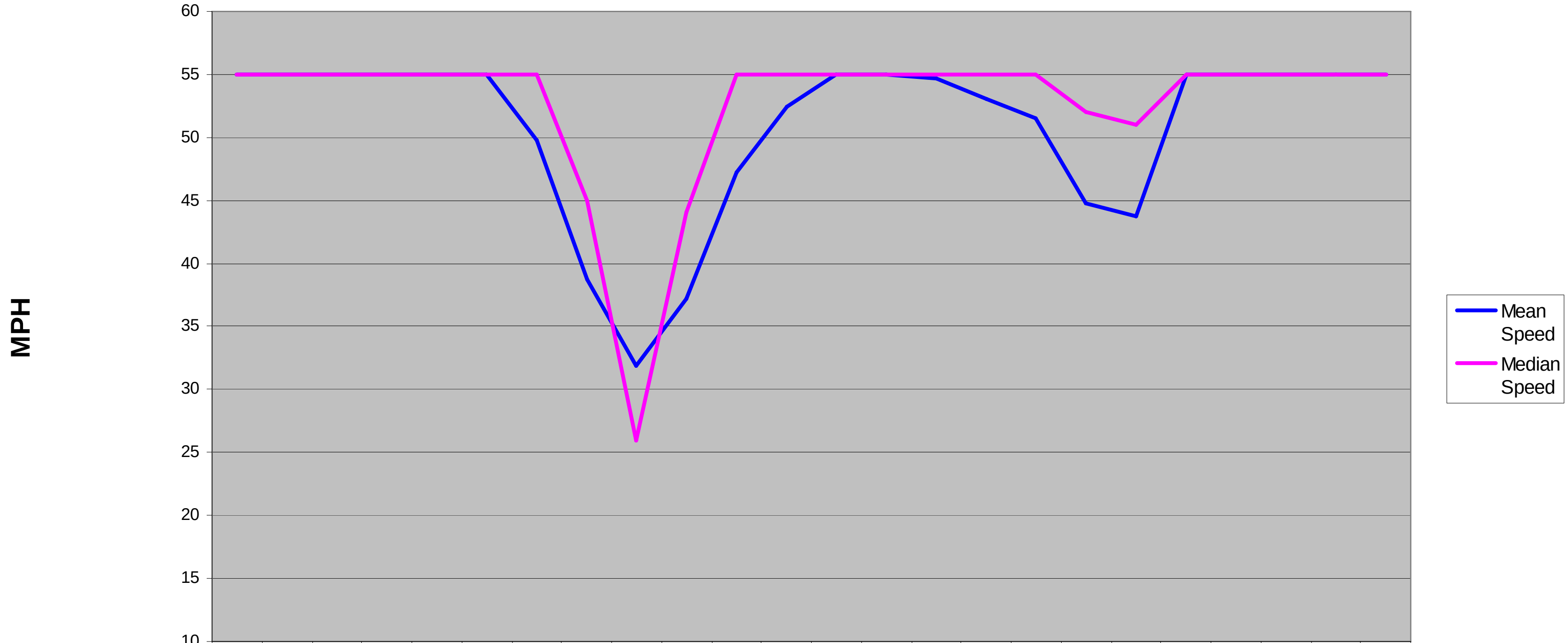
Bottleneck Location: Near Washington D.C., Interstates 495/95

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 6 miles of roadway were included in the study area.

Positions: There were approximately 36,540 truck position reads used in this analysis.

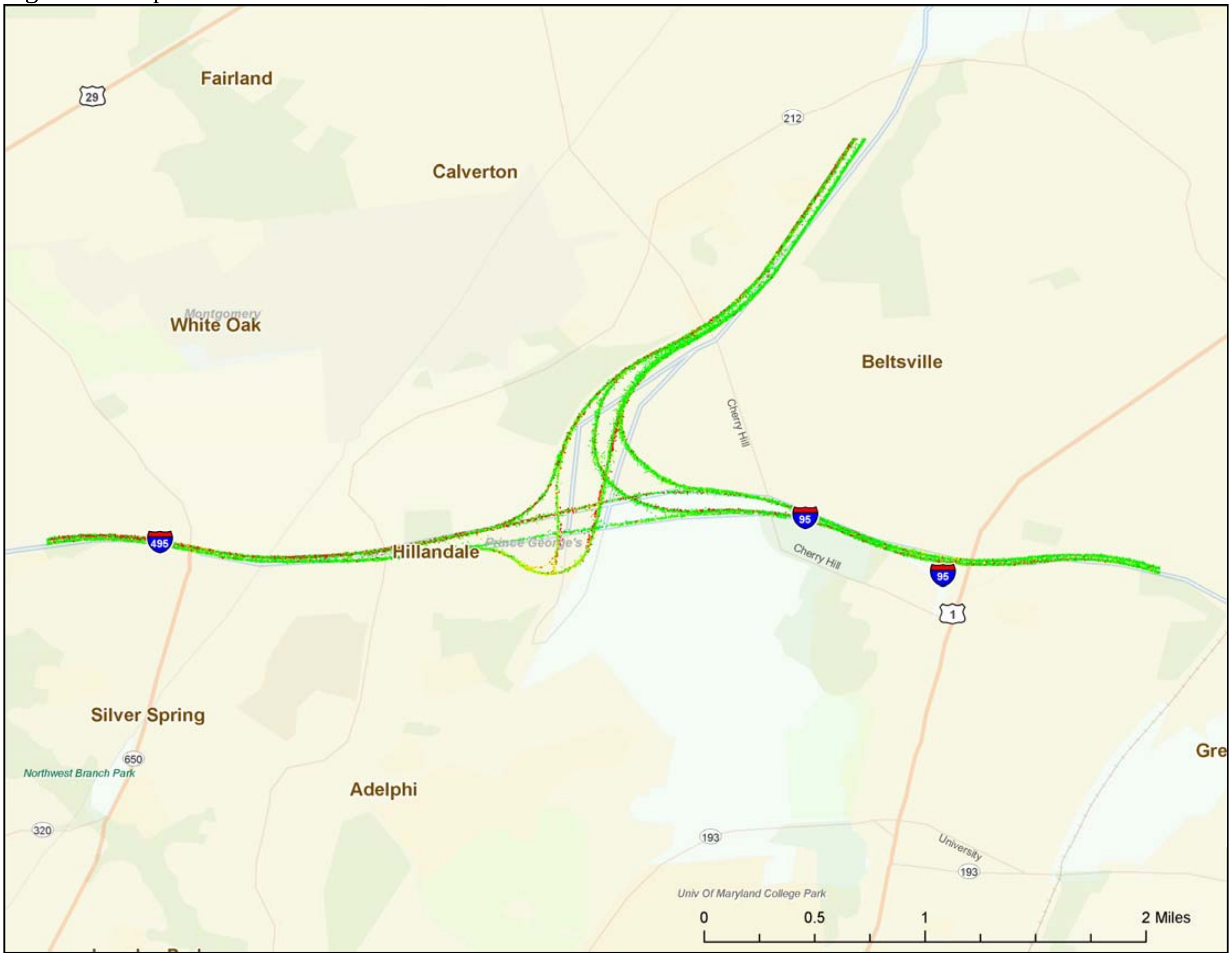
Mean & Median Speed by Time of Day
Washington DC: Interstates 495/95



