Final Report

EVALUATION OF TRAVEL TIME METHODS TO SUPPORT MOBILITY PERFORMANCE MONITORING

FY 2001 SYNTHESIS REPORT

To

Office of Freight Mgt. and Operations

Federal Highway Administration

U.S. Department of Transportation

Washington, DC 20590

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Texas Transportation Institute

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International Border Crossing Truck Travel Time for 2001

by

Texas Transportation Institute
The Texas A&M University System

and

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EXECUTIVE SUMMARY

The purpose of this study was to determine a benchmark border crossing delay measure for commercial vehicles. Seven ports of entry (POE) were surveyed – four on the U.S./Canada border and three on the U.S./Mexico border. Those ports of entry were Otay Mesa, El Paso, Laredo, Blaine, Ambassador Bridge, Peace Bridge, and Blue Water Bridge.

Toward that end, average delay times were calculated for each port of entry. The delay time represents the difference between the average crossing time and the free-flow crossing time. In total, for all seven ports of entry, the average inbound delay time was 16.0 minutes and the average outbound delay time was 8.1 minutes. (Inbound means traffic entering the United States. Outbound means traffic exiting the United States.) The average delay time for all northern ports in the survey, both inbound and outbound, was 9.8 minutes and for all southern ports in the survey, 18.0 minutes. The average delay time for all ports of entry, both inbound and outbound, was 12.4 minutes.

A Buffer Time and Buffer Index for each port of entry was also calculated. The Buffer Time is the difference between the 95th percentile crossing time and the average crossing time for all trucks. The Buffer Time, then, represents the "extra time" above the average that a driver must budget to cross the border and arrive "on time" for 95 percent of the trips. The Buffer Index is the Buffer Time expressed as a percentage of average time, i.e., the extra percentage of time that must be budgeted to cross the border. As such, the Buffer Index eliminates differences in the physical length of crossings and provides a standardized measure among ports.

The Buffer Time for all outbound crossings was 23.3 minutes with a Buffer Index of 164 percent. The Buffer Time for all inbound crossings was 43.3 minutes with a Buffer Index of 162 percent. These Index values are much higher than values for urban freeway systems studied in "Monitoring Urban Roadways in 2000," which indicates less reliable travel at border crossings.

The number of inspection/processing booths open at each port at any given time has a significant influence on travel times and often serves as a leading indicator of that particular variable. At many ports there appears to be significant variability during the day with respect to the number of booths open at any given time. Decisions with regard to how many lanes are open at any given time are not made purely with mobility/crossing times in mind and are not made by transportation agencies. Finally, to whatever degree mobility was a consideration in the number of open booths/lanes prior to the events of September 11, 2001, that level of consideration has lessened.

Other implications found are:

- Crossing times at the Ambassador Bridge POE are clearly superior and more consistent than any other port of entry in the study. While, like other ports, inbound crossing times exceed outbound crossing times, the margin of difference is significantly narrower and more consistent. Further, lower crossing times are achieved despite the bridge having a consistently higher volume of traffic.

- The performance of the three "truck only" bridges as measured as a function of the time/volume relationship did not differ significantly from those crossings where auto and truck traffic are intermingled.

- It can be generally said that U.S./Canada ports of entry processed inbound trucks in less time and with less variability than did U.S./Mexico ports of entry.

- The extent to which changes implemented as a result of the events of September 11, 2001 will affect traffic volumes and crossing times in the long term is not yet clear – but certainly the transportation system will be affected. Transportation agencies as well as companies that operate near the border will be challenged to operate as efficiently as possible and adapt to the changes

Table ES1. Performance Measure Summary

Crossing	Average Volume	Average Delay per Trip (minutes)	Buffer Index
Ambassador Bridge Outbound	4,969	3.1	55.7%
Ambassador Bridge Inbound	4,587	7.5	65.7%
Blaine Outbound	Not available	16.2	64.5%
Blaine Inbound	1,335	9.2	105.8%
Blue Water Bridge Outbound	2,030	1.2	46.8%
Blue Water Bridge Inbound	2,289	23.1	134.8%
El Paso Outbound	1,080	4.2	187.1%
El Paso Inbound	1,973	29.6	108.1%
Laredo Outbound	3,048	15.4	161.6%
Laredo Inbound	2,956	19.0	76.0%
Otay Mesa Outbound	Not available	9.6	93.2%
Otay Mesa Inbound	1,886	28.6	83.7%
Peace Bridge Outbound	1,992	12.7	74.6%
Peace Bridge Inbound	1,990	13.2	265.7%

INTRODUCTION

The purpose of this study was to determine a benchmark border crossing delay measure for commercial vehicles. The delay measures calculated were average delay and the Buffer Index. In order to establish these measures, seven ports of entry (POE) were surveyed – four on the U.S./Canada border (Ambassador Bridge, Peace Bridge, Blue Water Bridge, and Blaine) and three on the U.S./Mexico border (Otay Mesa, El Paso, and Laredo).

For consistency among all border crossings visited as part of the overall project, the data collection positions were distinguished by the direction of travel that they were measuring (outbound or inbound). Movement from the U.S. into Mexico was referred to as outbound. Conversely, the term inbound was used to refer to movement from Mexico to the U.S. Similarly, movement from Canada into the U.S. is referenced as inbound, while movement from the U.S. to Canada is referred to as outbound.

BORDER CROSSING PROCESS

One of the first steps in developing a performance measure for international border crossings is to understand the system. The border crossing environment and procedures include a variety of operating agencies, each of them "in charge" of a certain portion of the crossing or the infrastructure. A performance measure will be successful only if it accepts and supports these often competing goals.

While there are differences in the paperwork requirements and operating procedures for freight crossing in each direction on the northern and southern borders of the U.S., the process can be described in a few common steps that are useful for defining the data collection necessary to support a national measure of freight crossing delay. Steps related to paperwork, duties and tolls are somewhat ignored in the description below. The delay from these steps is typically not a transport issue, or the transaction takes place within a queue of vehicles controlled by other steps of the process.

The crossing summary (see Figure 1) uses the term "points" to describe locations where particular actions take place. The actual point of data collection may be slightly different than the physical location of the action referred to in the description, based on the design of the individual crossing. And the points have different names—Point 3 is known as Primary Inspection in the U.S. and Canada and Primary Selection in Mexico. "Segments" refers to portions of road between the points. The segments are designed to produce information about the truck travel time and the location of delay. The "points" are not the only features in the border crossing process that can cause longer travel times, however. Specific locations, such as toll booths, might be added to the basic data collection scheme listed in this report to further investigate the contribution to delay, or the location of delay in the system.

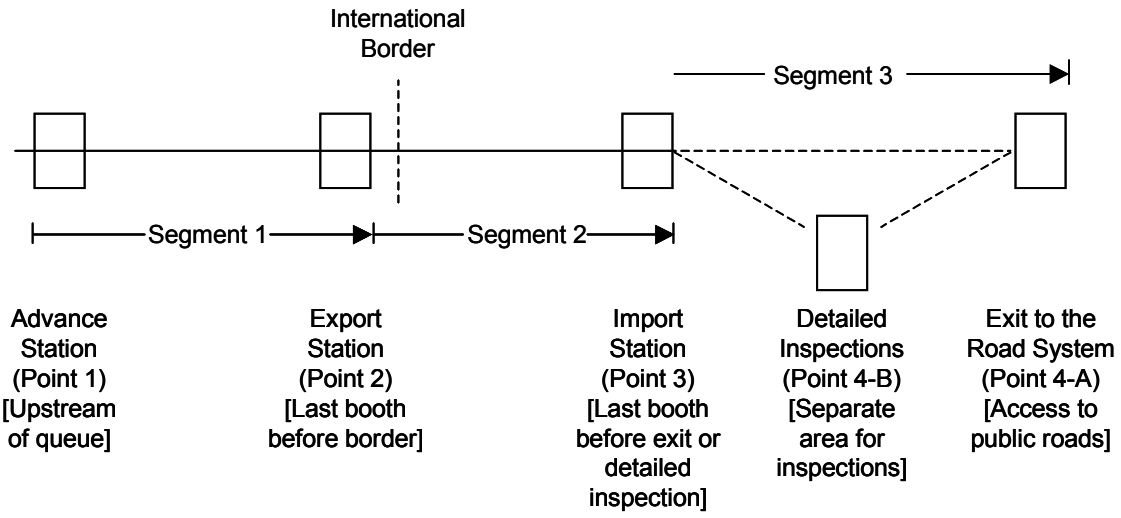


Figure 1. Data Collection Locations and Typical Border Crossing System (Simplified Diagram)

WHAT IS THE MOBILITY MEASURE?

The measure of system performance that concerns manufacturers, shippers and truckers is door-to-door trip time. For the border crossing measure to be useful, it should relate to this measure as closely as possible, but it should also be more comparative than simple travel time.

Delay per Truck Trip (in Minutes or Hours)

The best measure for the freight transportation system at international roadway border crossings is travel delay per truck trip through the first inspection point in the import country. The more detailed inspections downstream of this point are substantially related to issues such as the safety and welfare of the importing country, and the potential improvements are more related to the inspection process and the design of individual port operations. This will be measured for travel in both directions on both the northern and southern U.S. border crossings. Initially the focus should be on collecting this statistic at the major ports of entry, with refinements and automated data collection facilitating expansion to other ports.

The term "delay" will be defined relative to operations at relatively low volume. This standard allows the processing time that the inspection agencies need to accomplish their mission to be removed from the definition of delay. The processing time will be included in the low volume condition. Using a free-flow condition, similar to operations along a normal city street or freeway, is a standard that is not relevant unless the inspection process is greatly reduced through treaties or other agreements.

Figure 2 is an example of the three conditions (the lines illustrate the cumulative travel time for free-flow, low volume and roadway operations) and the delay estimate - the difference between the low volume and roadway operating conditions. This difference will be tracked throughout the day and the delay time for each hour will be multiplied by the number of trucks experiencing

the delay. As a practical matter the data collection could be concentrated in periods when delay may occur.

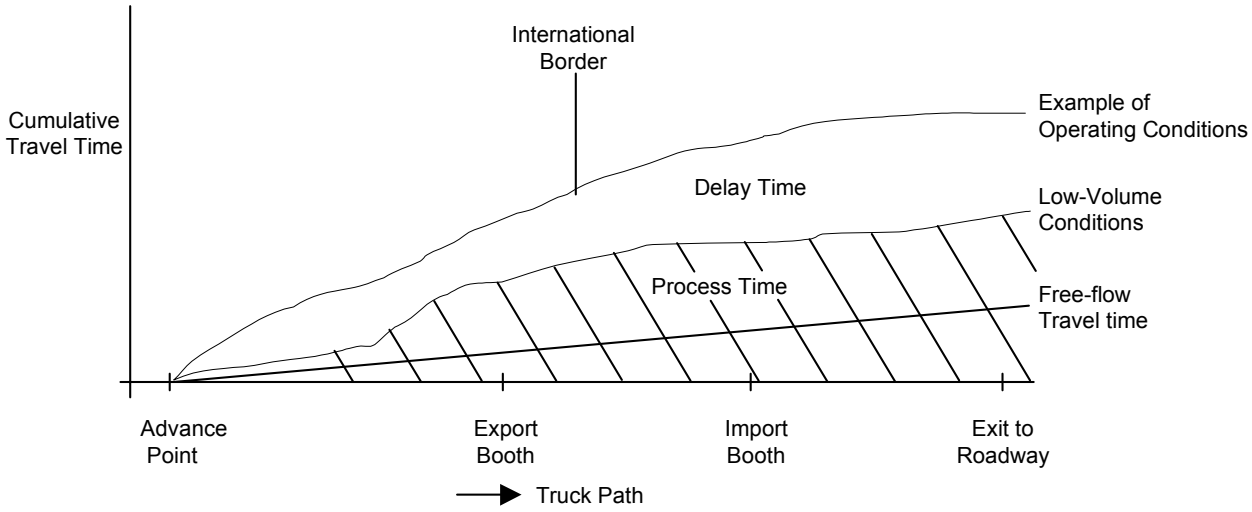


Figure 2. Schematic Display of Free-Flow Time, Process Time and Delay Time

For the purposes of this study, the following terms are defined:

- Baseline Travel Time – The time through the system at low volume conditions. For this report, the value used was that of the lowest hourly travel time in that direction for each day. This value represents the "no delay" travel time.

- Average Number of Open Booths – The average number of commercial vehicle inspection booths open and available for processing trucks at the initial import country's checkpoint. This figure is not used to compute delay but is useful to help understand the relationship between booths, traffic volume, and delay.

- Average Travel Time – The average amount of travel time through the data collection area from entry to exit for trucks entering the system each hour. The time the vehicle passes the advance point determines the time period label.

- Delay per Trip – The difference between the average travel time and the "no delay" time.

- Average Traffic Volume – The average hourly truck volume for the "season" or time of year being analyzed.

- Total Delay – The product of the average hourly truck volume and delay per trip.

Data Collection

For this study, two data collection locations were used in each direction. The first location was at a point upstream from the first point where trucks might experience delay in approaching the border and the second location was immediately after the primary inspection booths. Each data collector used a handheld computer to record license plate information of all commercial vehicles that passed their location. The computer would also store the time that each license plate was entered. The data from the two locations in each direction would be combined, allowing the determination of the travel time between each location throughout the time when most trucks were using the crossings. The number of matches are noted for statistical analysis and the travel time is noted for each hour. The travel time was assigned to the hour when the truck passed through the import country's primary customs inspection location as this was the only location that remained consistent throughout the data collection.

Data were collected at the following locations and shown in Table 1.

Table 1. Data Collection Dates and Times

Port of Entry	Survey Date(s)	Survey Time(s)	Inbound Average Daily Volume[2]	Outbound Average Daily Volume[2]
Otay Mesa, CA	July 17-19, 2001	6:00AM to 8:00PM	1,886	not available
El Paso, TX	June 26-28, 2001	8:00AM to 8:40PM	1,973	1,080
Laredo, TX	October 30-November 1, 2001	8:30AM to 7:00PM	2,956	3,048
Blaine, WA	July 10-12, 2001	7:00AM to 8:00PM	1,335	not available
Blue Water Bridge, MI[1]	June 12-14, 2001 August 14-16, 2001	6:00AM to 9:30PM 6:00AM to 9:30PM	2,289	2,030
Ambassador Bridge, MI[1]	May 22-24, 2001 June 19-21, 2001	6:00AM to 9:00PM 5:30AM to 9:45PM	4,587	4,969
Peace Bridge, NY[1]	May 22-24, 2001 June 19-21, 2001	6:00AM to 10:00PM 6:00AM to 10:00PM	1,990	1,992

Notes: [1]As new sites in the 2001 survey, data was collected in two different periods to provide a wider sample.

[2]Average daily volumes was based on data provided by Customs officials of the import country. Average daily volumes were derived from either monthly or annual totals.

The Buffer Time is a measure of travel reliability calculated by ranking crossing times of individual trucks at each port of entry. A crossing time for the 95th percentile of trucks is calculated, i.e., the time within which 95 percent of all trucks would have been processed through the point where they first experience delay and the exit from primary inspection of the import country. An average crossing time for all trucks is also calculated. The Buffer Time is the difference between the 95th percentile time and the average time for all trucks. The Buffer Time, then, represents the "extra time" a driver must budget to cross the border at the average time with a 95 percent certainty. This measure becomes particularly important as more and more goods are moved under the stricter requirements of such practices as just-in-time inventory/manufacturing where timely, dependable, and consistent goods movement is critical.

The Buffer Index is the Buffer Time necessary expressed as a percentage of average time, i.e., the extra percentage of time that must be budgeted to cross the border. This is the measure that will be the most comparable over the years and between the crossings as it serves to standardize the measure by remove differences in crossing length as an element.

RESULTS

Crossing Volumes

Figures A1 and A2 show crossing volumes by hour for inbound and outbound crossings respectively. Figures A3 through A6 show inbound and outbound volumes for southern and northern ports of entry respectively. Most notable in the figures are the differences in relative volumes between northern border crossings and southern border crossings. Southern crossings generally handle more traffic with generally more variability. Northern border crossing volumes, except for the Ambassador Bridge tend to be more consistent throughout the measurement periods. The significance of these differences as they relate to travel/delay times and other issues is discussed elsewhere in this report.

Delay Time

Average delay times were calculated for each port of entry (see Table 2 and Figure 3). The delay time represents the difference between the average crossing time and the free-flow crossing time. Inbound delay times exceed outbound delay times and southern border delay times exceed northern border delay times. In total, for all ports of entry, the average inbound delay time is 16.0 minutes and the average outbound delay time is 8.1 minutes. The average delay time for all ports of entry, both inbound and outbound, is 12.4 minutes.

Figures A7 through A10 show the variation that exists among crossings at both borders by plotting delay in minutes across each individual hour of the day. As expected, there are general peaks in activity during normal business hours with the peaks most pronounced with inbound traffic among at southern ports.