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	49.82	38.74	31.9	37.24	47.23	52.42	55	55	54.64	53.01	51.54	44.8	43.72	55	55	55	55	55
Median Speed	55	55	55	55	55	55	55	45	26	44	55	55	55	55	55	55	55	52	51	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 26: Houston, Texas

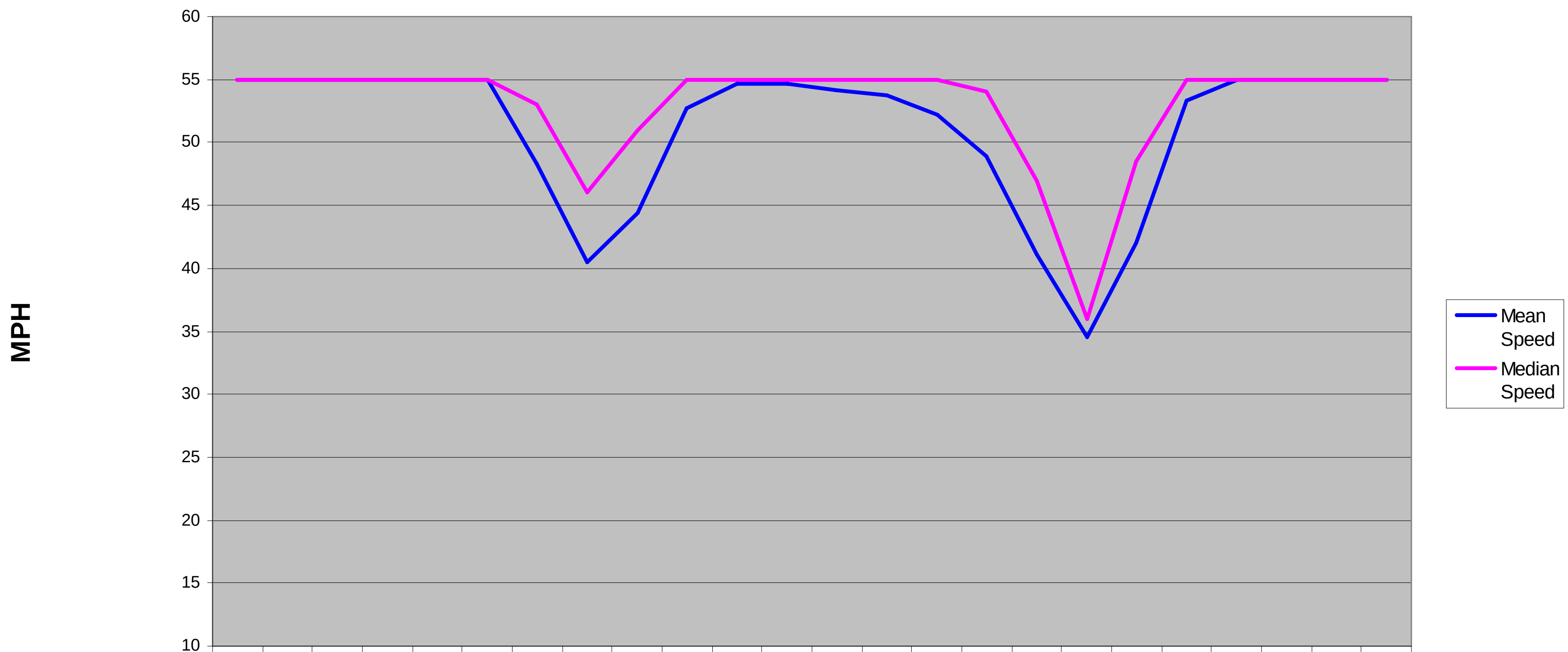
Bottleneck Location: Houston, Texas, Interstate 45 at Highway 610

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: From the bottleneck (the interchange) the study area extends 1.5 miles in each direction for a total of approximately 6 miles in the study area.