Table 2: Average Delay Time Summary at Selected Border Crossings

Delay Time and Location	Time in Minutes
Ambassador Bridge Inbound Delay	7.5
Ambassador Bridge Outbound Delay	3.1
Blaine Inbound Delay	9.2
Blaine Outbound Delay	16.2
Blue Water Bridge Inbound Delay	23.1
Blue Water Bridge Outbound	1.2
Peace Bridge Inbound Delay	13.2
Peace Bridge Outbound Delay	12.7
El Paso Inbound Delay	29.6
El Paso Outbound Delay	4.2
Laredo Inbound Delay	18.9
Laredo Outbound Delay	15.4
Otay Mesa Inbound Delay	28.6
Otay Mesa Outbound Delay	9.6
Average Northern POE Inbound Delay	12.5
Average Northern POE Outbound Delay	6.2
Average Northern POE Delay	9.8
Average Southern POE Inbound Delay	24.9
Average Southern POE Outbound Delay	11.6
Average Southern POE Delay	18.0
Average Inbound POE Delay	16.0
Average Outbound POE Delay	8.1
Average POE Delay	12.4

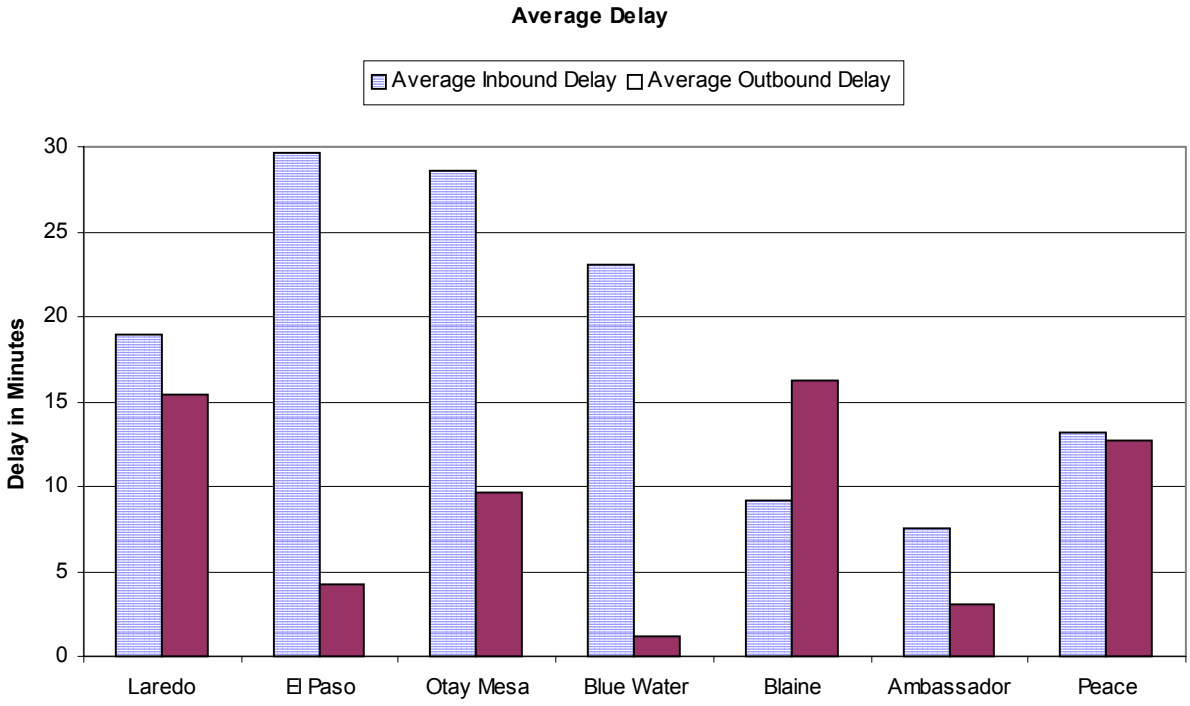


Figure 3. Average Delay

Buffer Time and Buffer Index

Table 3 provides a comparison of the differences between the baseline time, the average crossing time, and the 95th percentile time for each port of entry in each direction.

From these data, a Buffer Time and Buffer Index was developed (Tables 4 through 6) for each crossing, both inbound and outbound, and also aggregated by inbound vs. outbound traffic at both the northern and southern border, and all inbound versus all outbound traffic.

The relationship between these two calculations is perhaps best illustrated in the comparison of all outbound and all inbound crossings in Table 4. The Buffer Time for all inbound crossings is almost twice as large as that for outbound traffic. However, the Buffer Index is slightly larger for outbound crossings than for inbound crossings. In other words, the variability of the 95th percentile time from the average outbound crossing time may be larger, but the impact in real time of the variability in inbound crossings is significantly greater in terms of actual delay.

Another point of interest is the difference demonstrated in Tables 5 and 6 relative to inbound versus outbound Buffer Times. Inbound Buffer Times are significantly larger than outbound Buffer Times in the aggregate at 43 minutes versus 23 minutes. The largest single Buffer Time occurs with Peace Bridge inbound traffic at 62 minutes while the shortest Buffer Time is experienced by Blue Water and Ambassador Bridge outbound traffic at 5 and 3 minutes respectively.

Table 3. Travel Time Information

Crossing	Baseline Time	Average Crossing Time	95th Percentile Time
Ambassador Bridge Outbound	5.9	8.8	13.9
Ambassador Bridge Inbound	12.9	20.4	33.9
Blaine Outbound	4.8	21.0	35.3
Blaine Inbound	8.1	17.3	35.6
Blue Water Bridge Outbound	4.9	6.2	9.1
Blue Water Bridge Inbound	11.1	34.2	80.3
El Paso Outbound	5.1	9.3	34.0
El Paso Inbound	7.7	37.2	77.4
Laredo Outbound	2.2	17.2	45.0
Laredo Inbound	12.2	31.2	54.9
Otay Mesa Outbound	9.5	19.1	36.9
Otay Mesa Inbound	6.3	35.0	64.3
Peace Bridge Outbound	9.0	21.7	38.0
Peace Bridge Inbound	8.3	21.5	83.4

Table 4: Comparison of Outbound and Inbound Buffer Times (in minutes)

Crossing	Average Time[1]	95th Percentile Time[2]	Buffer Time[3]	Buffer Index[4]
All Outbound Crossings	14.2	37.4	23.3	164.1%
All Inbound Crossings	26.8	70.1	43.3	161.6%
All Northern Outbound Crossings	12.6	34.3	21.7	172.2%
All Northern Inbound Crossings	24.1	70.3	46.2	191.7%
All Southern Outbound Crossings	17.2	45.2	28.1	163.4%
All Southern Inbound Crossings	33.8	64.9	31.1	92.0%
Ambassador Bridge Outbound	8.8	13.7	4.9	55.7%
Ambassador Bridge Inbound	20.4	33.9	13.4	65.7%
Blaine Outbound	21.5	35.3	14.3	66.5%
Blaine Inbound	17.3	35.6	18.3	105.8%
Blue Water Bridge Outbound	6.2	9.1	2.9	46.8%
Blue Water Bridge Inbound	34.2	80.3	46.1	134.8%
El Paso Outbound	13.2	34.0	24.7	187.1%
El Paso Inbound	37.2	77.4	40.2	108.1%
Laredo Outbound	17.2	45.0	27.8	161.6%
Laredo Inbound	31.2	54.9	23.7	76.0%
Otay Mesa Outbound	19.1	36.9	17.8	93.2%
Otay Mesa Inbound	35.0	64.3	29.3	83.7%
Peace Bridge Outbound	21.7	38.0	16.2	74.7%
Peace Bridge Inbound	23.3	83.4	61.9	265.7%

Notes: 95th percentile time - 95 percent of the trucks cross in less than this time.
Average time - total crossing time of all trucks divided by the number of trucks crossing.

[1]Average time (in minutes) to travel the study distance (between the starting point in the exporting country and the initial inspection point in the importing country).

[2]Time (in minutes) for 95 percent of trucks to travel the study distance.

[3]Time (in minutes) between the average time and the 95th percentile time for trucks to travel the study distance. This is the "extra time" that must be budgeted to cross the border relative to the average time.

[4]Buffer time necessary expressed as a percentage of average time. This is the extra percentage of average time that must be budgeted to cross the border.

Table 5: Comparison of Inbound Buffer Times (in minutes)

Crossing	Average Time[1]	95th Percentile Time[2]	Buffer Time[3]	Buffer Index[4]
All Inbound Crossings	26.8	70.1	43.3	161.6%
All Northern Inbound Crossings	24.1	70.3	46.2	191.7%
All Southern Inbound Crossings	33.8	64.9	31.1	92.0%
Ambassador Bridge	20.4	33.9	13.4	65.7%
Blaine	17.3	35.6	18.3	105.8%
Blue Water Bridge	34.2	80.3	46.1	134.8%
El Paso	37.2	77.4	40.2	108.1%
Laredo	31.2	54.9	23.7	76.0%
Otay Mesa	35.0	64.3	29.3	83.7%
Peace Bridge	23.3	83.4	61.9	265.7%

Notes: 95th percentile time - 95 percent of the trucks cross in less than this time. Average time - total crossing time of all trucks divided by the number of trucks crossing.

[1]Average time (in minutes) to travel the study distance (between the starting point in the exporting country and the initial inspection point in the importing country).

[2]Time (in minutes) for 95 percent of trucks to travel the study distance.

[3]Time (in minutes) between the average time and the 95th percentile time for trucks to travel the study distance. This is the "extra time" that must be budgeted to cross the border relative to the average time.

[4]Buffer time necessary expressed as a percentage of average time. This is the extra percentage of average time that must be budgeted to cross the border.

Table 6: Comparison of Outbound Buffer Times (in minutes)

Crossing	Average Time[1]	95th Percentile Time[2]	Buffer Time[3]	Buffer Index[4]
All Outbound Crossings	14.2	37.4	23.3	164.1%
All Northern Outbound Crossings	12.6	34.3	21.7	172.2%
All Southern Outbound Crossings	17.2	45.2	28.1	163.4%
Ambassador Bridge Outbound	8.8	13.7	4.9	55.7%
Blaine Outbound	21.5	35.3	13.8	66.5%
Blue Water Bridge Outbound	6.2	9.1	2.9	46.8%
El Paso Outbound	13.2	34.0	24.7	187.1%
Laredo Outbound	17.2	45.0	27.8	161.6%
Otay Mesa Outbound	19.1	36.9	17.8	93.2%
Peace Bridge Outbound	21.7	38.0	16.2	74.7%

Notes: 95th percentile time - 95 percent of the trucks cross in less than this time. Average time - total crossing time of all trucks divided by the number of trucks crossing.

[1]Average time (in minutes) to travel the study distance (between the starting point in the exporting country and the initial inspection point in the importing country).

[2]Time (in minutes) for 95 percent of trucks to travel the study distance.

[3]Time (in minutes) between the average time and the 95th percentile time for trucks to travel the study distance. This is the "extra time" that must be budgeted to cross the border relative to the average time.

[4]Buffer time necessary expressed as a percentage of average time. This is the extra percentage of average time that must be budgeted to cross the border.

There is one final point that further illustrates the potential importance of Buffer Times as a useful measure in assessing crossing times. Table 4 shows average inbound and outbound crossing times for each of the ports of entry surveyed. Among the POE's surveyed, the Peace Bridge shows the most similarity between inbound and outbound average crossing times and is among those crossings at the lower end of spectrum in terms of average time. However, Table 4 shows Peace Bridge with the highest inbound Buffer Index. The significance of these measures taken together is that while the average crossing time is consistent in both directions (see Figure 3), the potential exists to be significantly late in the inbound direction – later, on average, than at any other POE.

From the perspective of the user, the most desirable end is a consistent, predictably low crossing time, a low Buffer Time, which in turn yields a low Buffer Index.

Crossing Volume/Crossing Time Relationships

A scatter plot of each port of entry (Figures A11 through A17) was produced to show volume per hour per lane along the vertical axis and time in minutes along the horizontal axis. The shape of the scatter plots for each port tells an interesting story. With the exception of the Blaine and Ambassador Bridge crossings, as noted earlier, it takes longer to cross the border coming into the

U.S. than it does to leave and it is the case that inbound traffic crossing times show considerably more variability without regard to volume. In other words, at a given volume, it's just as likely to take 2*x* time as it will *x* time to be processed through the port when coming into the United States. As a general rule, for outbound traffic, it will take less time to cross, and there will be less variability in the time it takes to cross. Note that this is not a function of increased security in the post-September 11 environment as all but one of the surveys was conducted before September 11.

The "ideal" shape of a scatter plot is to have all of the outbound data points groups closely together and all of the inbound traffic data points grouped closely together. Such a distribution would indicate a consistent and reliable crossing time and varying volumes, with the distribution grouped more to the left along the horizontal axis indicating more desirable low crossing times.

Figure A14, the scatter plot of the Ambassador Bridge Crossing comes closest to the "ideal" shape demonstrating a consistently low crossing time for both inbound and outbound traffic. Figure A15, representing the Blaine crossing also shows less time variability compared to other crossings even though crossing times are somewhat longer. At the other end of the spectrum, Figures A11, A12, A13, A16, and A17, (Otay Mesa, , El Paso, Laredo, Blue Water Bridge, and Peace Bridge crossings respectively) have a less desirable distribution of volume/time data points. All, to varying degrees, show a horizontal distribution of points, meaning there is significant time variability across similar volumes.

Monitoring these time/volume relationships in future years and assessing how the shape of the scatter gram changes over time may well prove to be a significant analytical tool in assessing border crossing traffic flows and times. The Travel Time Index and the Buffer Index are measures that summarize these scatter grams.

Time/Volume per Lane/Open Booth Relationships

Not surprisingly, the number of booths open at each port at any given time has a potentially significant influence on travel times and often serves as a leading indicator of that particular variable. Figures A18 through A76 depict the relationship between the volume, travel time, and the number of open booths for each port, each direction, and each day surveyed.

At many ports there appears to be significant variability during the day with respect to the number of booths open at any given time. This relationship is dynamic with volume influencing the number of booths open, the number of booths open influencing traffic volume per lane, and both, to some degree, influencing travel time.

It is important to note three factors with respect to these particular data and their implications. First, as Figures A18 through A76 generally indicate, there is a relationship between the number of open booths and crossing time. Second, decisions with regard to how many lanes are open at any given time are not made purely with mobility/crossing times in mind and are not made by transportation agencies. Third, to whatever degree mobility was a consideration in the number of open booths/lanes prior to the events of September 11, 2001, that level of consideration has lessened.

Implications

Originally, this research was undertaken to document the development of a baseline border crossing dataset. With the tragic events of September 11, 2001, and subsequent changes to the international border crossing operation, the comparability of this data may be diminished or eliminated. However, the knowledge gained about data collection procedures, analysis steps, reporting format, and performance measures will be applicable for subsequent years and other efforts.

This report summarizes the baseline crossing times, delay times, a Buffer Time, a Buffer Index, general patterns of the volume/time relationships, and the patterns of volume/time/open lanes. Each of these factors can be assessed in subsequent years in light of future policy and infrastructure improvements to gauge impact.

With respect to the implications of what is known so far, there are a few clear lessons that can be learned. They are:

- Crossing times at the Ambassador Bridge POE are clearly superior and more consistent than any other port of entry in the study. While, like other ports, inbound crossing times exceed outbound crossing times, the margin of difference is significantly narrower and more consistent. Further, lower crossing times are achieved despite (as indicted in Figure 1) the bridge having a consistently higher volume of traffic. It's not known at this point whether the reason for this difference in performance is a function of policy, bridge ownership, tactics, infrastructure, capacity, or facility design, but clearly, the operations and/or facilities at the Ambassador Bridge port of entry seems to be one worthy of study.

- Three of the ports of entry included in the study (Otay Mesa, Blaine, and Laredo) have some form of "truck only" crossing, with the El Paso crossing (the Ysleta Bridge) being primarily trucks. However, the performance of these crossings as measured as a function of the time/volume relationship did not differ significantly from those crossings where auto and truck traffic are intermingled. This is unexpected and the reasons should be explored.

- It can be generally said that U.S./Canada ports of entry (with the exception of the Blue Water POE) processed inbound trucks in less time and with less variability than did U.S./Mexico ports of entry. There may be procedures/policies that reduce time at the U.S./Canada ports that are transferable to U.S./Mexico ports.

- Prior to the events of September 11, 2001, the perceived threats and levels of concern regarding commerce, homeland security, immigration, and related issues on northern and southern border were different than the environment in that regard after September 11. The extent to which those changes will affect traffic volumes and crossing times in the long term is not yet clear – but certainly the transportation system will be affected. The transportation agencies as well as companies that operate near the border will be challenged to operate as efficiently as possible and adapt to changes that that the inspection and security agencies will implement. The new operating environment may include procedures or technologies that can enhance both security and traffic flow.