Positions: There were approximately 46,856 truck position reads used in this analysis.

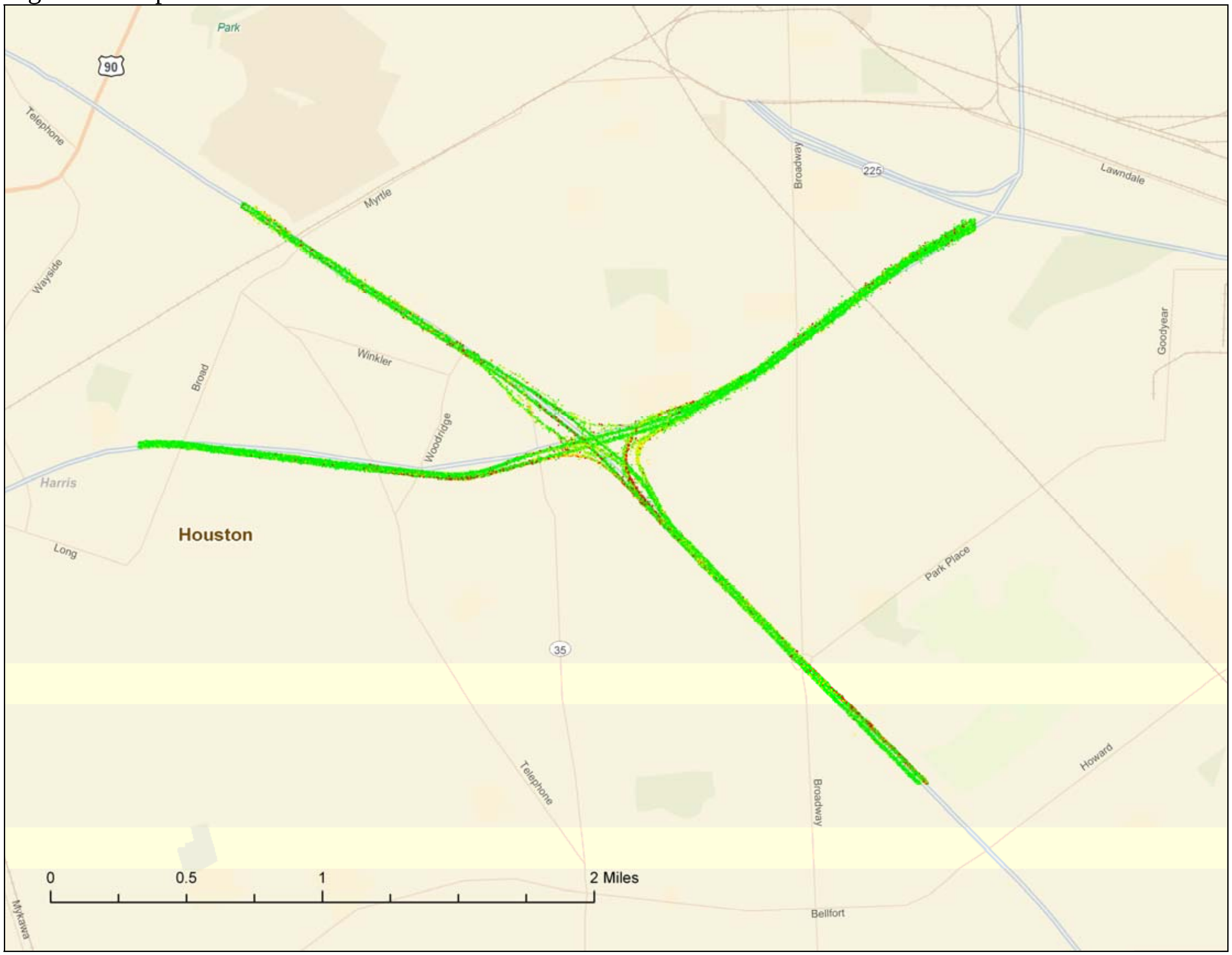
Mean & Median Speed by Time of Day
Houston: I-45 at 610



Time of Day	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	48.3	40.47	44.39	52.73	54.63	54.71	54.13	53.78	52.22	48.96	41.13	34.52	41.98	53.31	55	55	55	55
Median Speed	55	55	55	55	55	55	53	46	51	55	55	55	55	55	55	54	47	36	48.5	55	55	55	55	55