APPENDIX

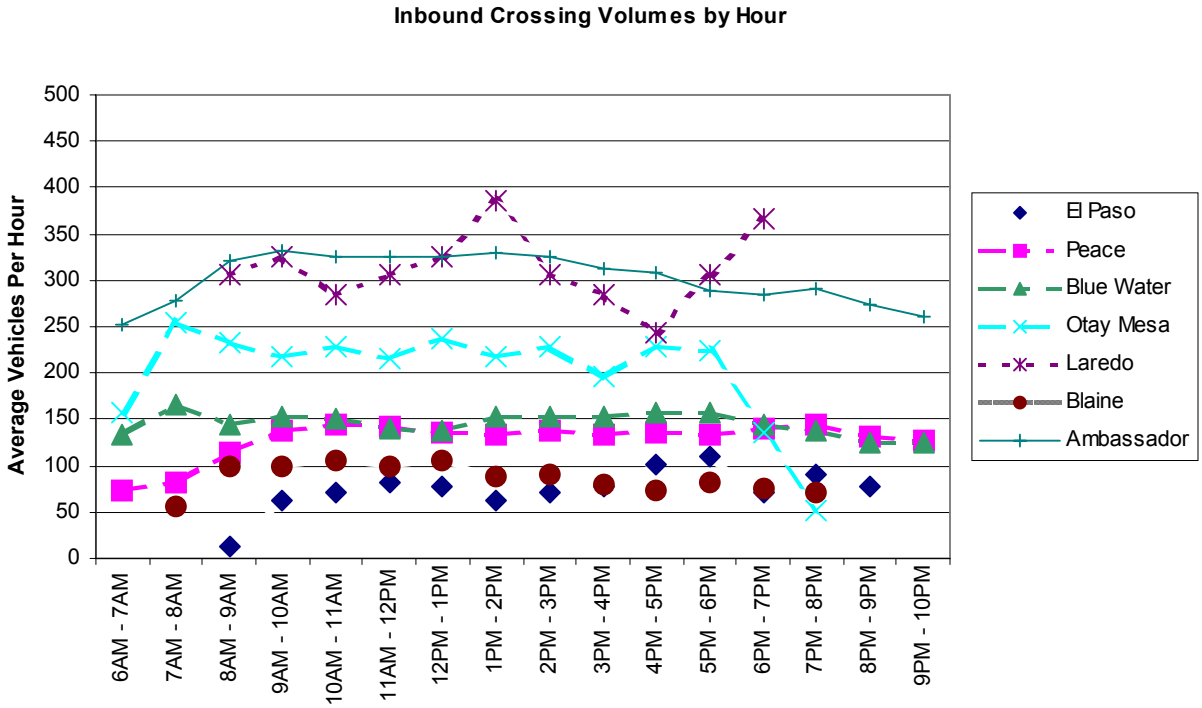


Figure A1

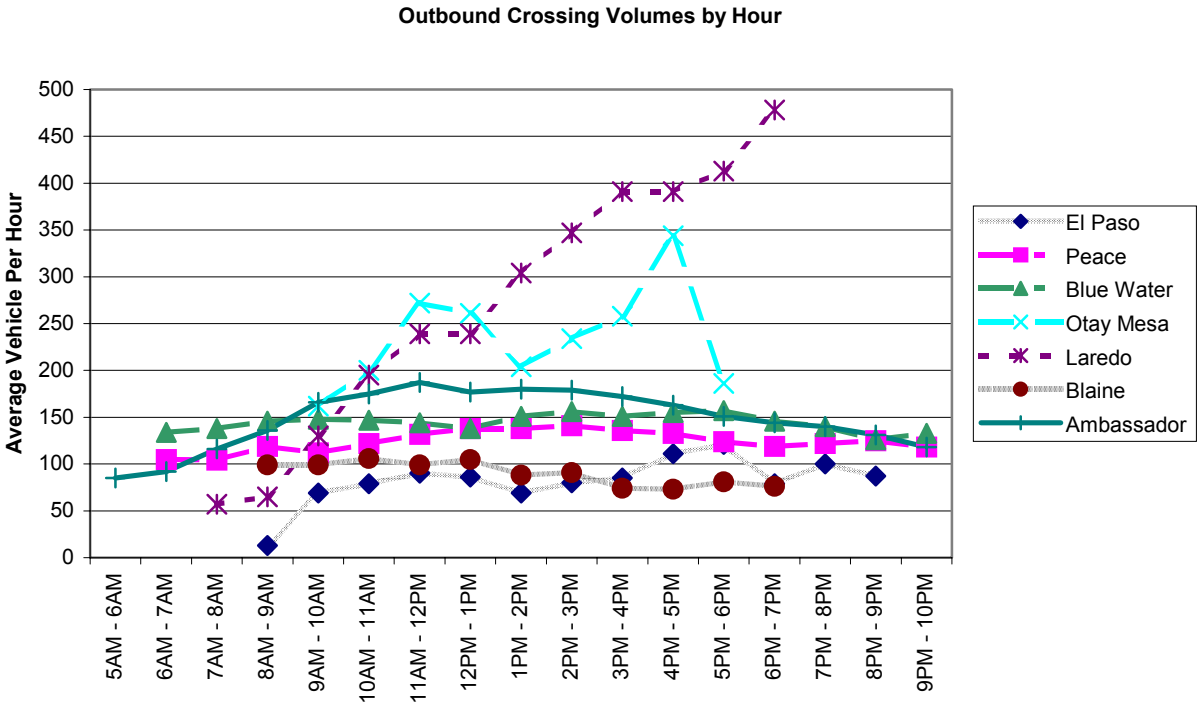


Figure A2

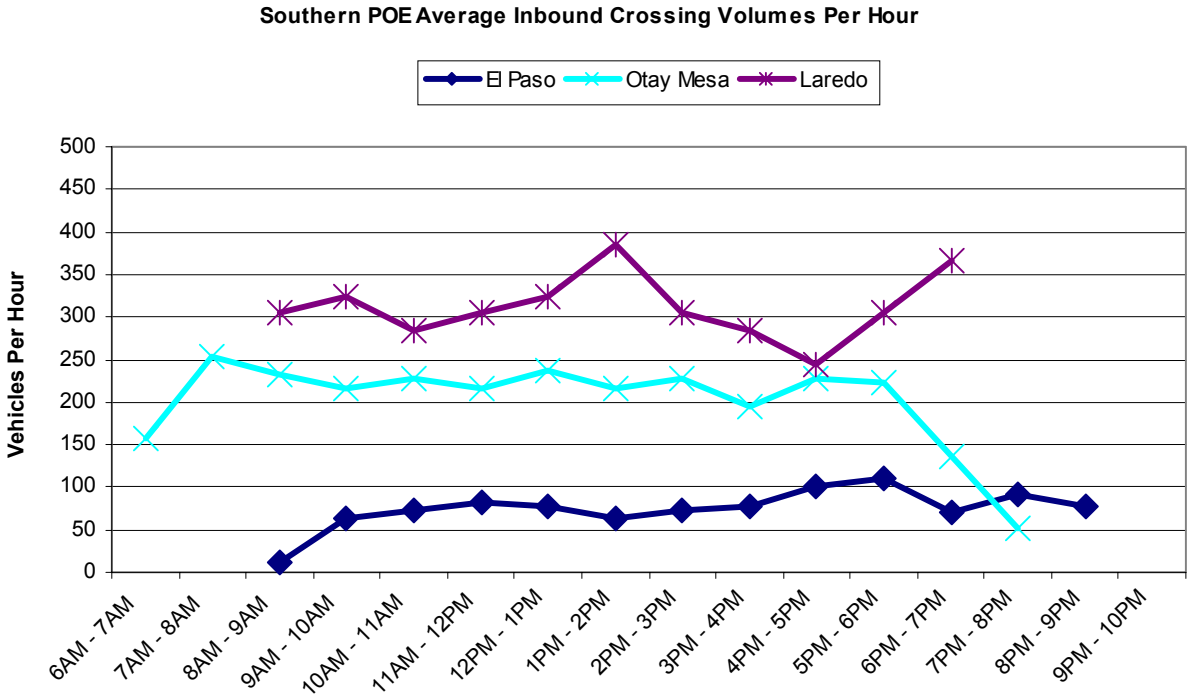
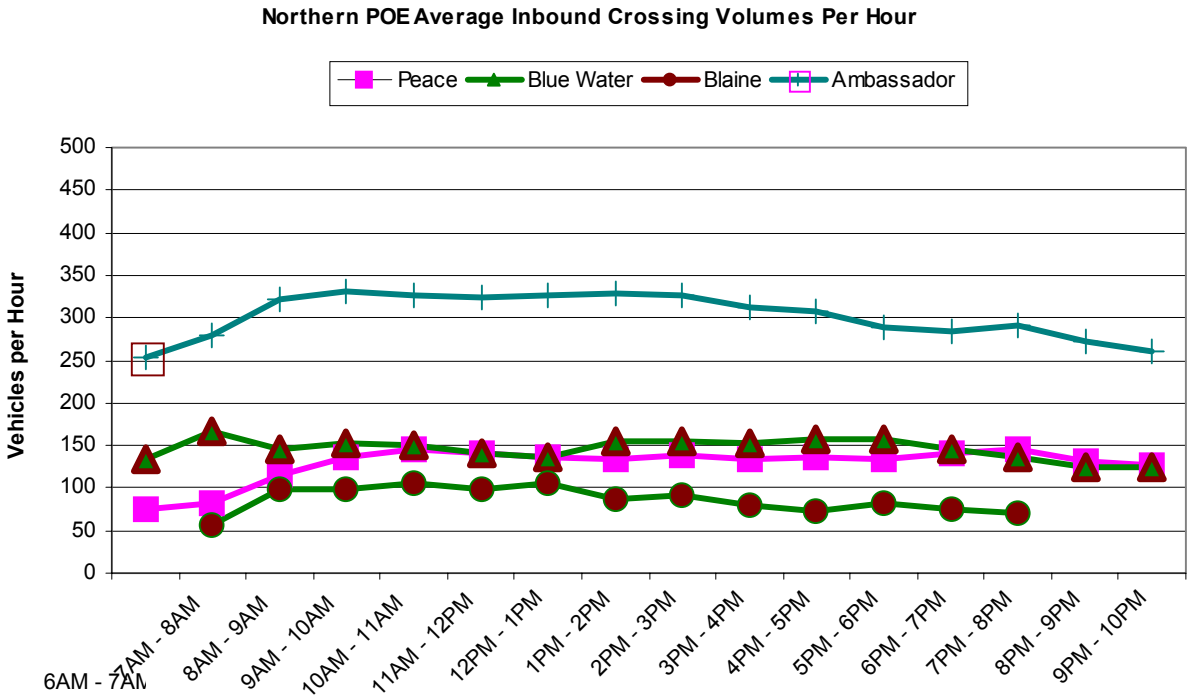


Figure A3



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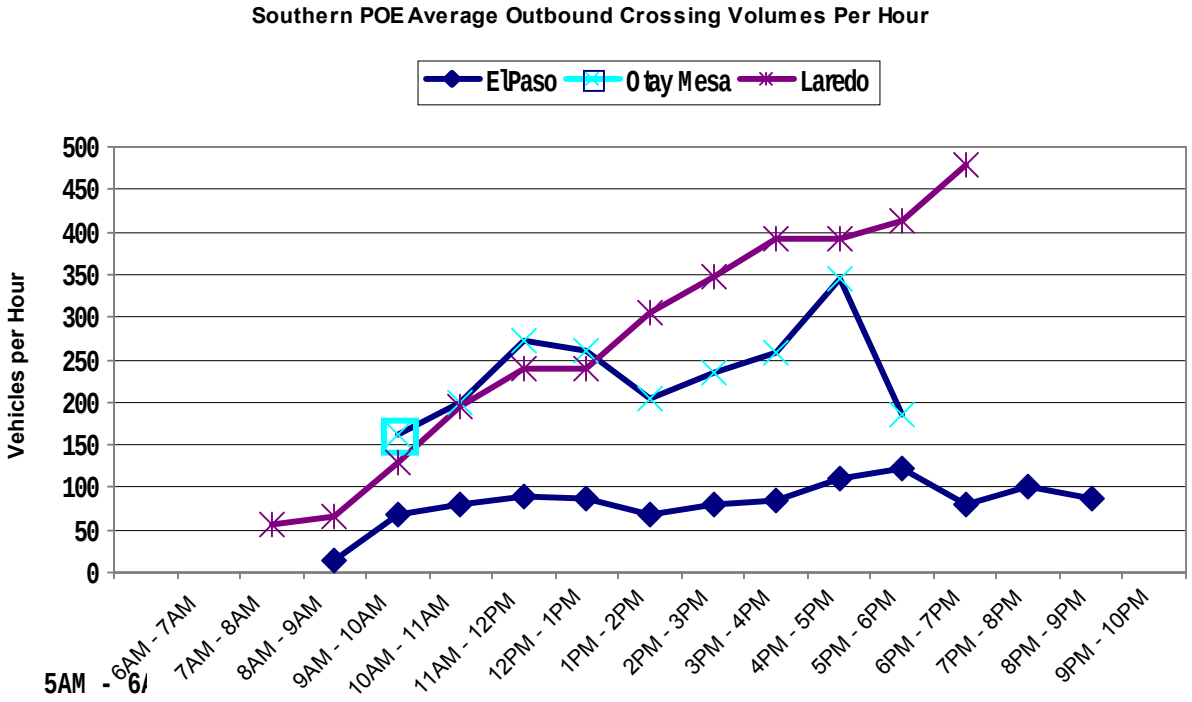

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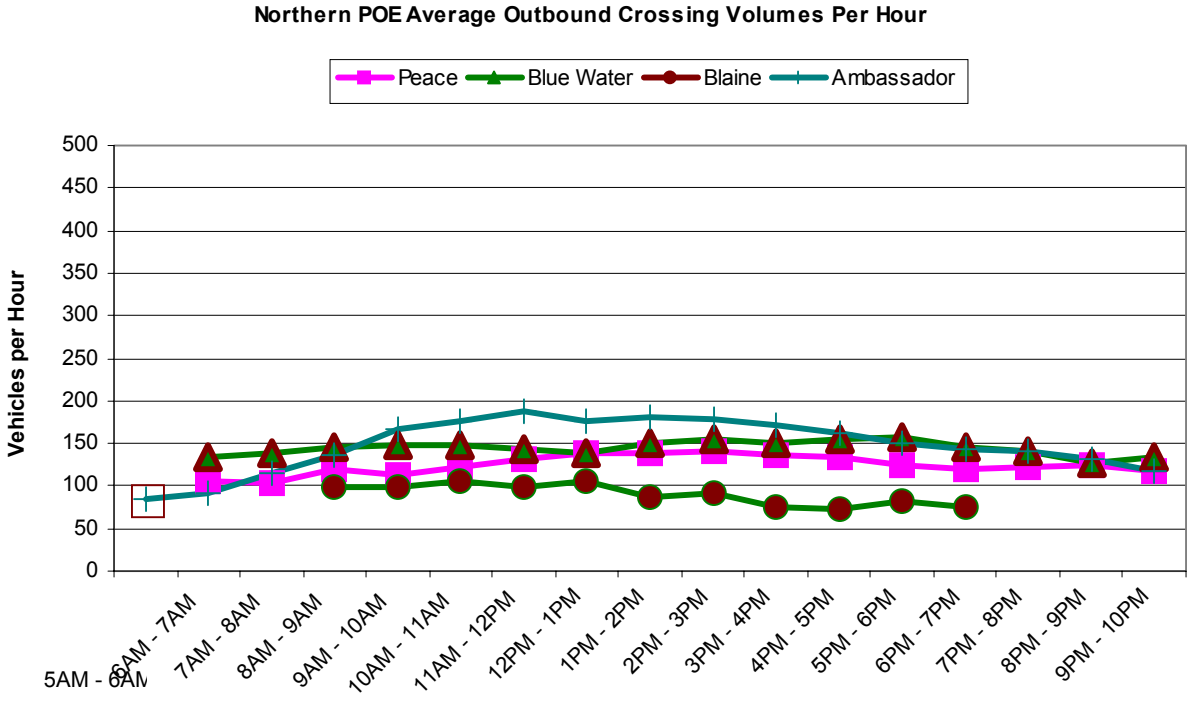

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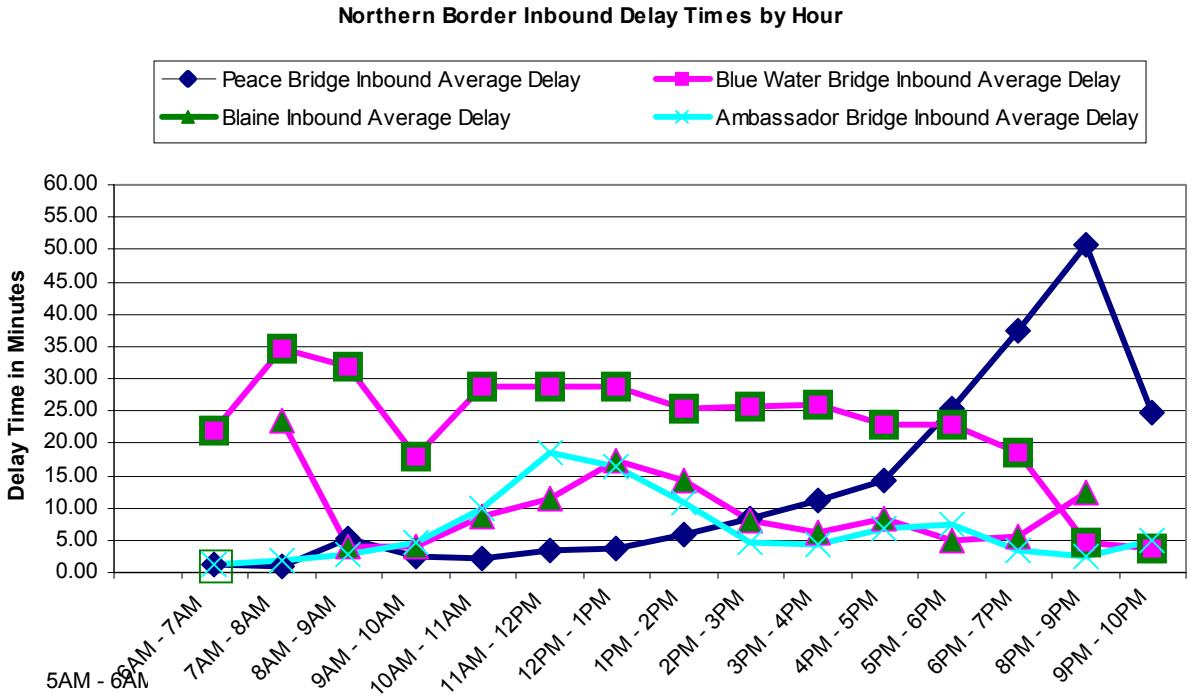

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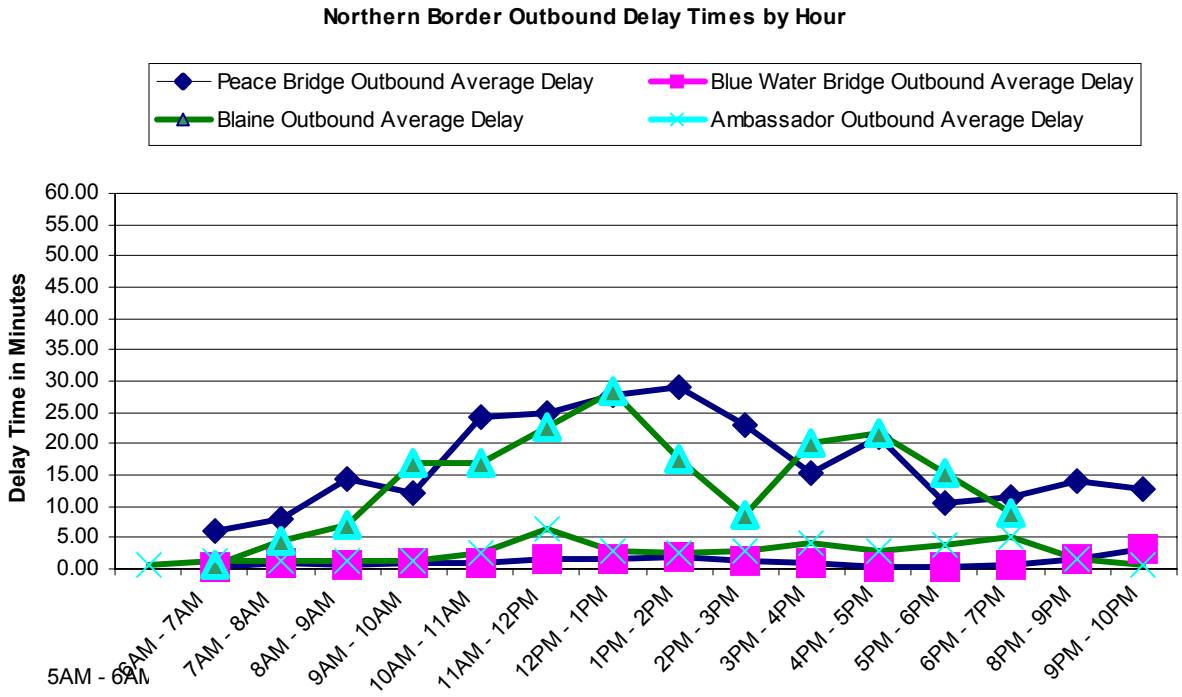

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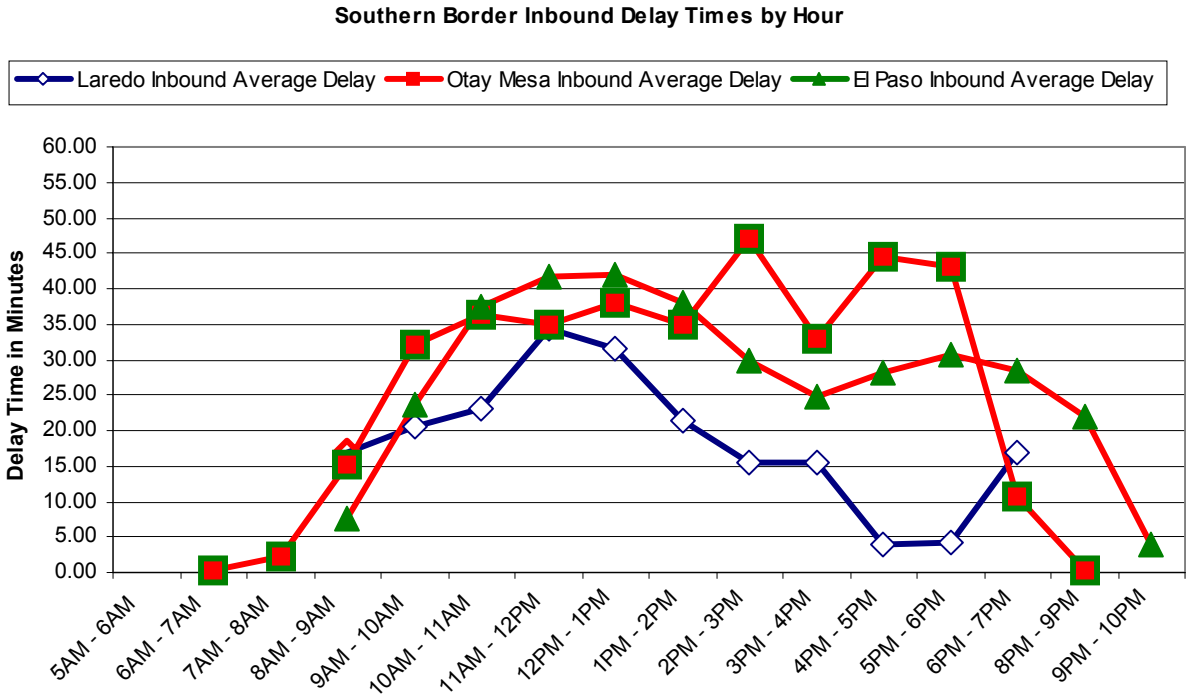

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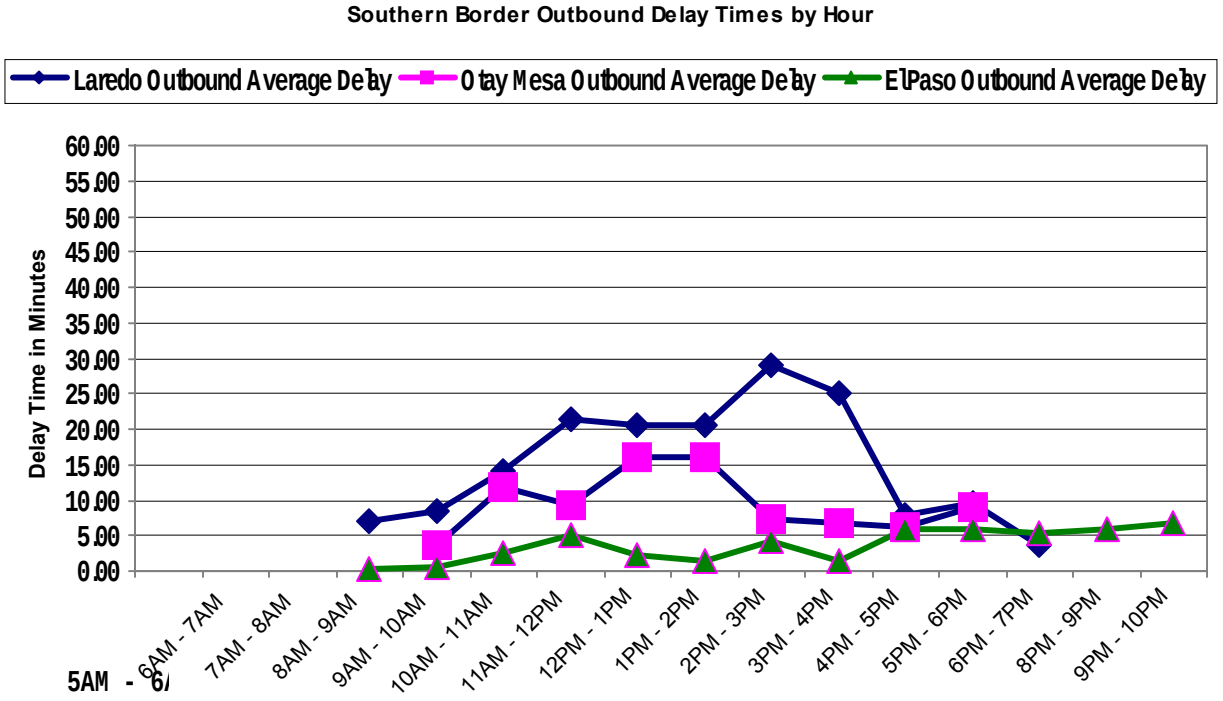

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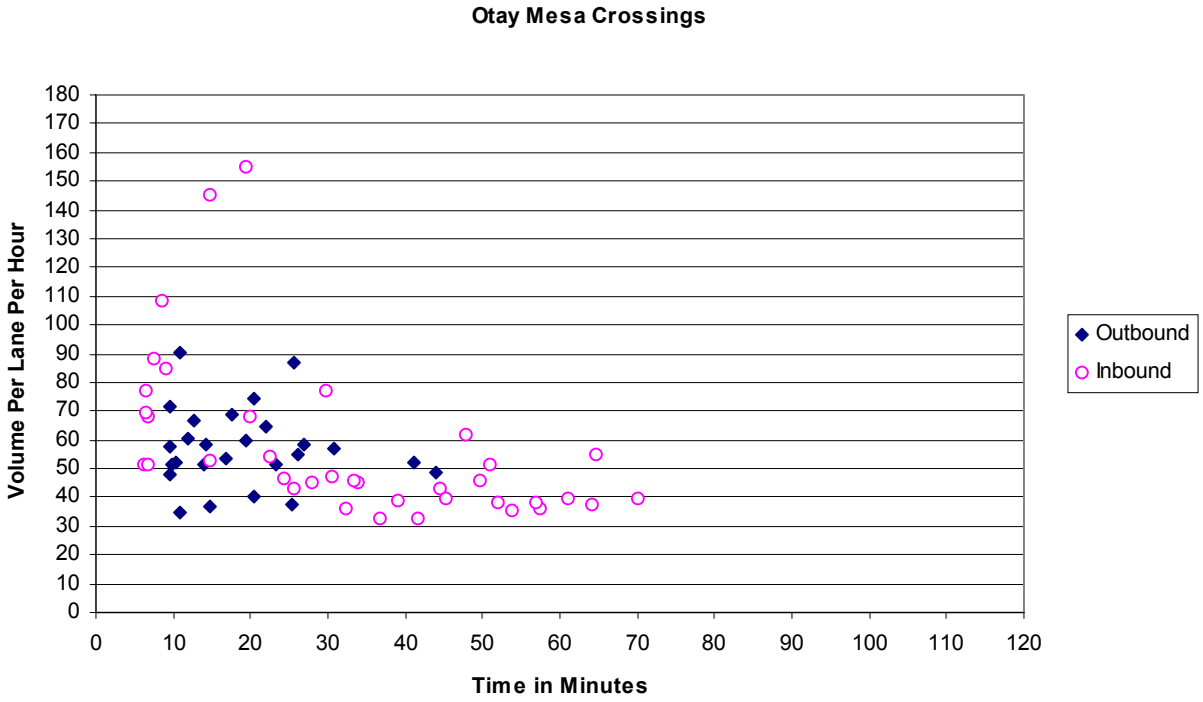

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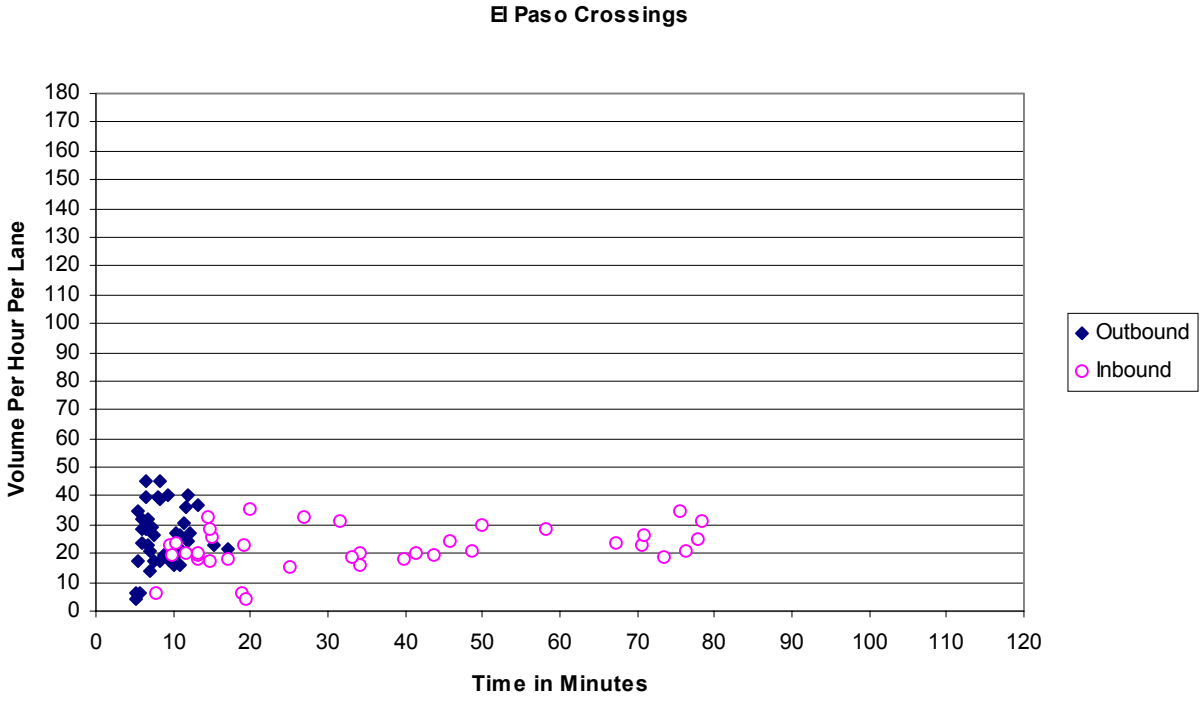

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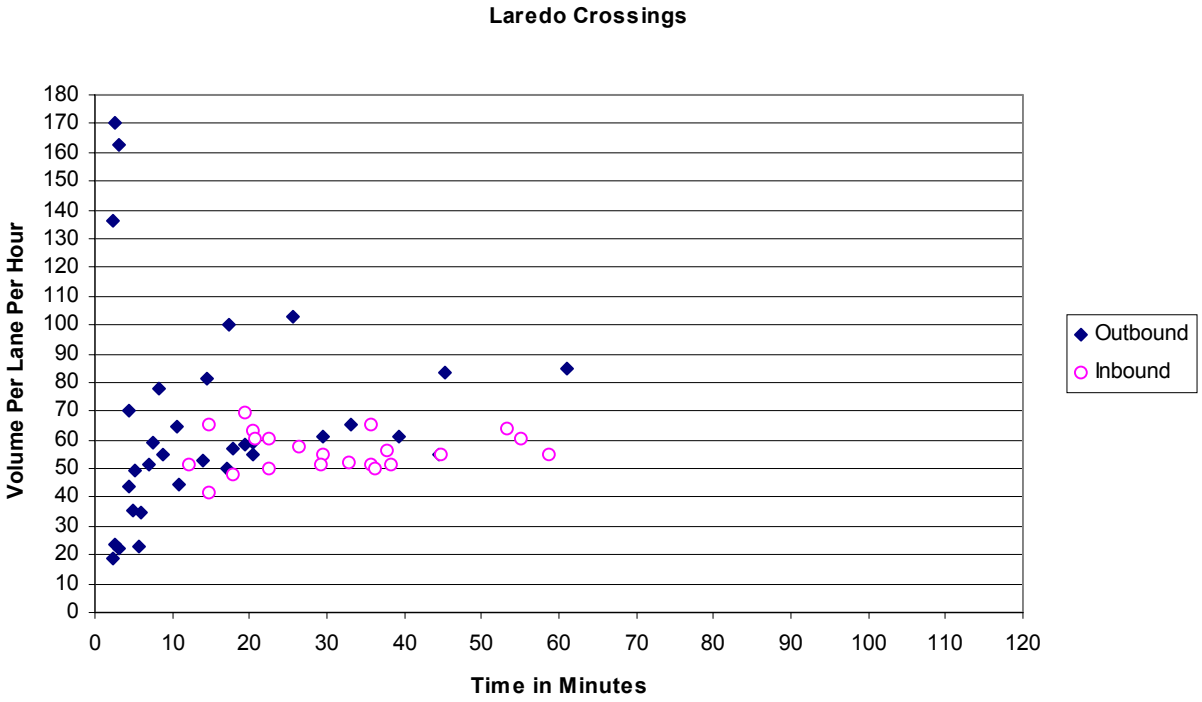

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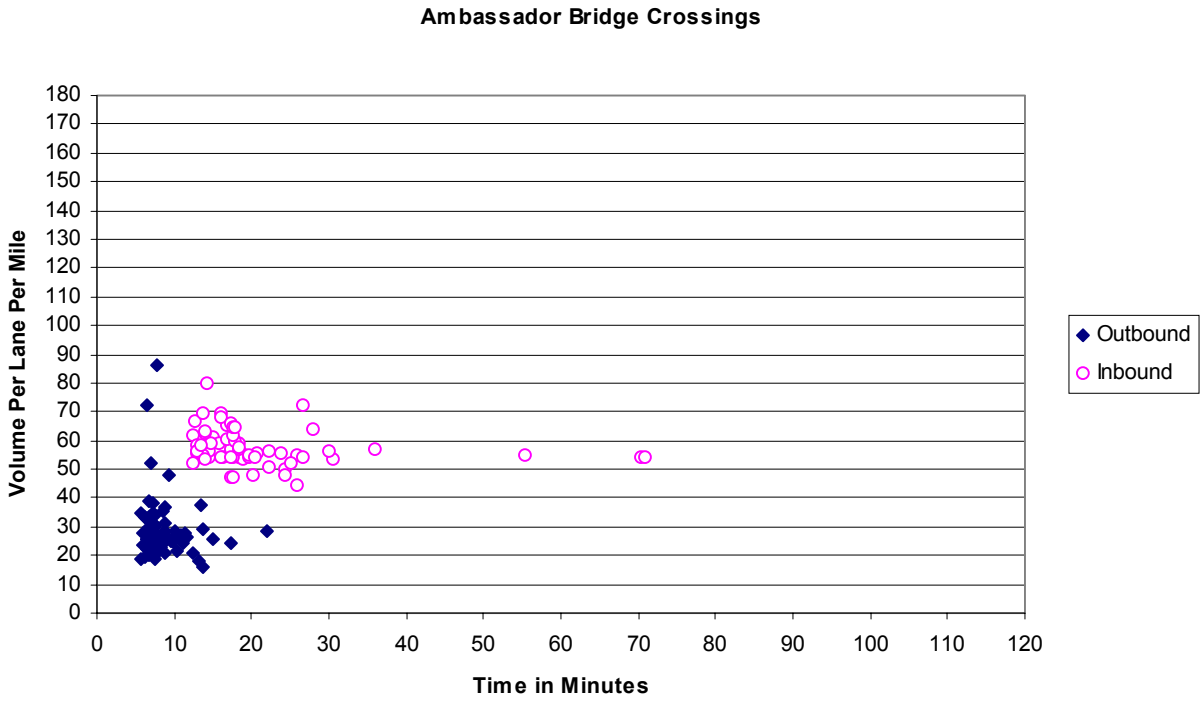

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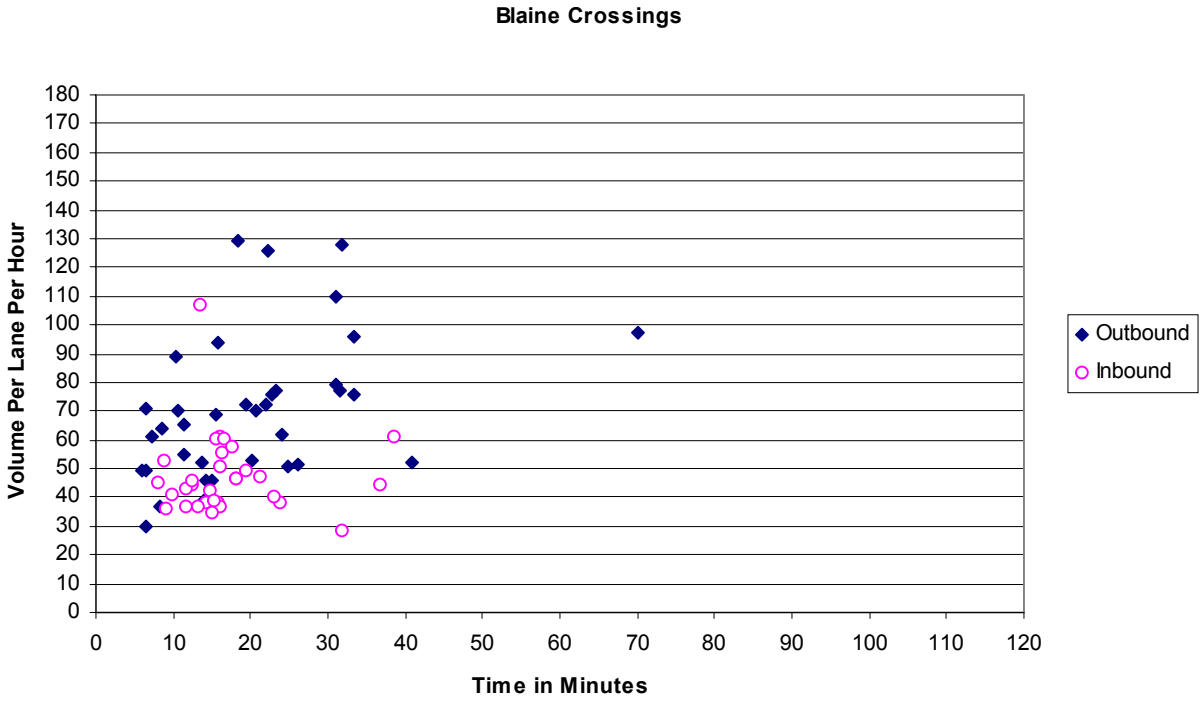