Time of Day

Figure 1: Map of Location



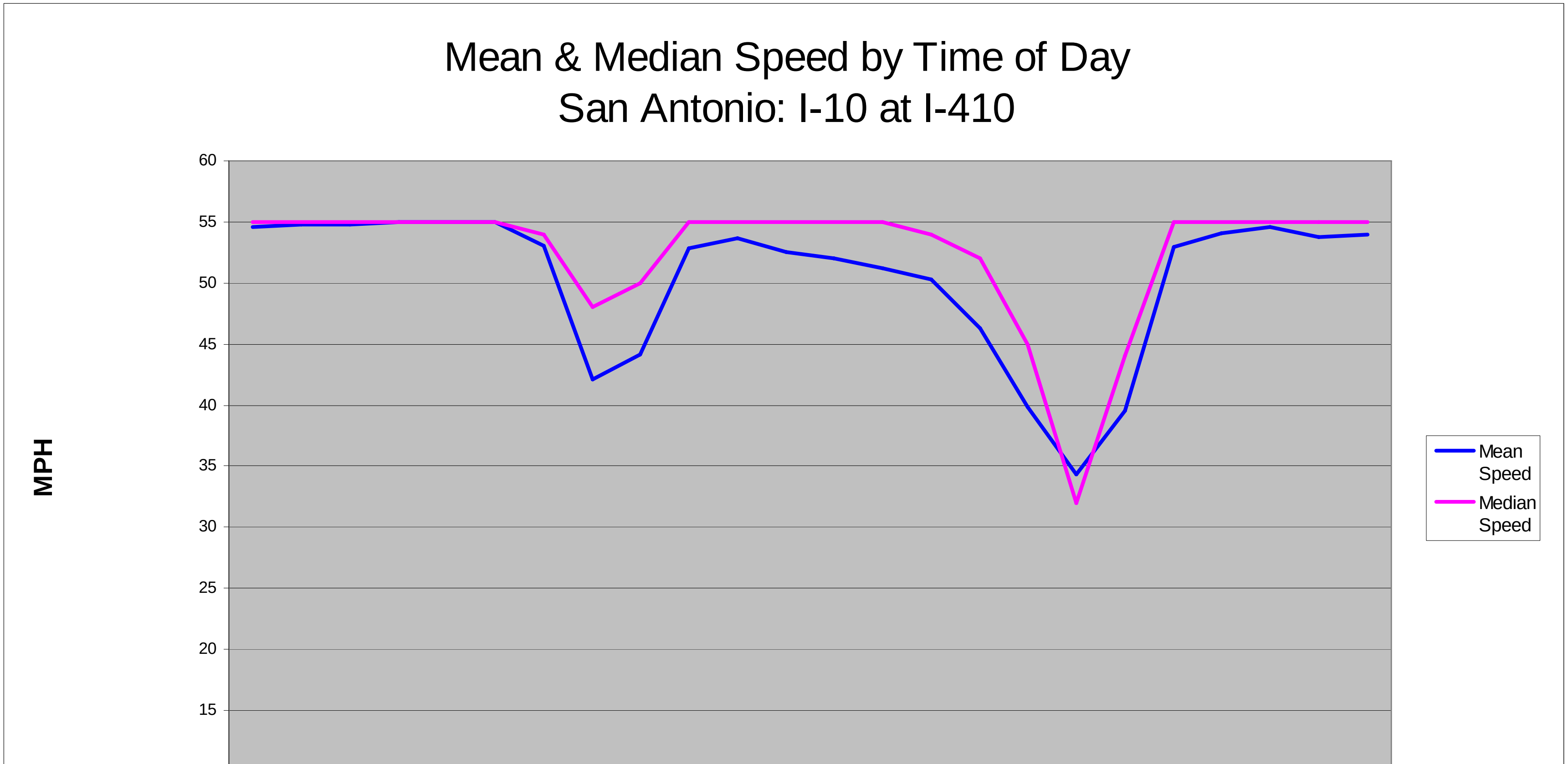
Bottleneck 27: San Antonio, Texas

Bottleneck Location: San Antonio, Texas, Interstate 10 at Interstate 410

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

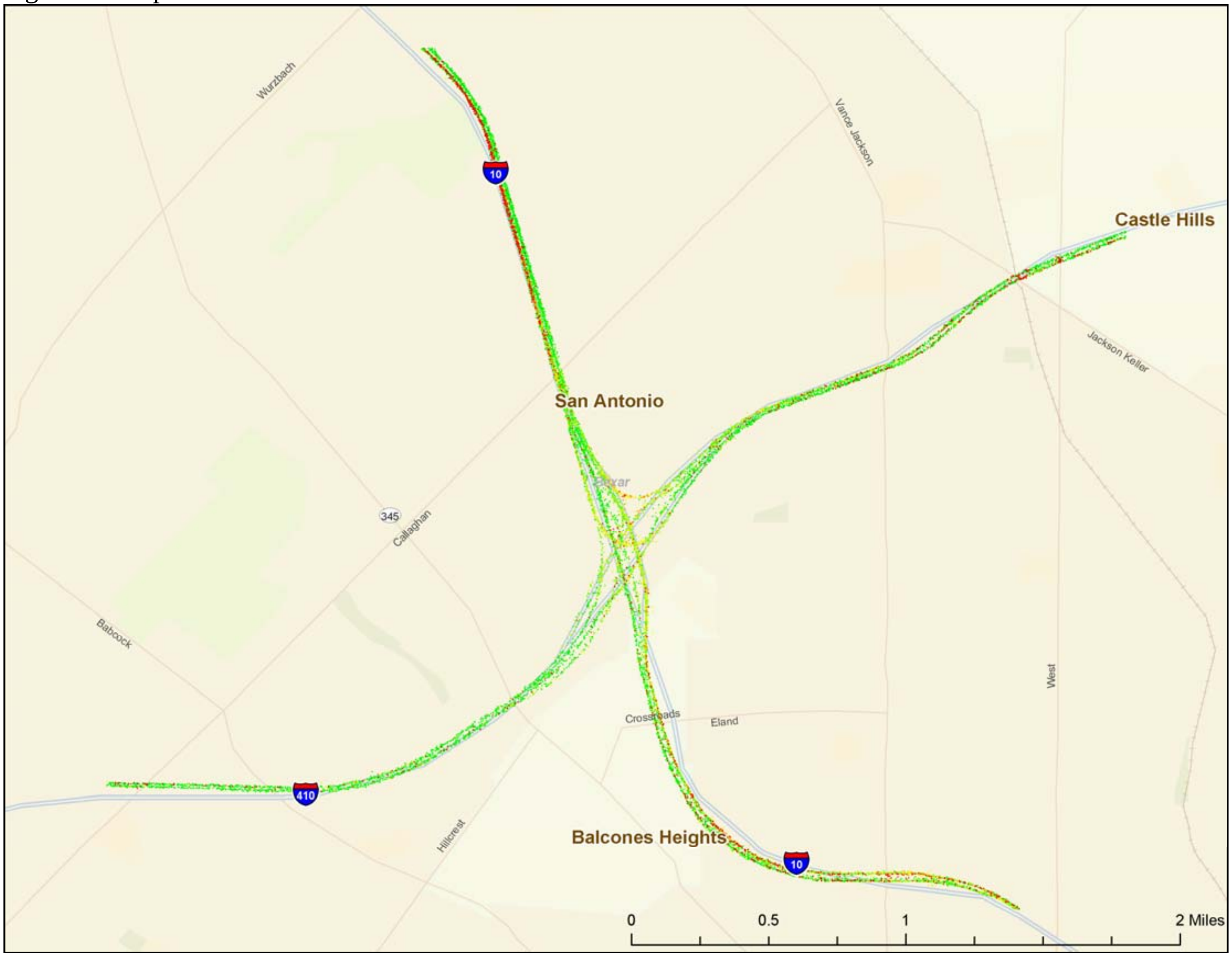
Positions: There were approximately 15,243 truck position reads used in this analysis.