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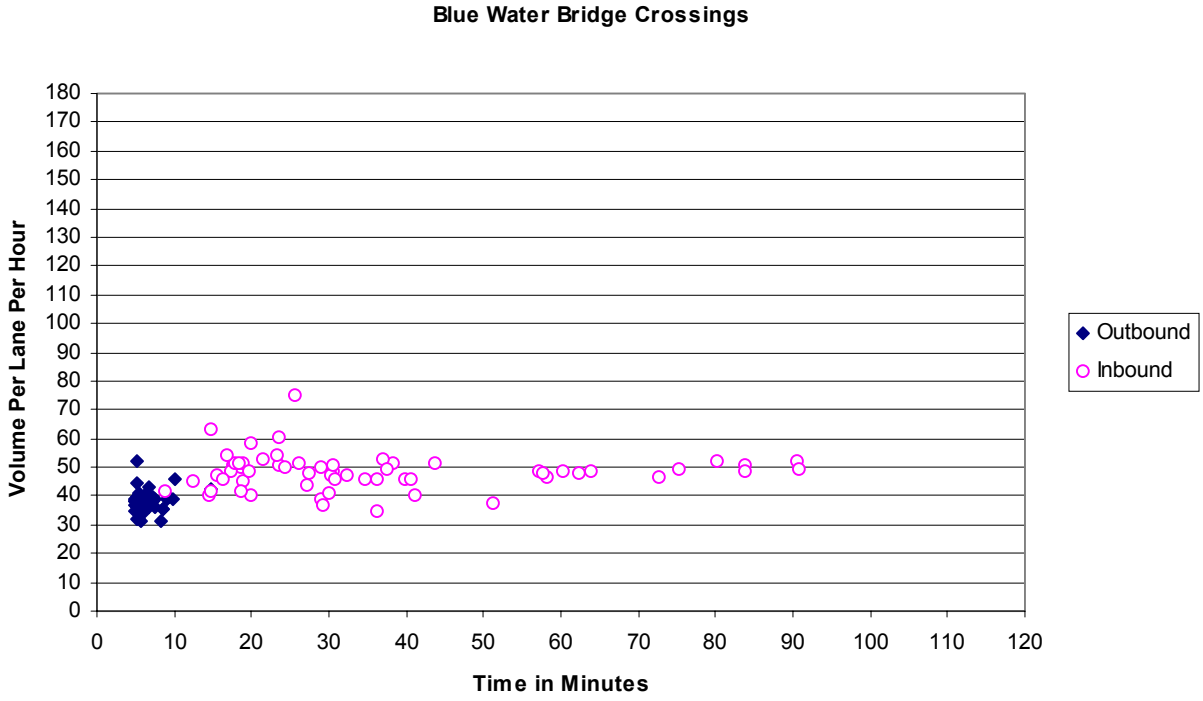

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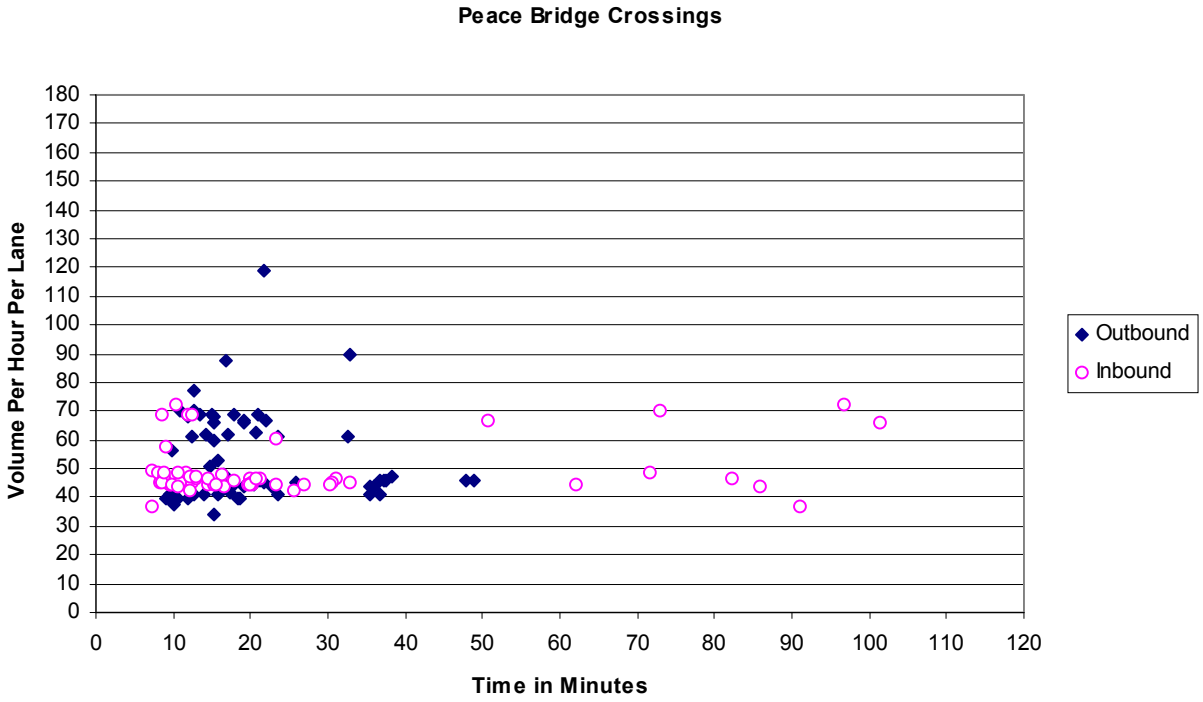

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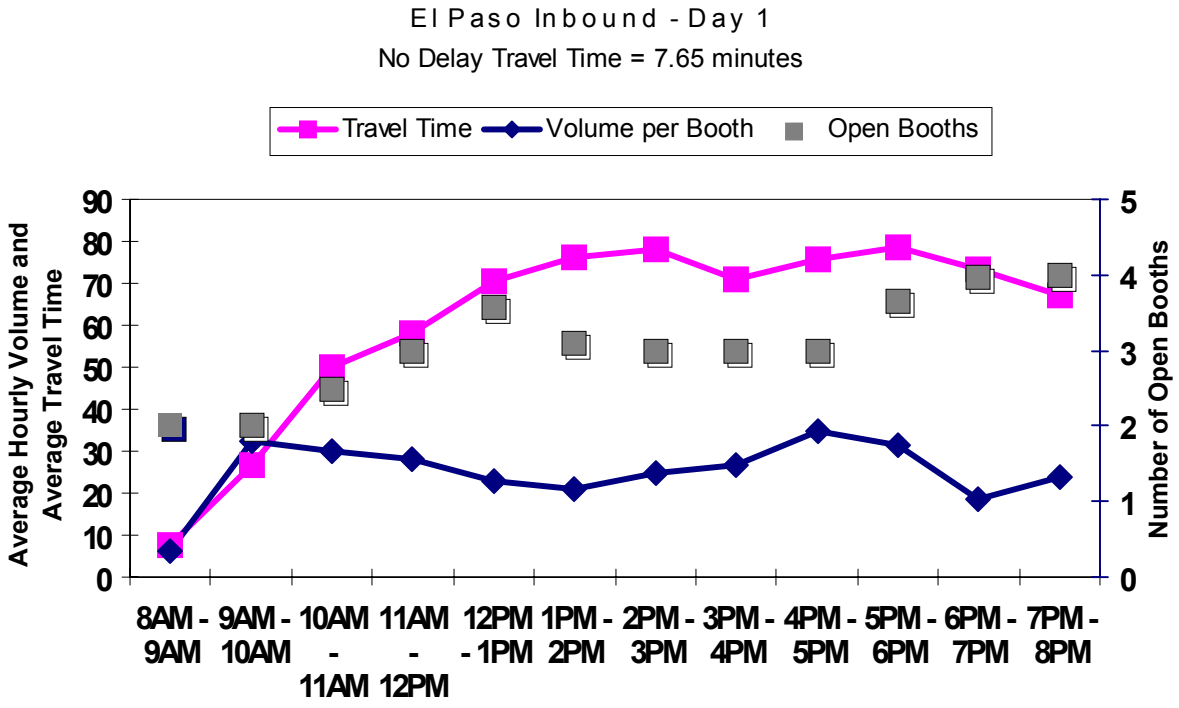

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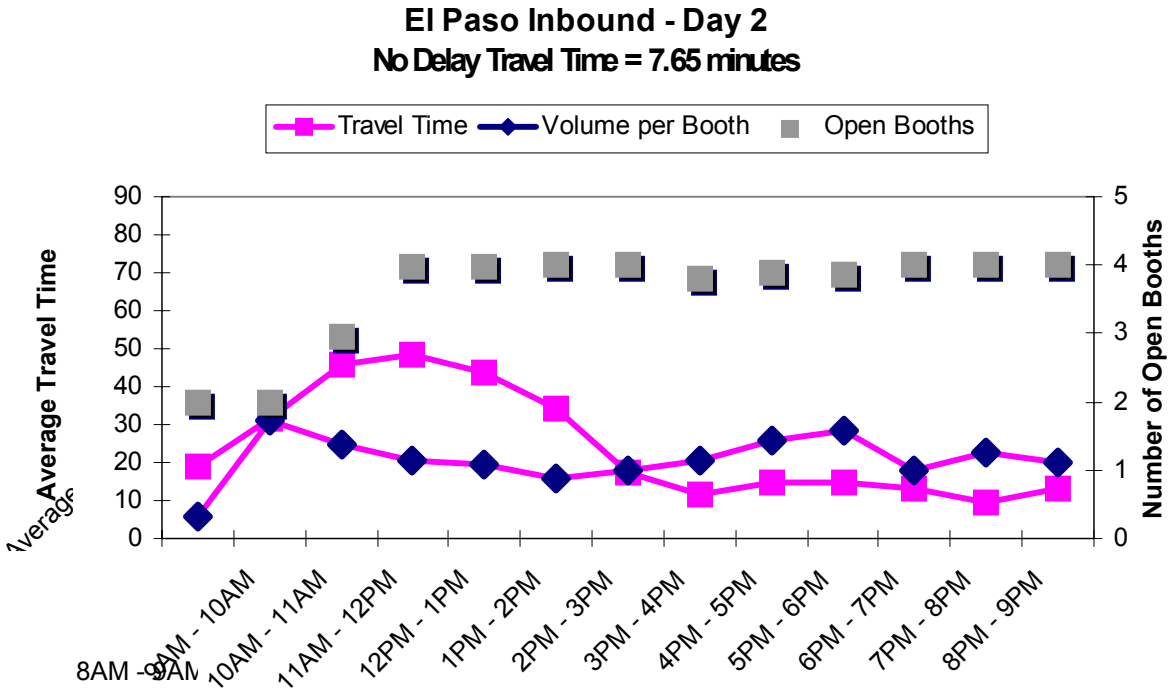

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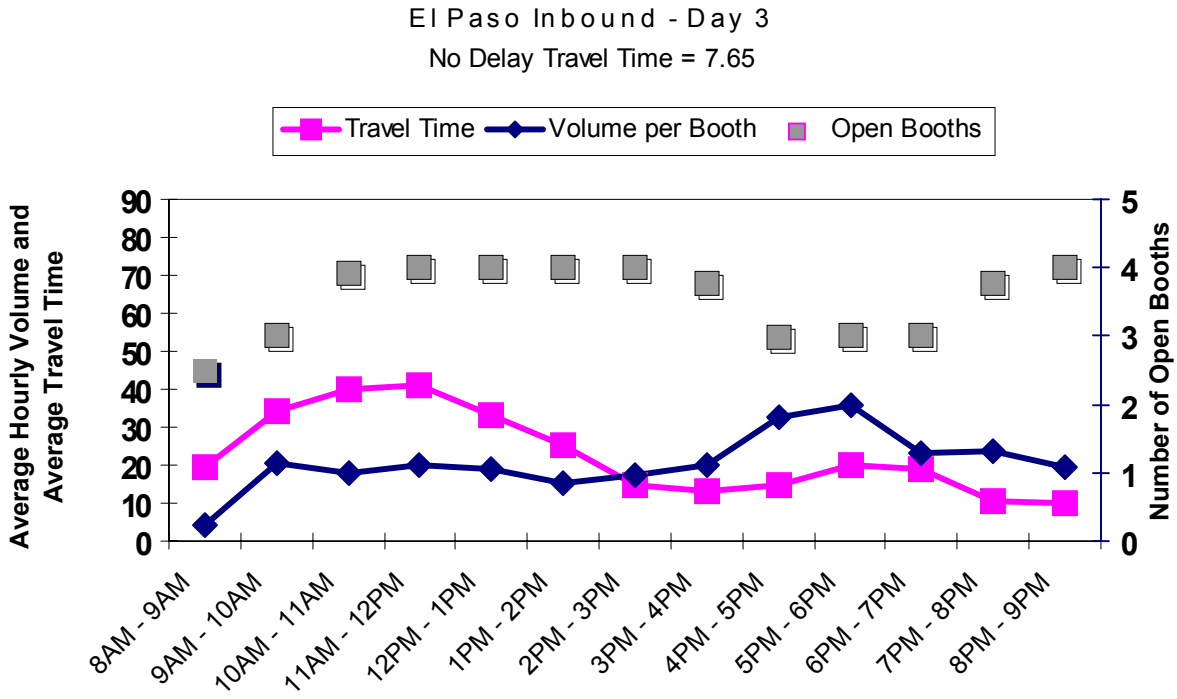

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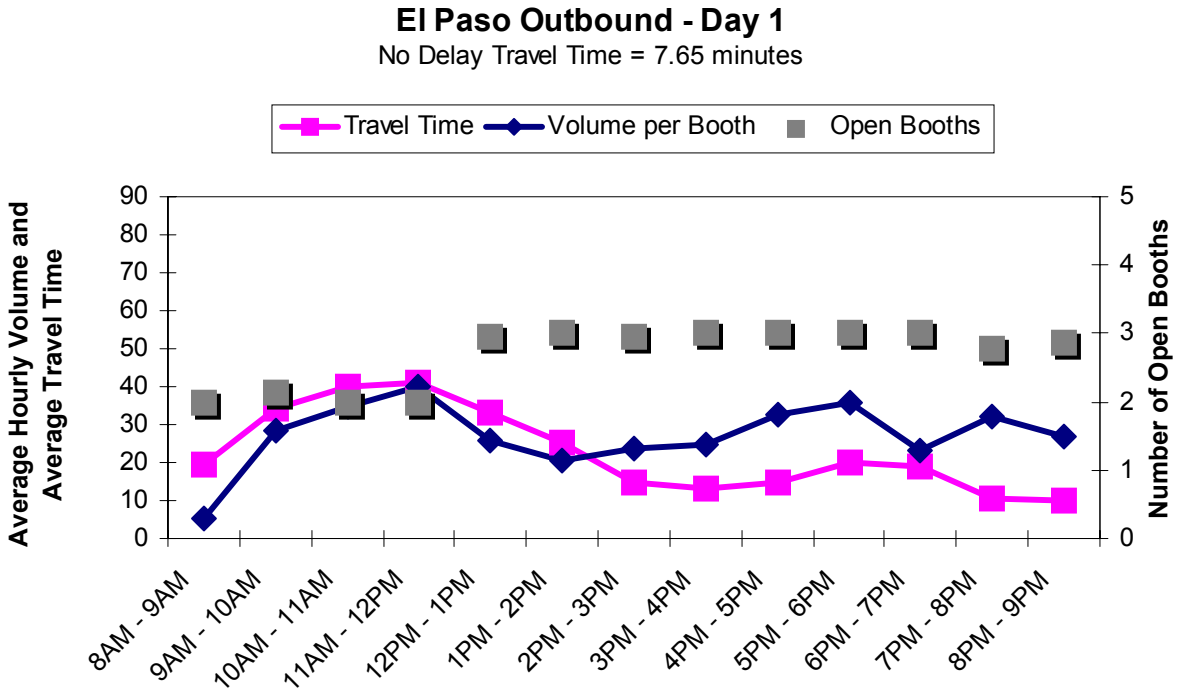

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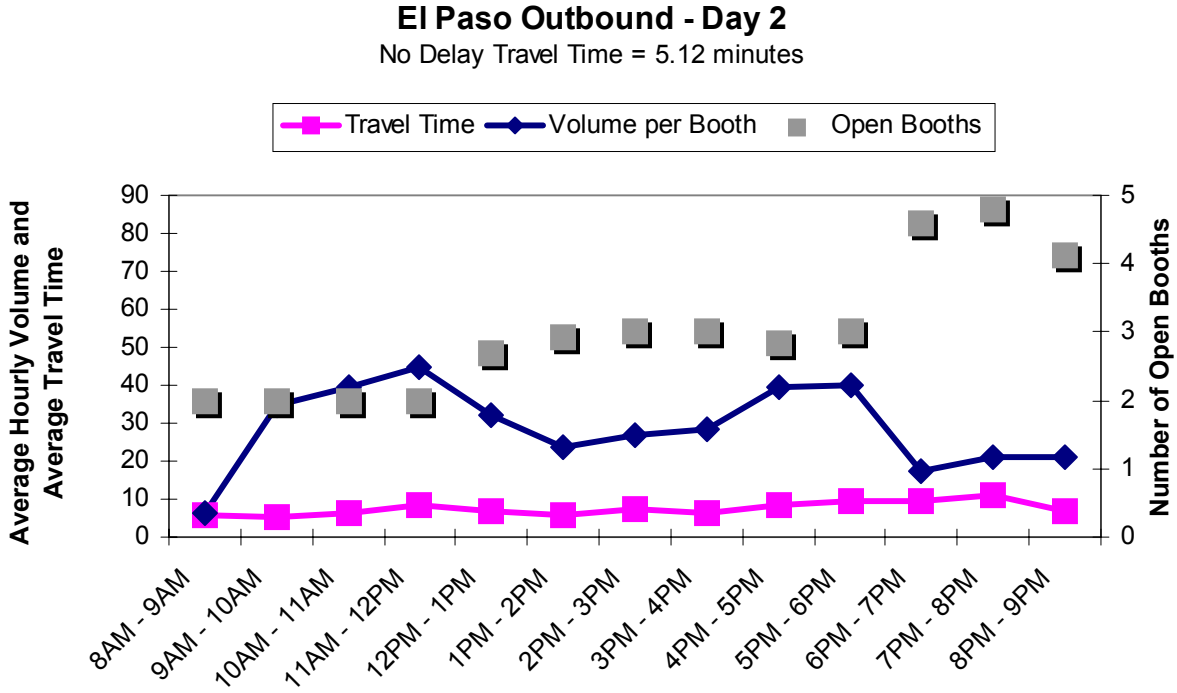