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	54.57	54.83	54.78	55	55	55	53.06	42.15	44.19	52.86	53.67	52.54	52.02	51.23	50.29	46.31	39.81	34.31	39.53	52.95	54.07	54.55	53.8	53.99
Median Speed	55	55	55	55	55	55	54	48	50	55	55	55	55	55	54	52	45	32	44	55	55	55	55	55

Time of Day

Figure 1: Map of Location



Bottleneck 28: Los Angeles, California

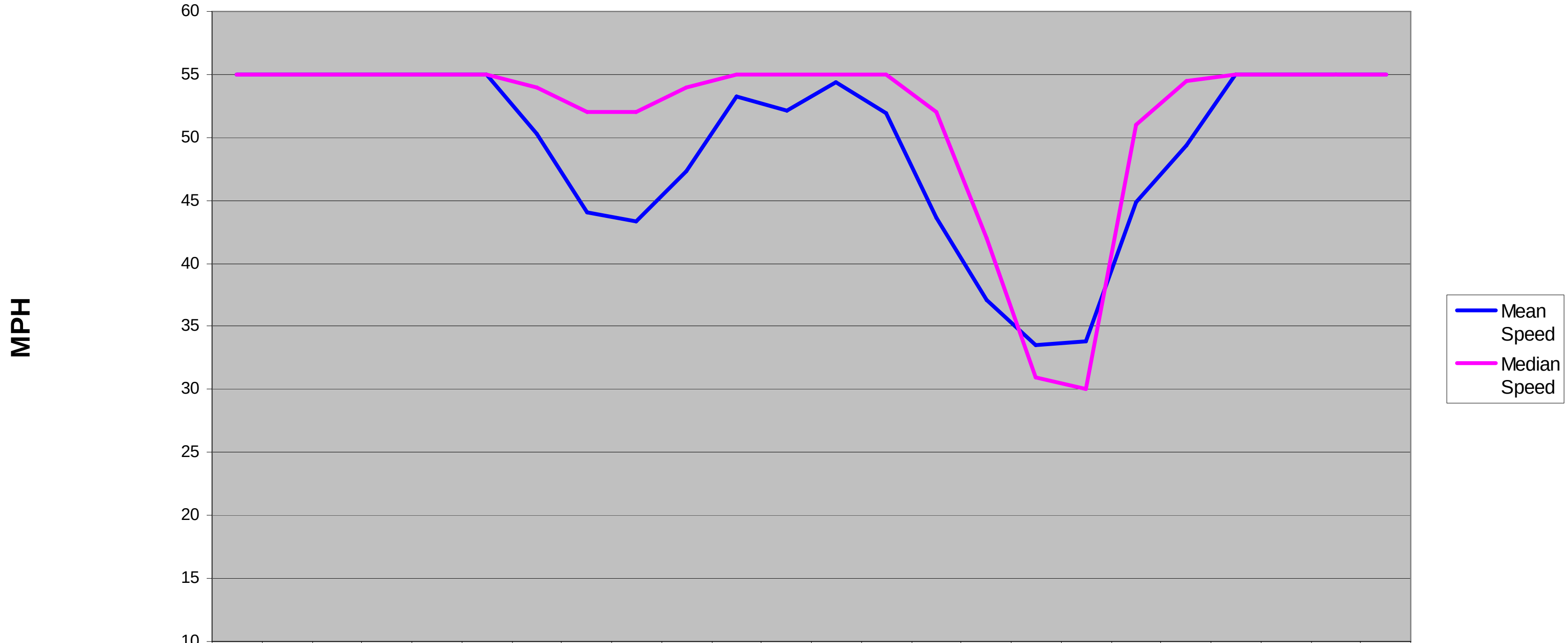
Bottleneck Location: Los Angeles, California, Interstate 110 at Interstate 105

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

Positions: There were approximately 6,370 truck position reads used in this analysis.

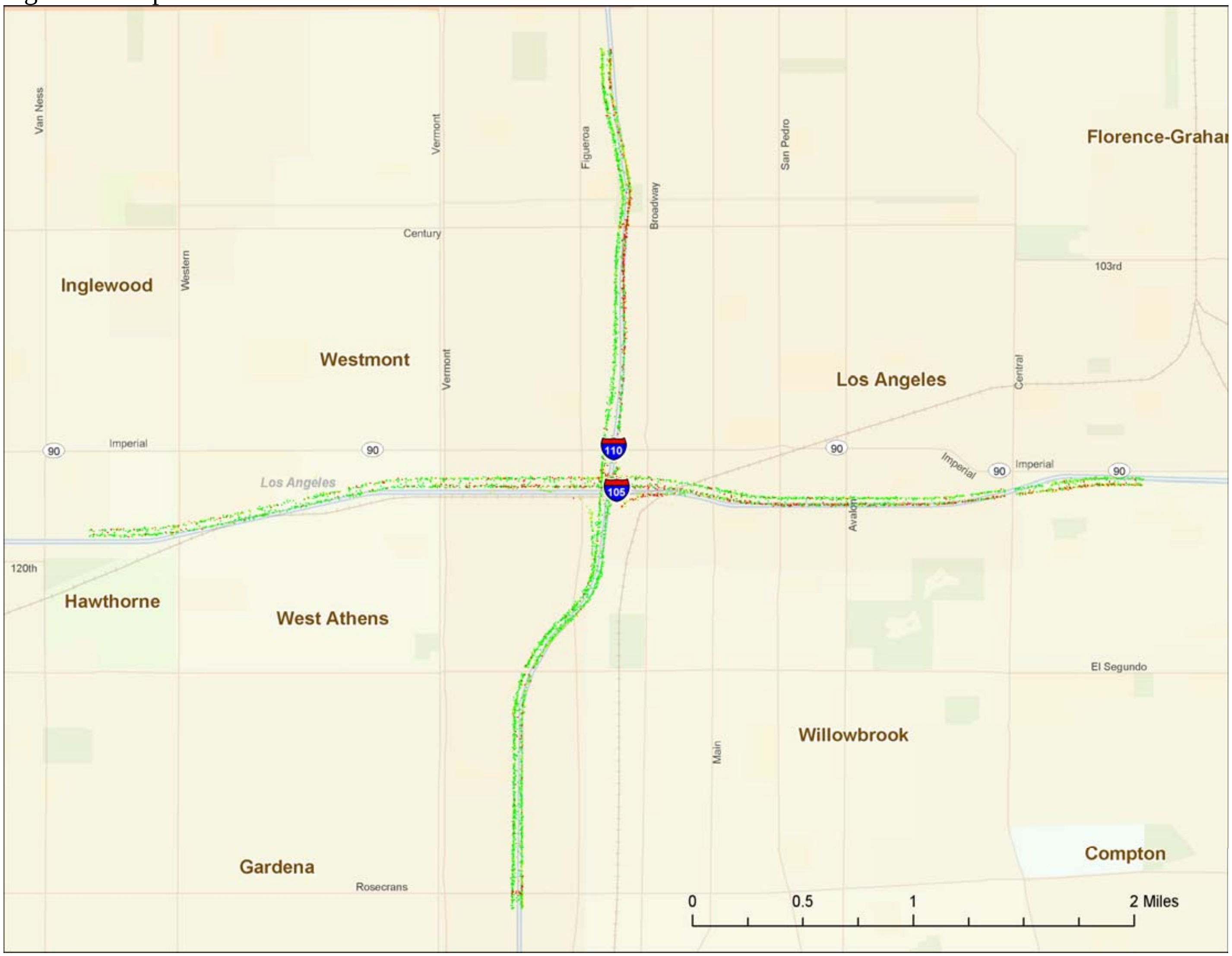
Mean & Median Speed by Time of Day
Los Angeles: I-110 at I-105



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	50.29	44.05	43.29	47.28	53.24	52.15	54.37	51.94	43.66	37.08	33.51	33.81	44.84	49.33	55	55	55	55
Median Speed	55	55	55	55	55	55	54	52	52	54	55	55	55	55	52	42	31	30	51	54.5	55	55	55	55