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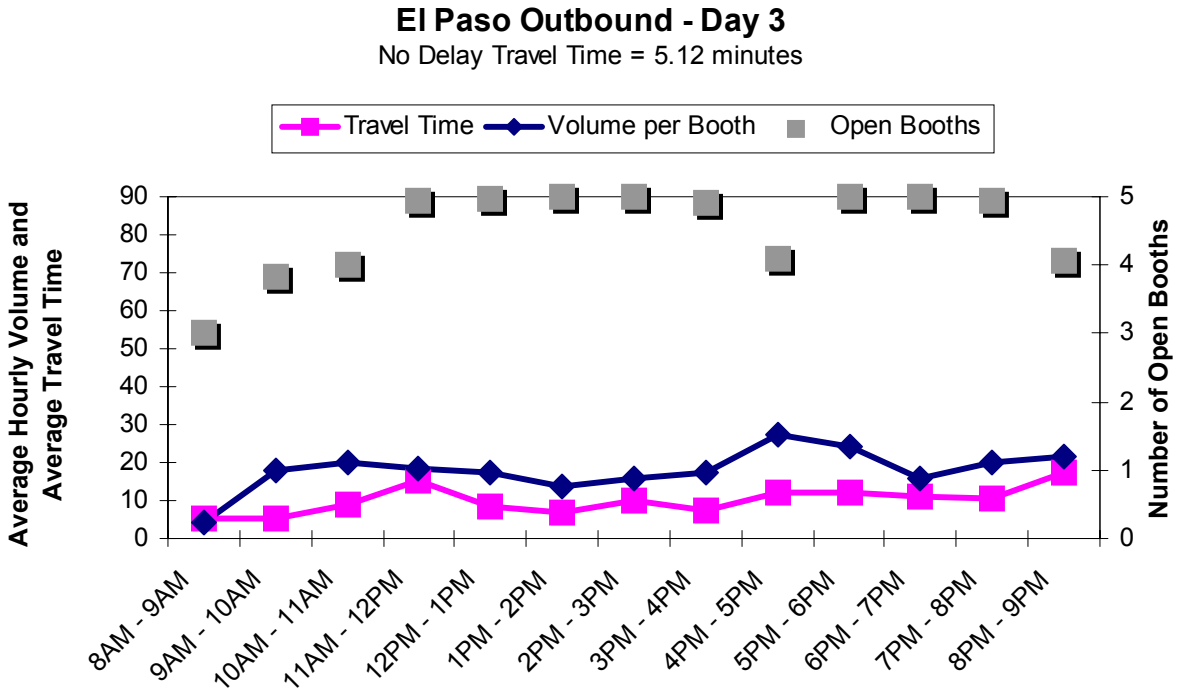

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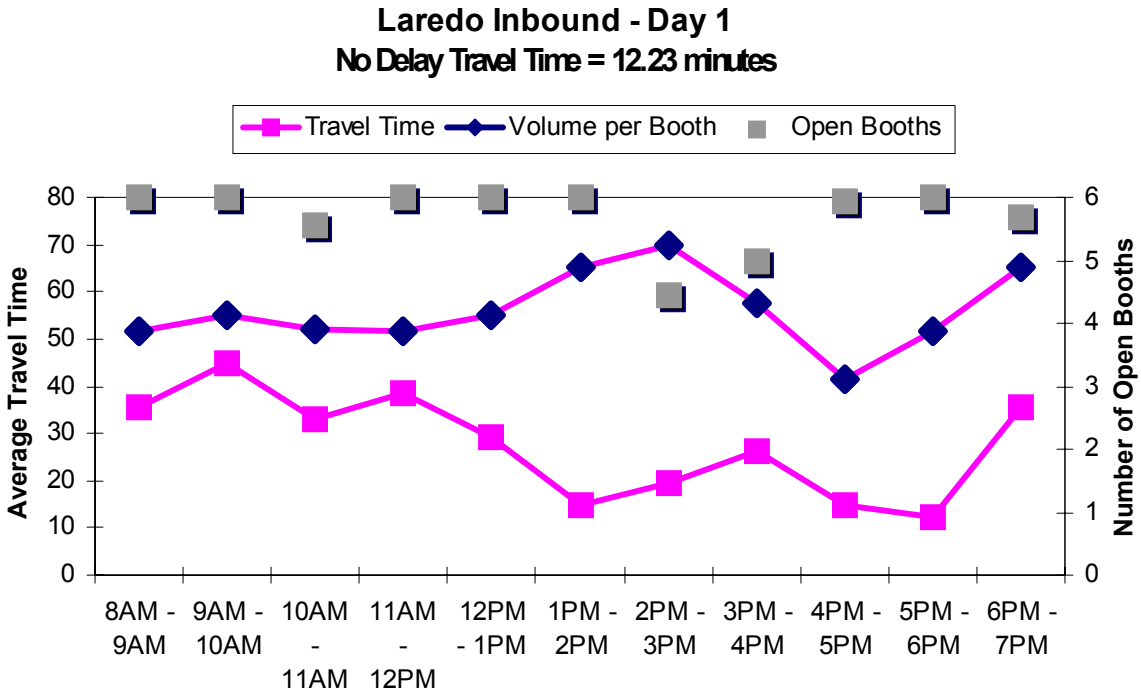

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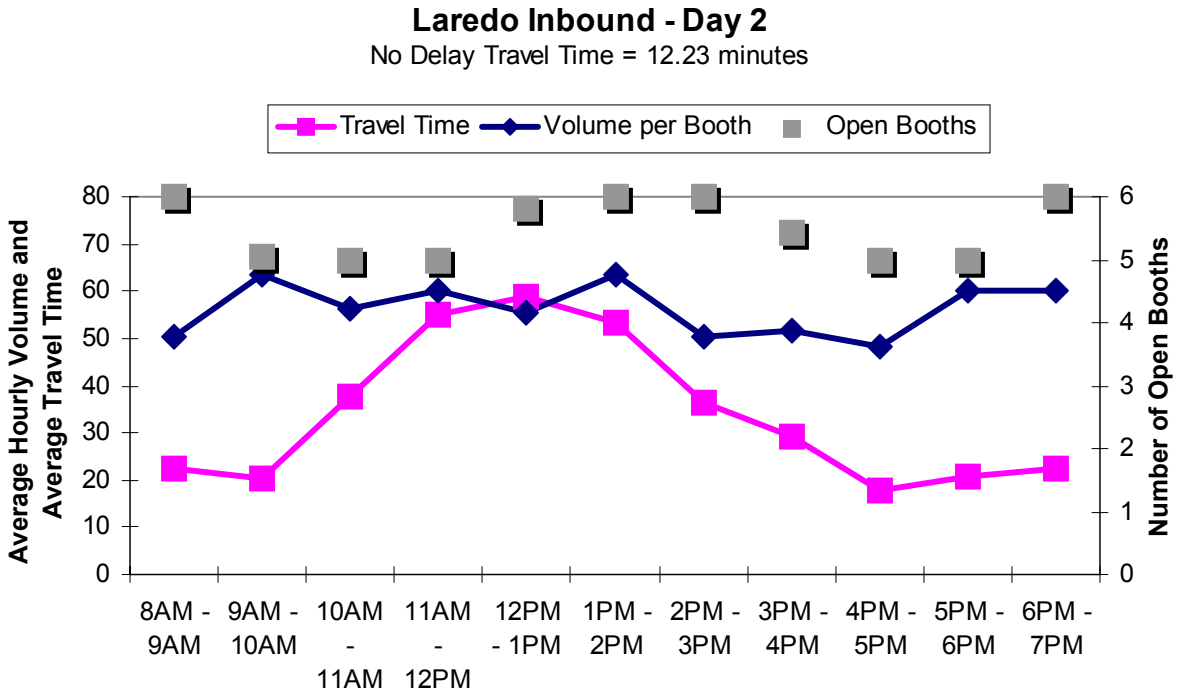

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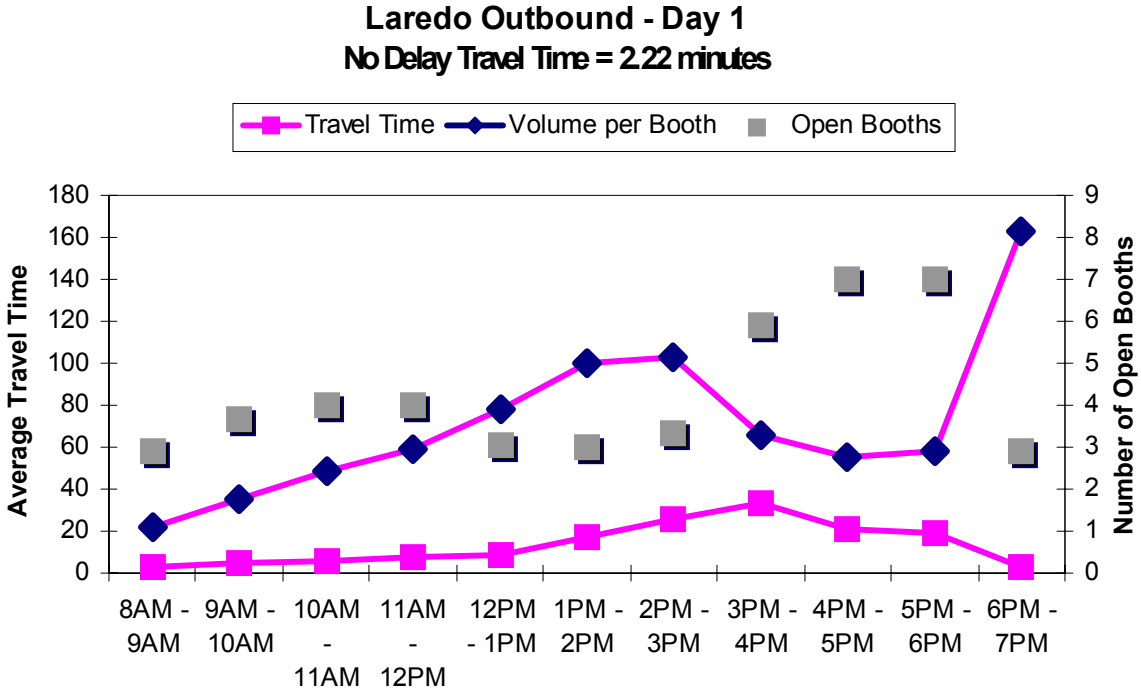

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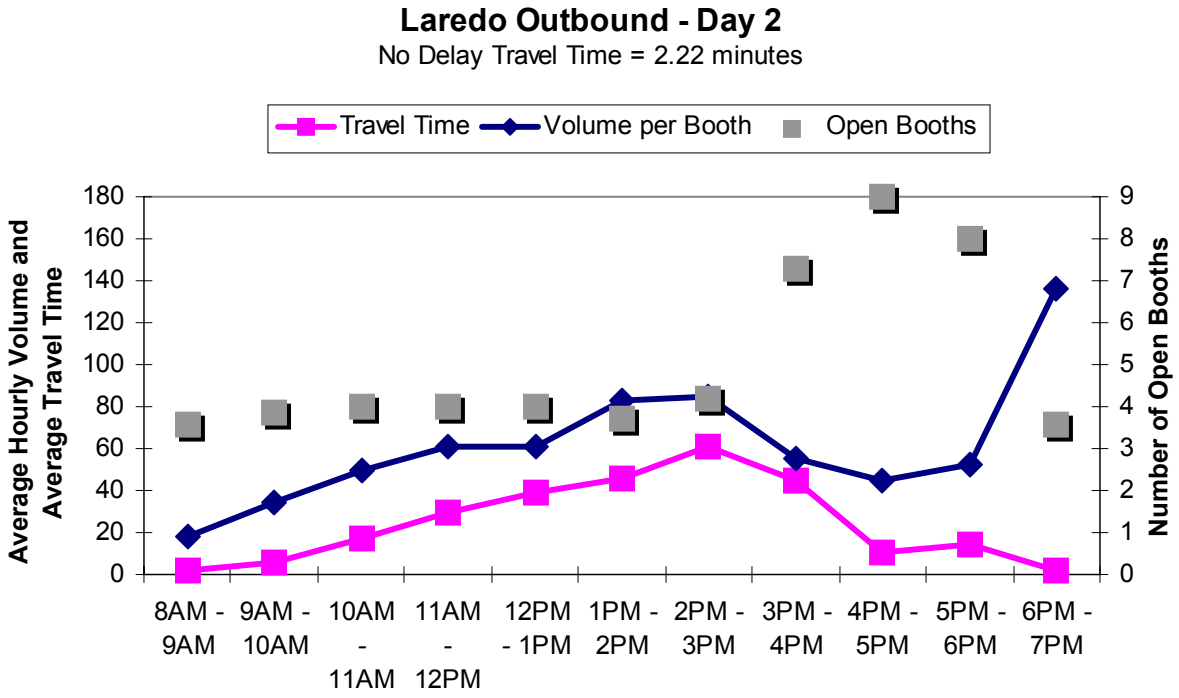

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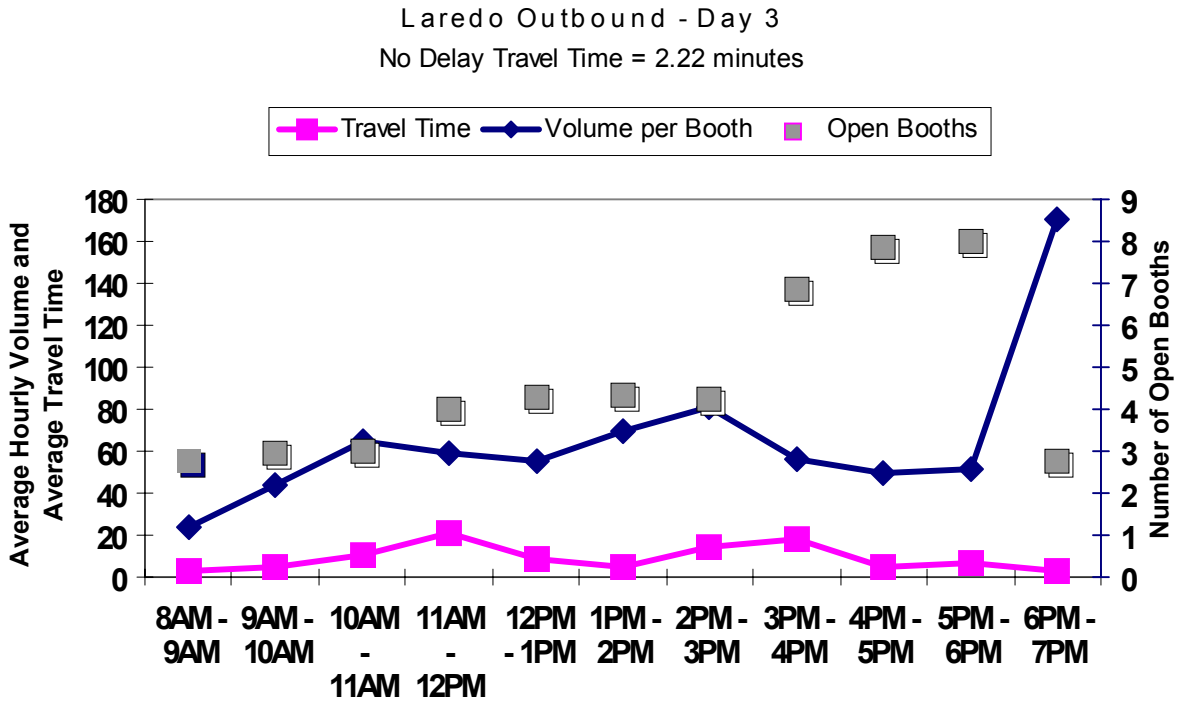

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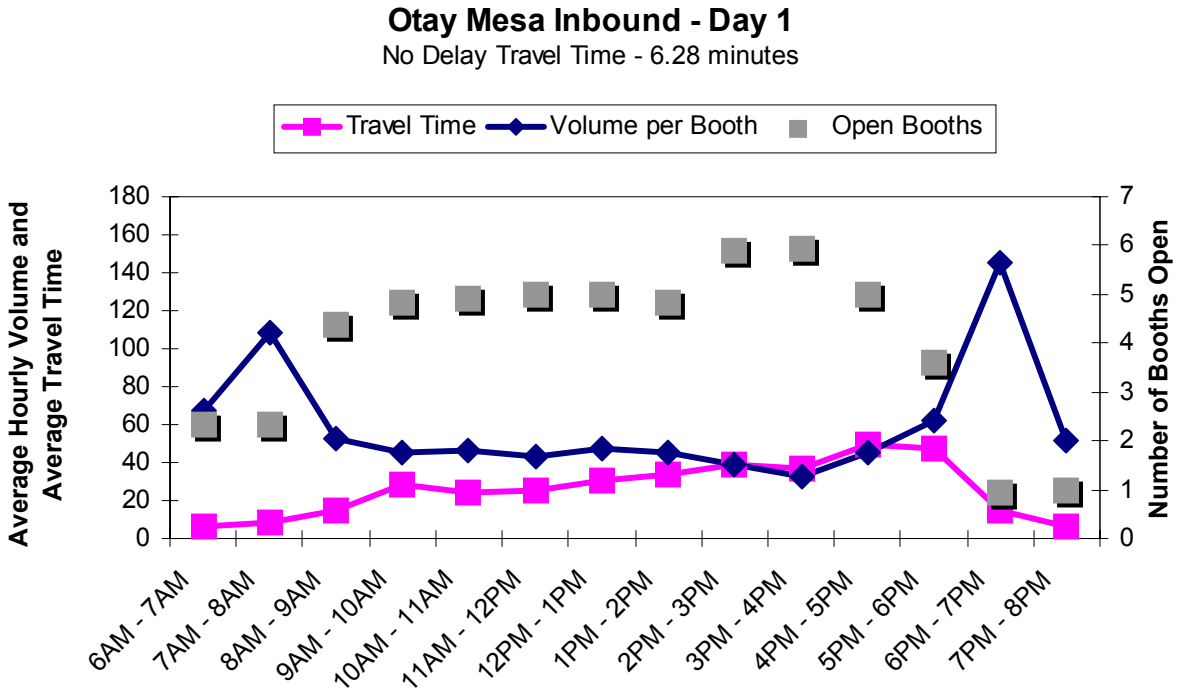