Time of Day

Figure 1: Map of Location



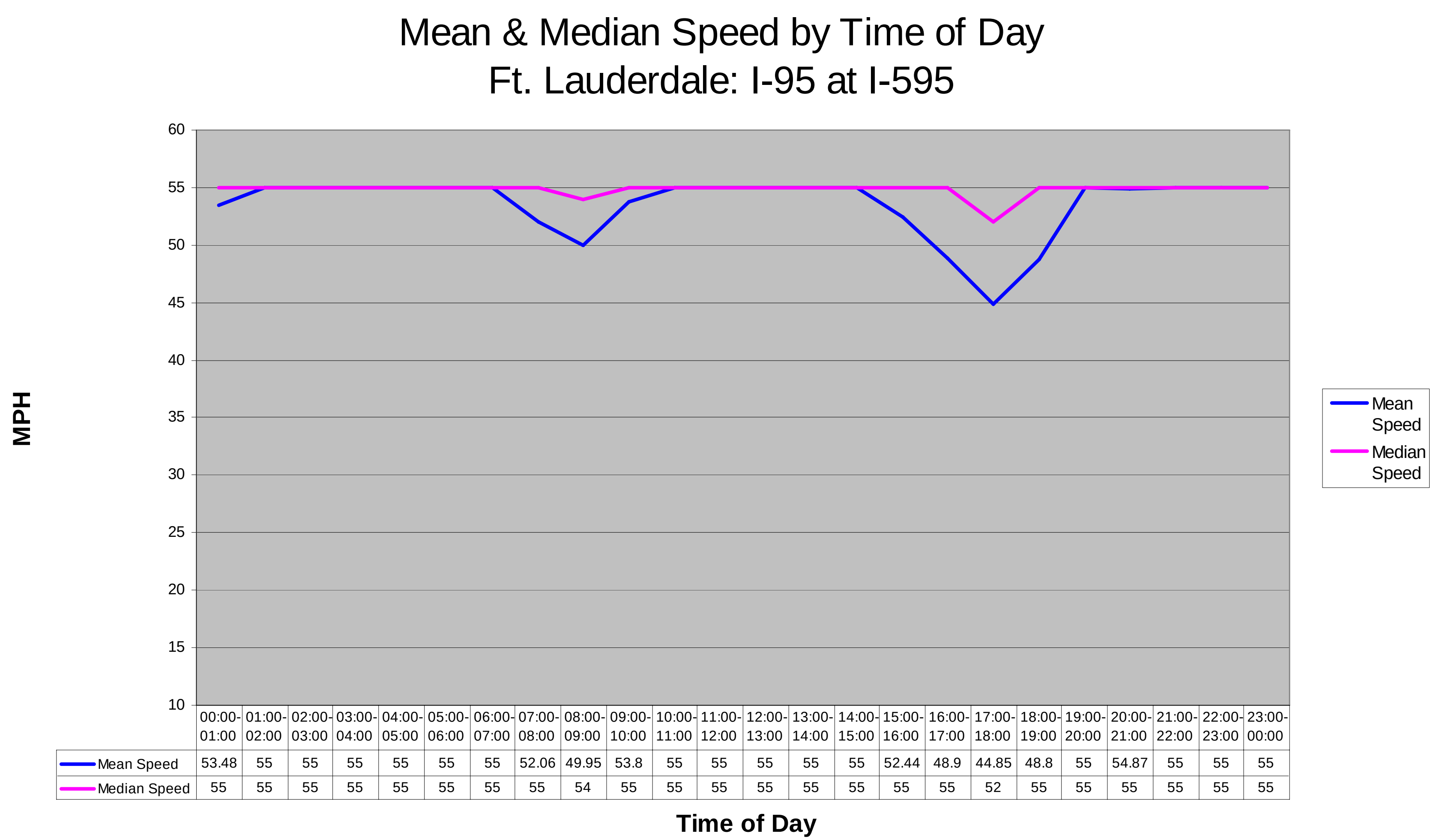
Bottleneck 29: Ft. Lauderdale, Florida

Bottleneck Location: Ft. Lauderdale, Florida, Interstate 95 at Interstate 595

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

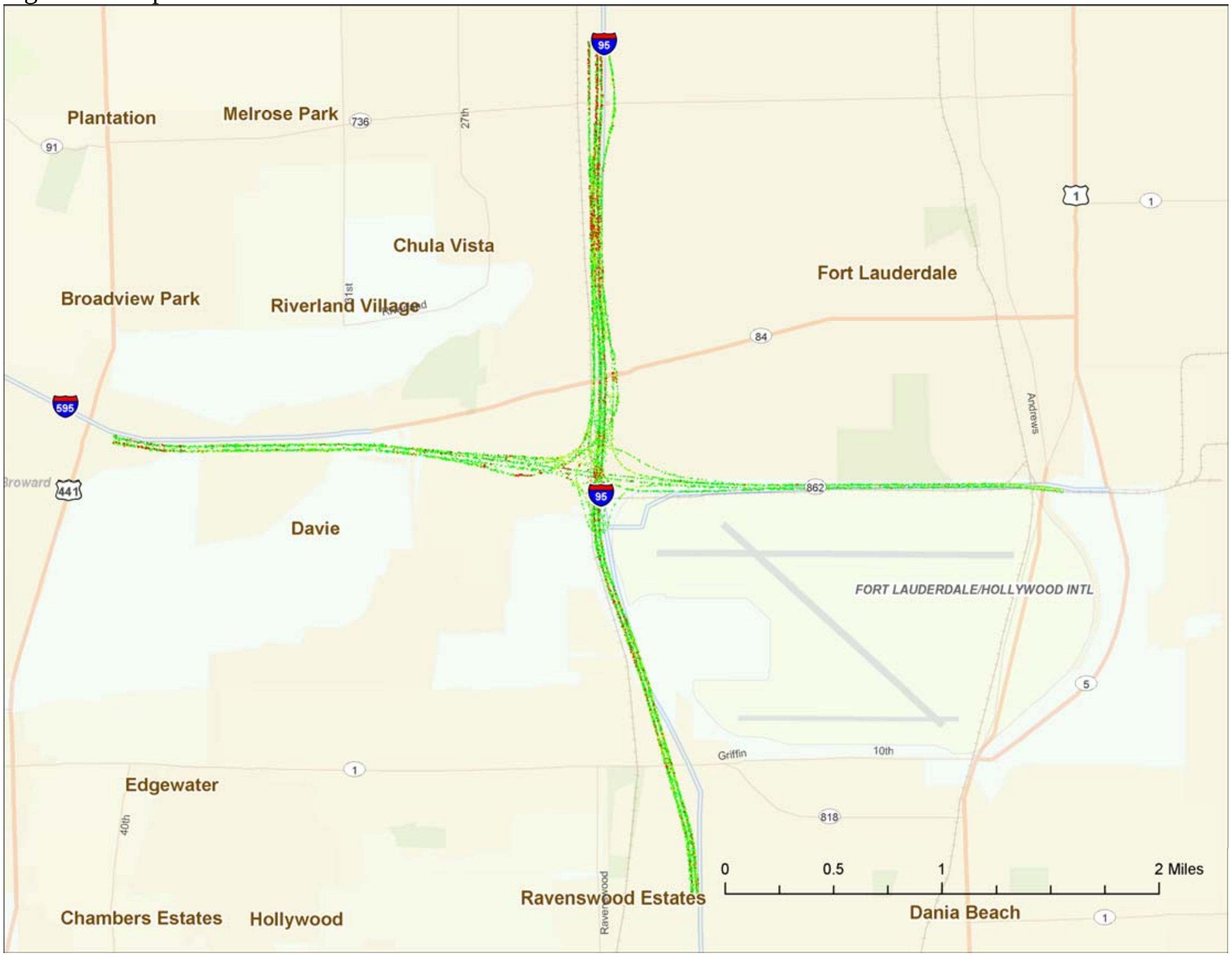
Positions: There were approximately 16,635 truck position reads used in this analysis.



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00
Mean Speed	53.48	55	55	55	55	55	55	52.06	49.95	53.8	55	55
Median Speed	55	55	55	55	55	55	55	55	54	55	55	55

	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	52.44	48.9	44.85	48.8	55	54.87	55	55	55
Median Speed	55	55	55	55	55	52	55	55	55	55	55	55

Figure 1: Map of Location



Bottleneck 30: Denver, Colorado

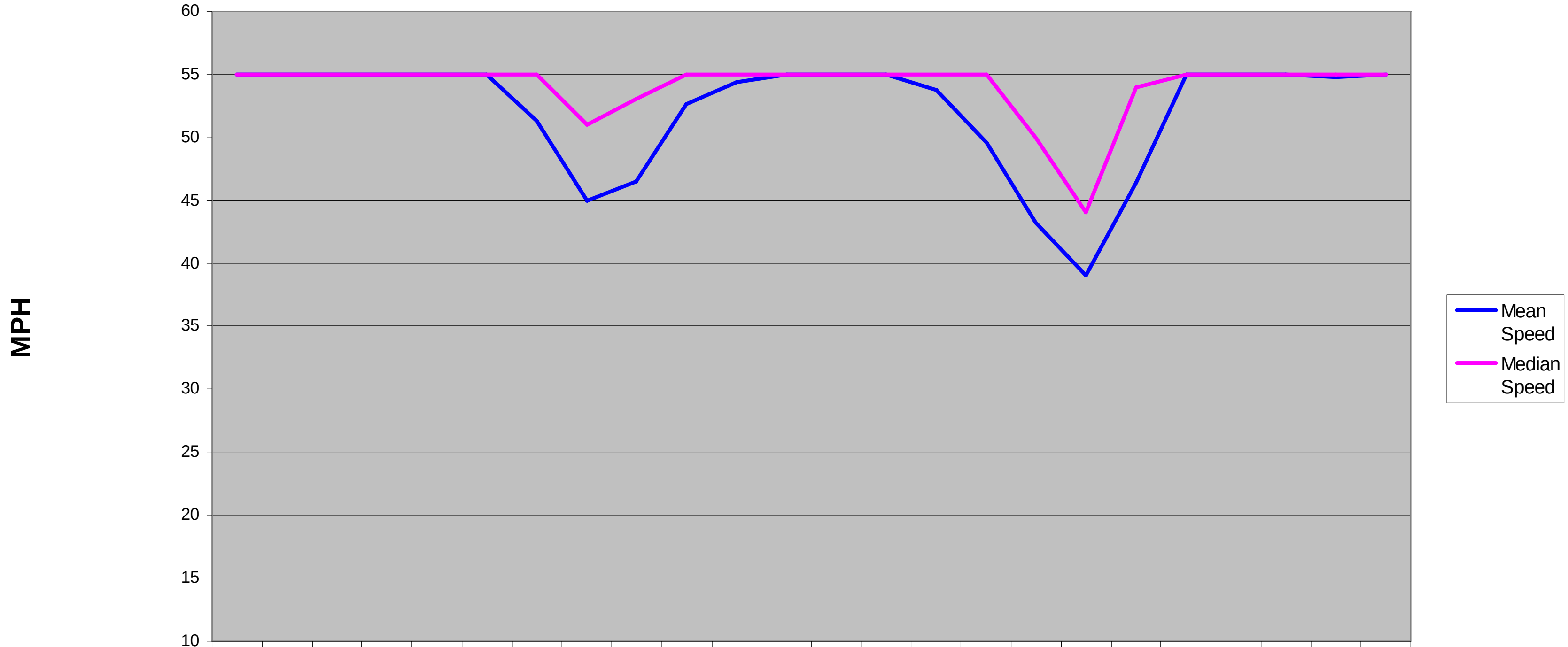
Bottleneck Location: Denver, Colorado, Interstate 25 at Interstate 76

Dates: Weekdays; June 1, 2006 - May 31, 2007; 1 year time period

Distances: Approximately 8 miles of roadway were included in the study area.

Positions: There were approximately 30,826 truck position reads used in this analysis.

Mean & Median Speed by Time of Day
Denver: I-25 at I-76



	00:00-01:00	01:00-02:00	02:00-03:00	03:00-04:00	04:00-05:00	05:00-06:00	06:00-07:00	07:00-08:00	08:00-09:00	09:00-10:00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14:00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	18:00-19:00	19:00-20:00	20:00-21:00	21:00-22:00	22:00-23:00	23:00-00:00
Mean Speed	55	55	55	55	55	55	51.36	44.94	46.55	52.59	54.37	55	55	55	53.76	49.62	43.27	39.06	46.39	55	55	55	54.74	55
Median Speed	55	55	55	55	55	55	55	51	53	55	55	55	55	55	55	55	50	44	54	55	55	55	55	55

Time of Day

Figure 1: Map of Location