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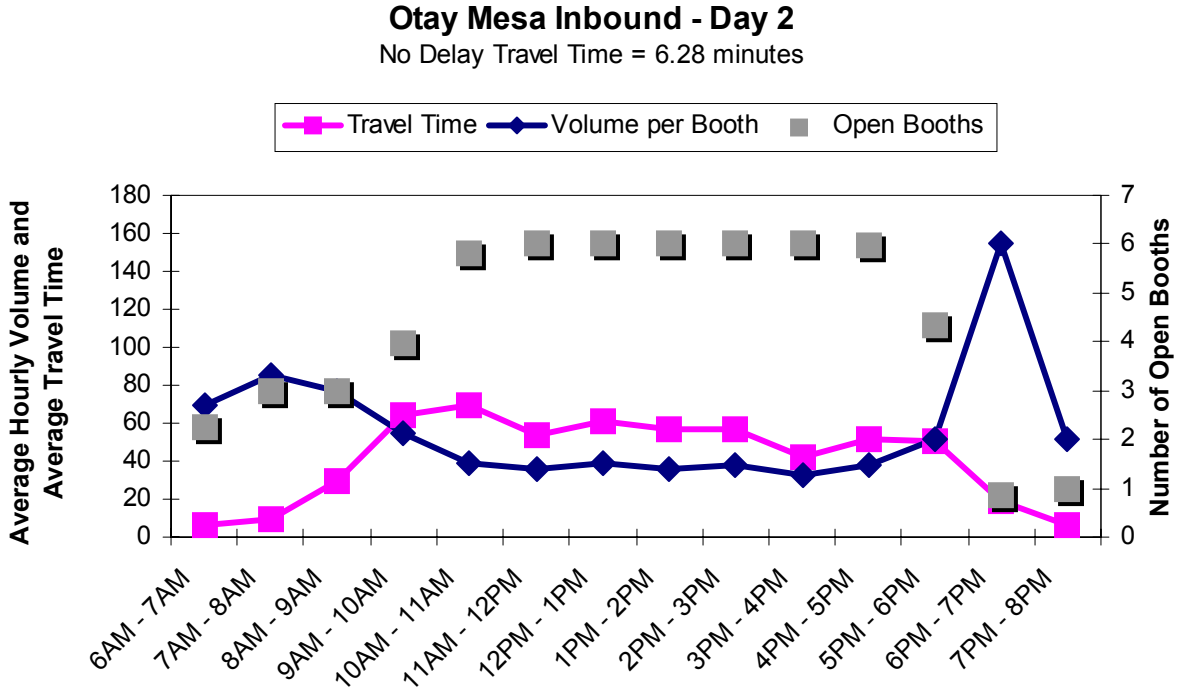

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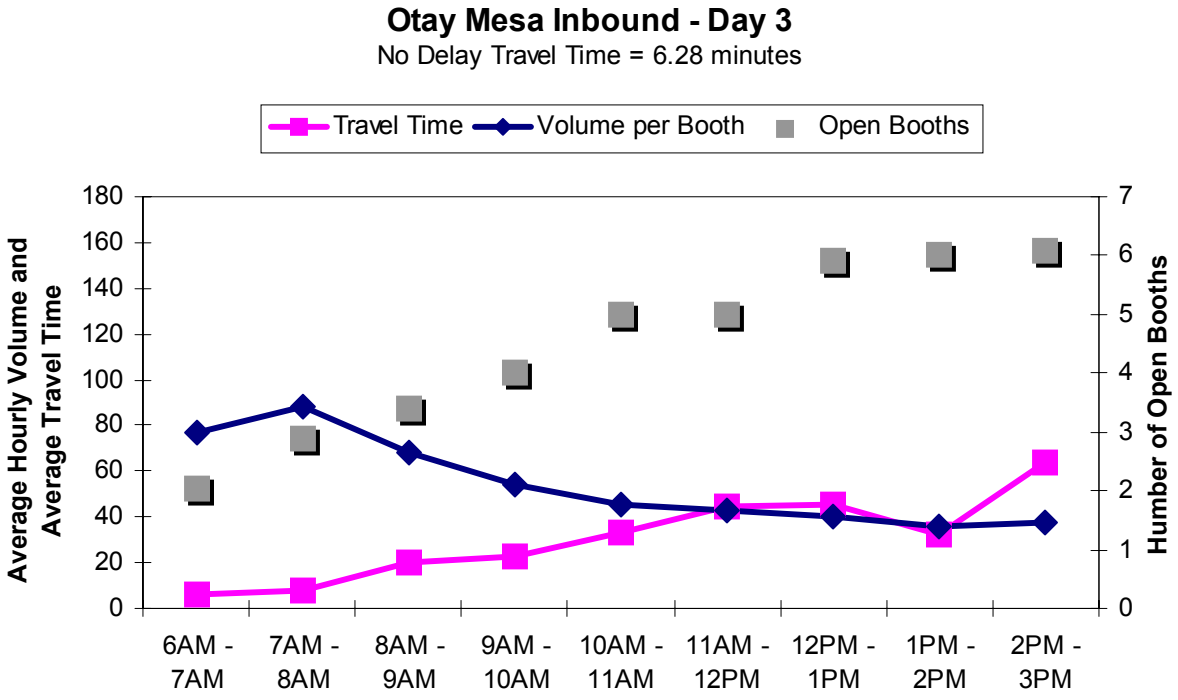

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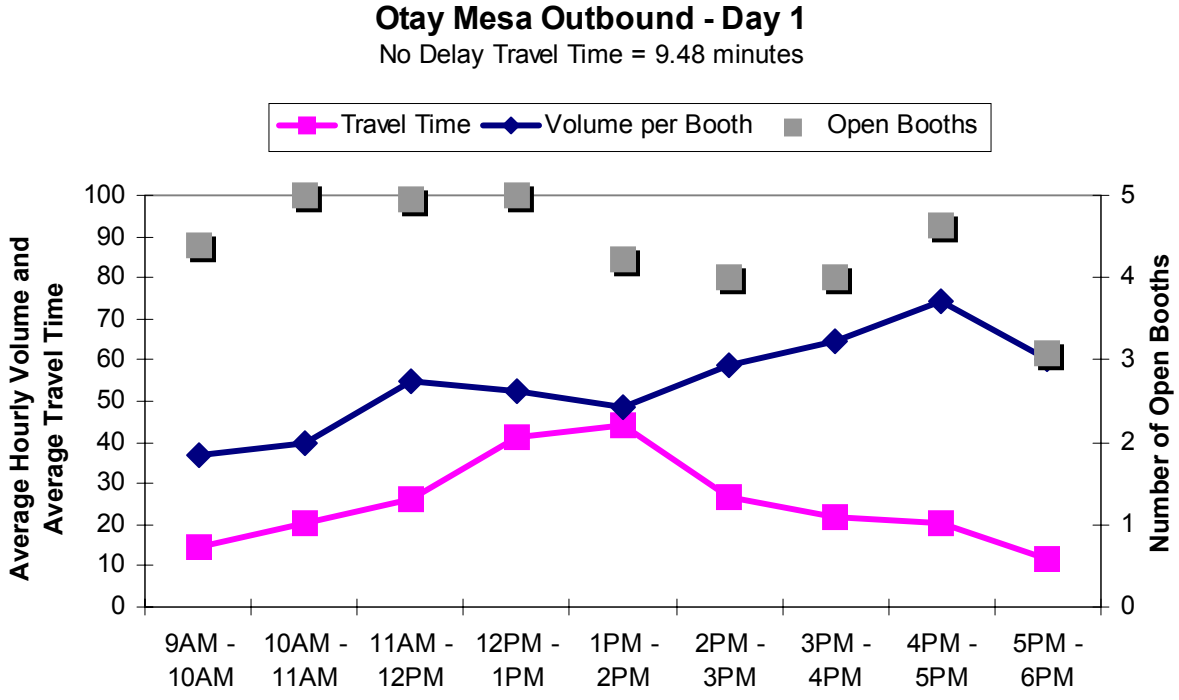

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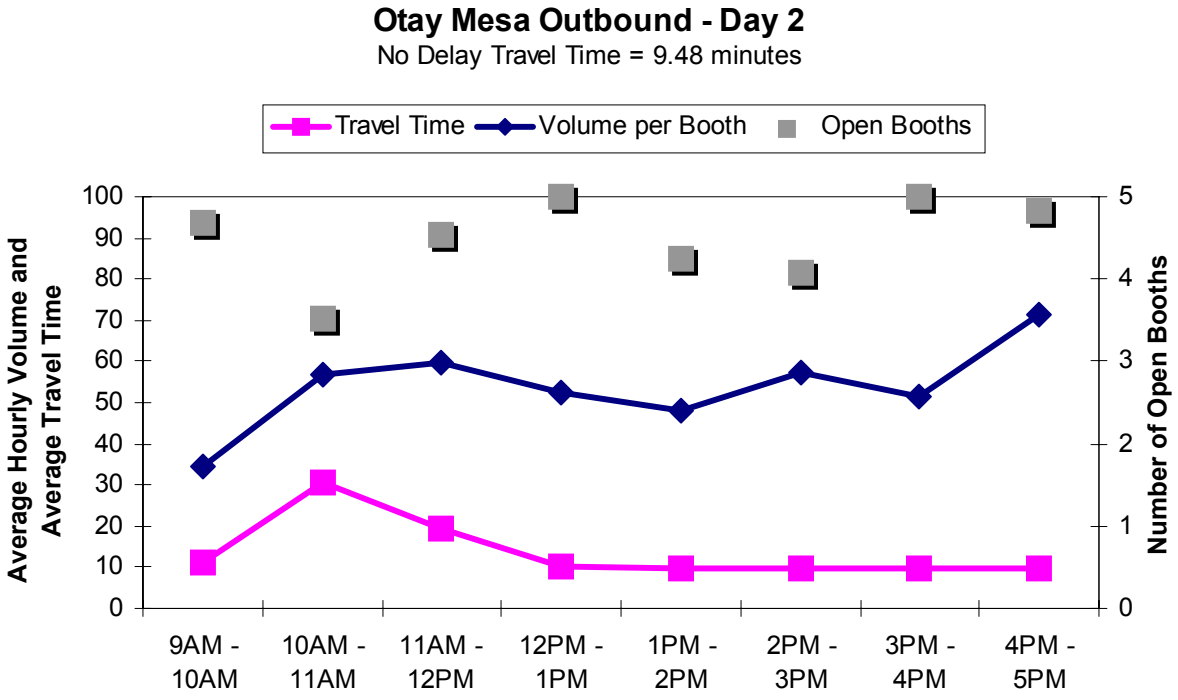

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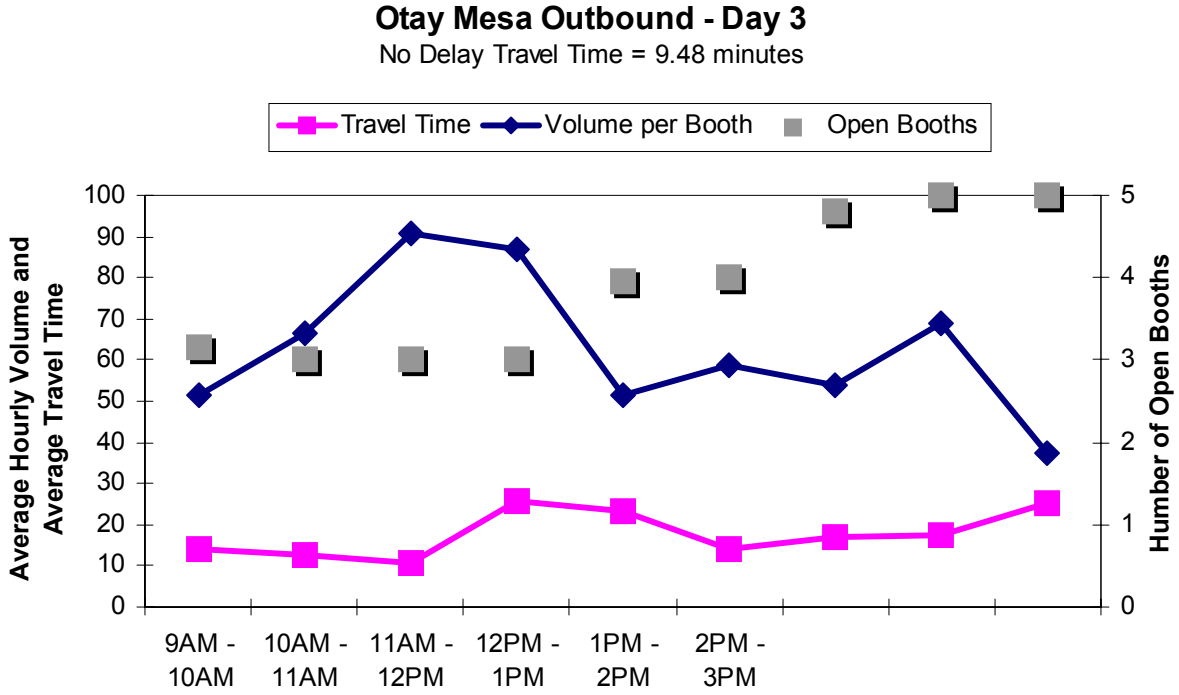
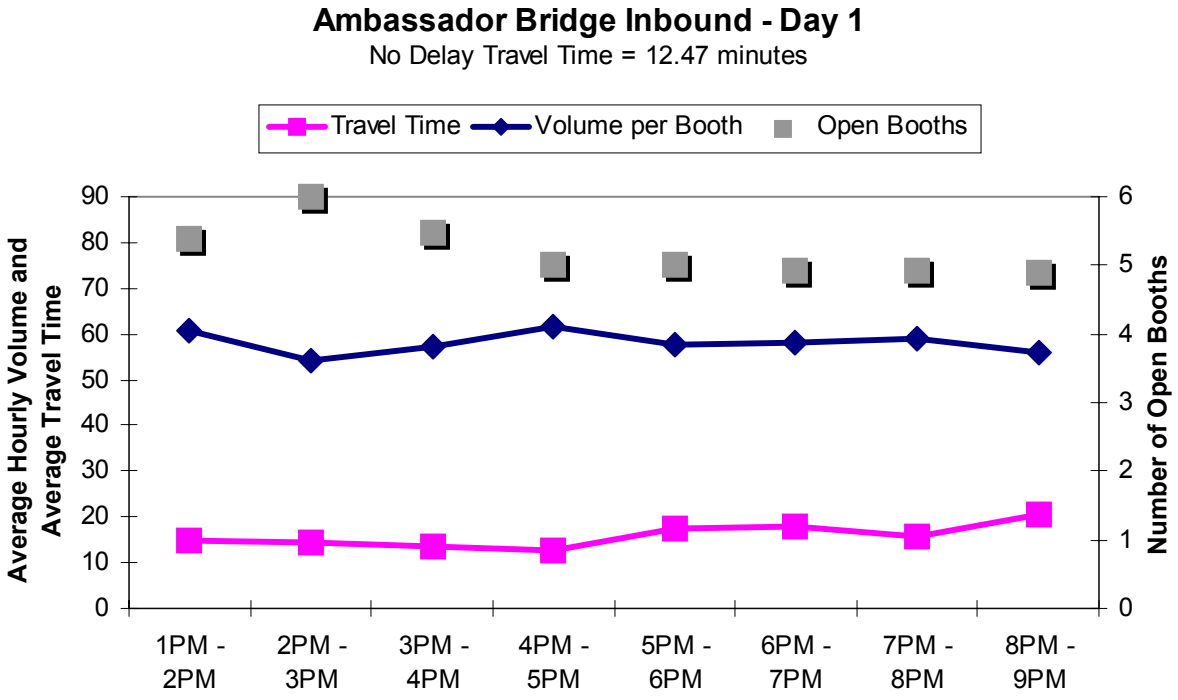


Figure A34



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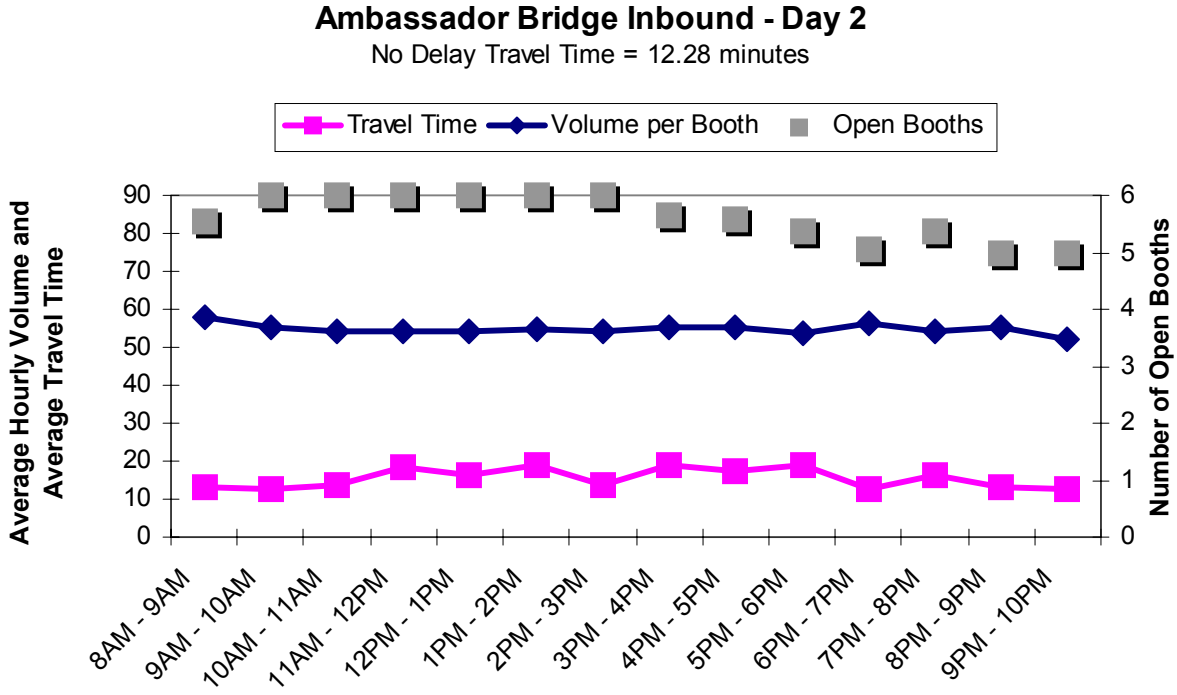

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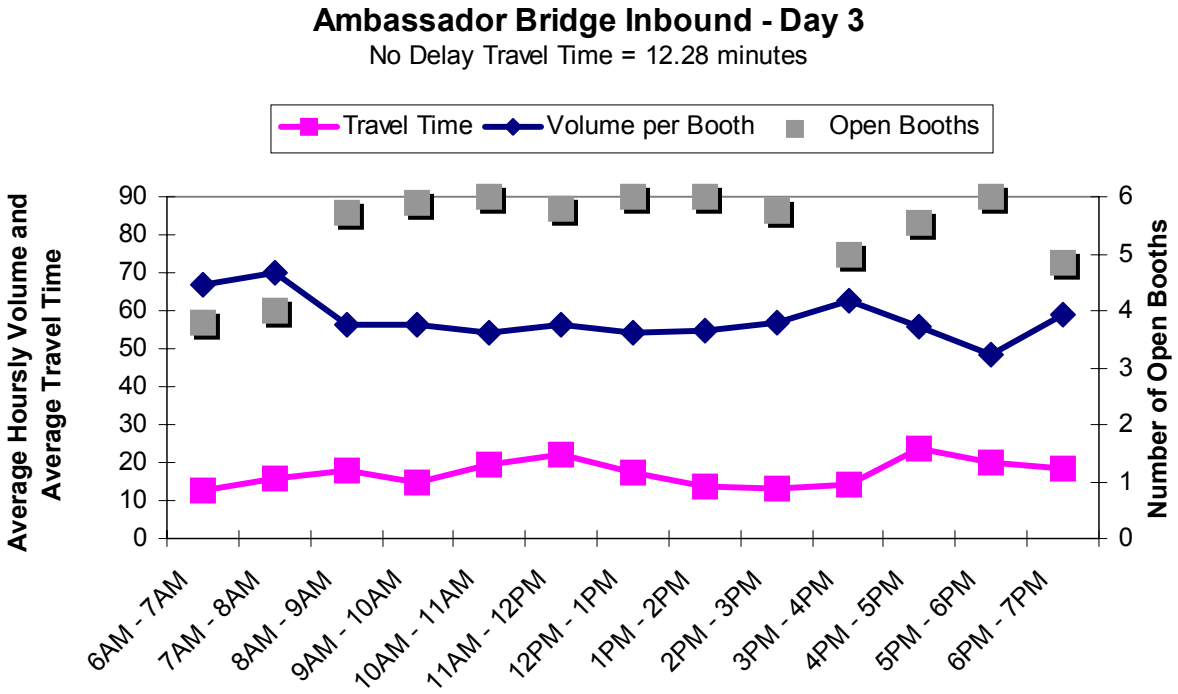

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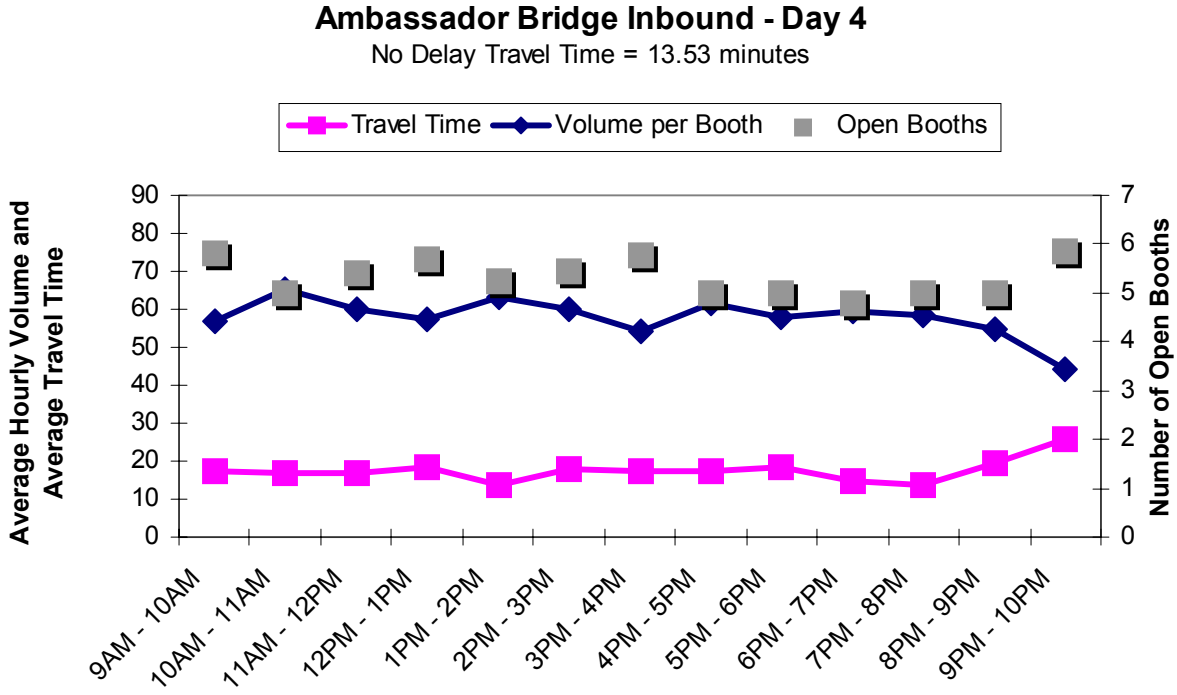
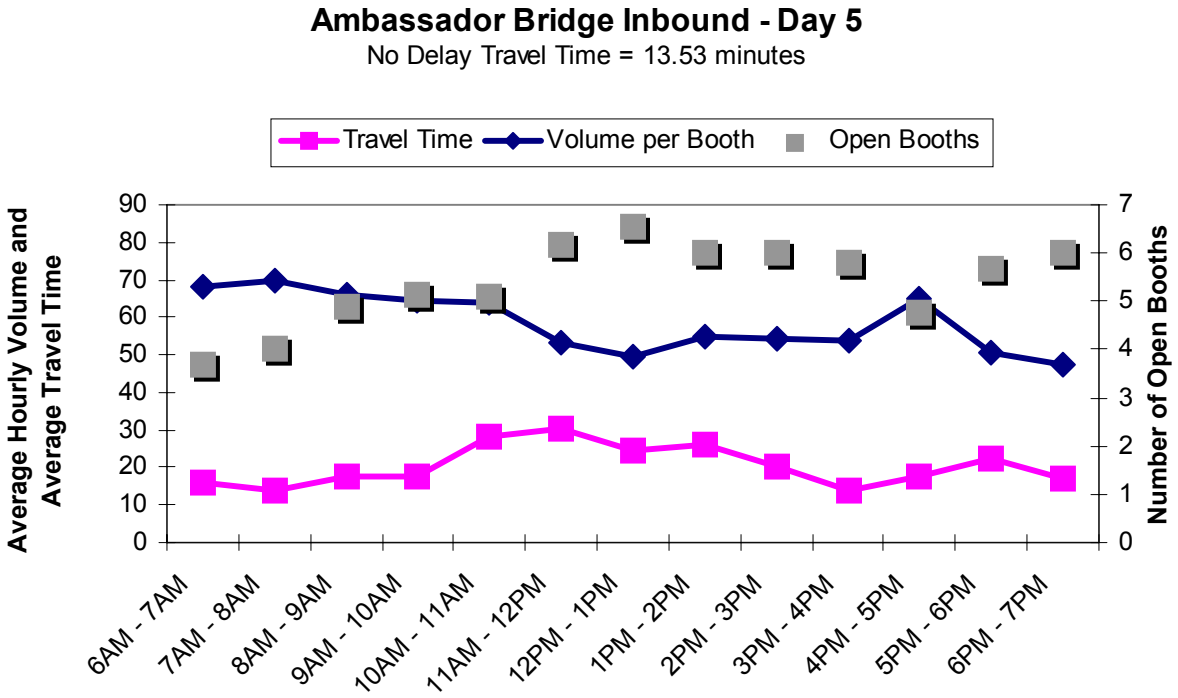


Figure A38



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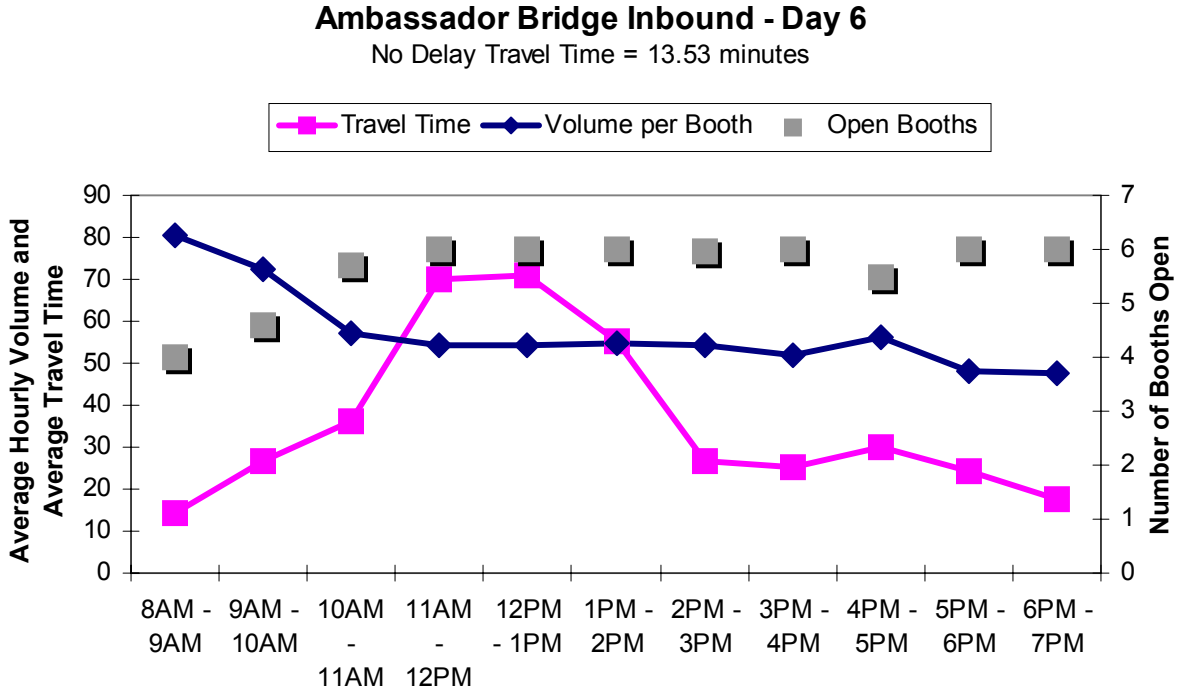

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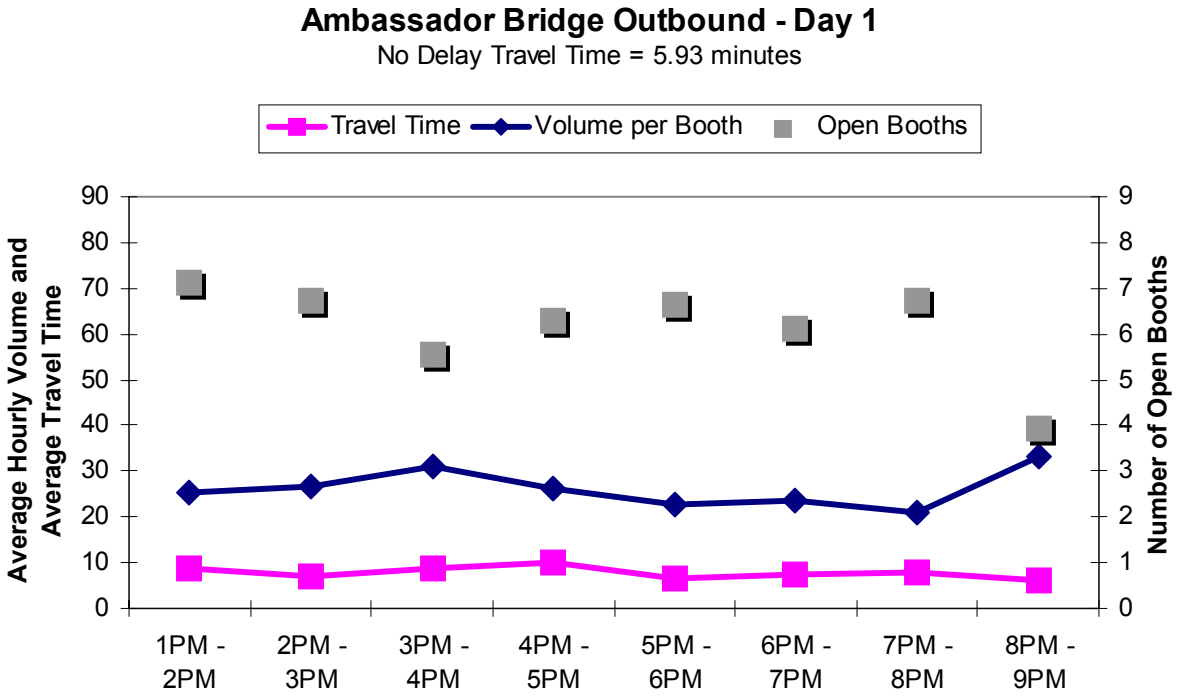


Figure A41

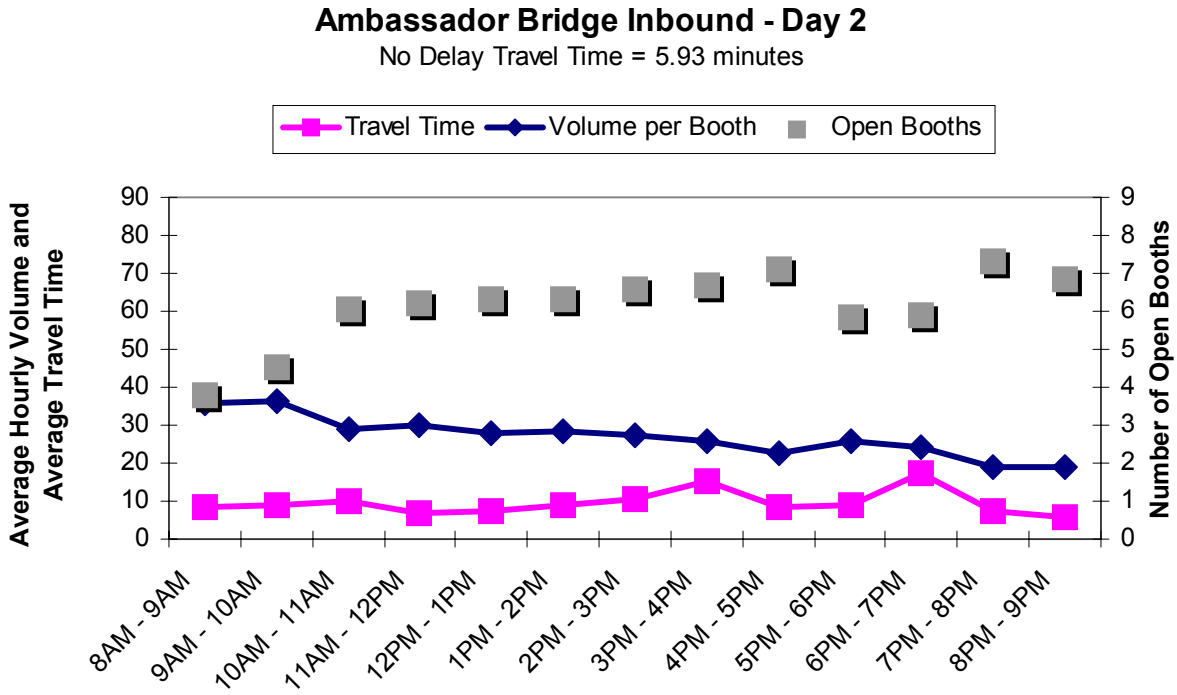


Figure A42

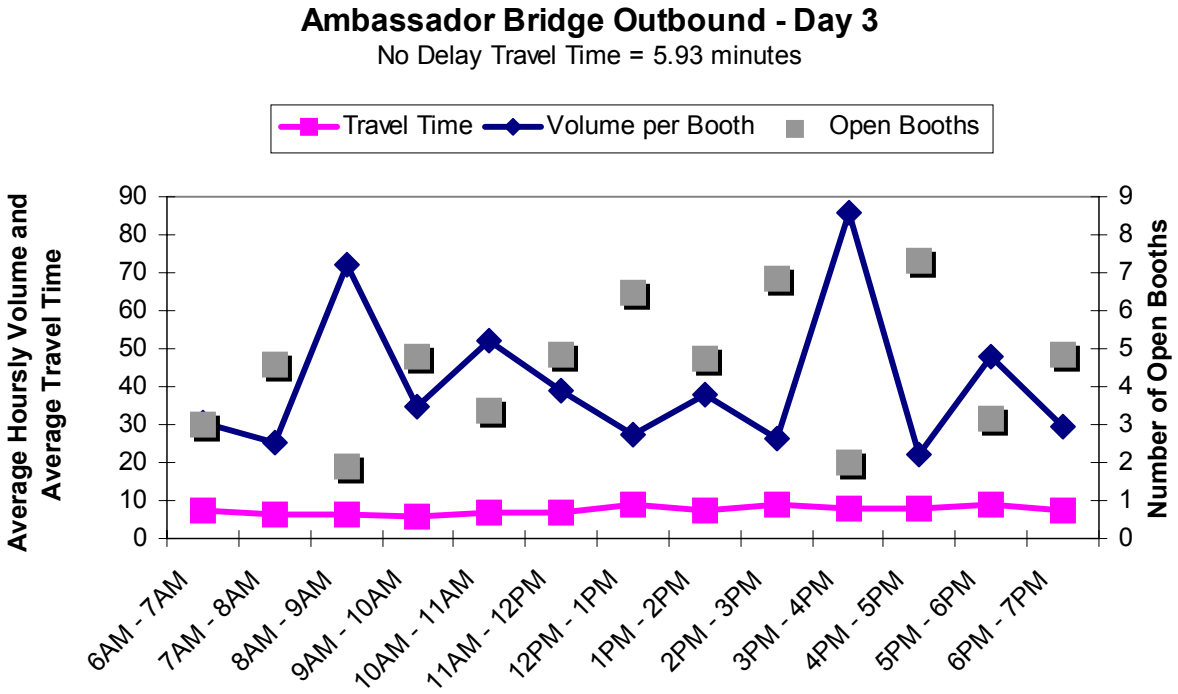


Figure A43

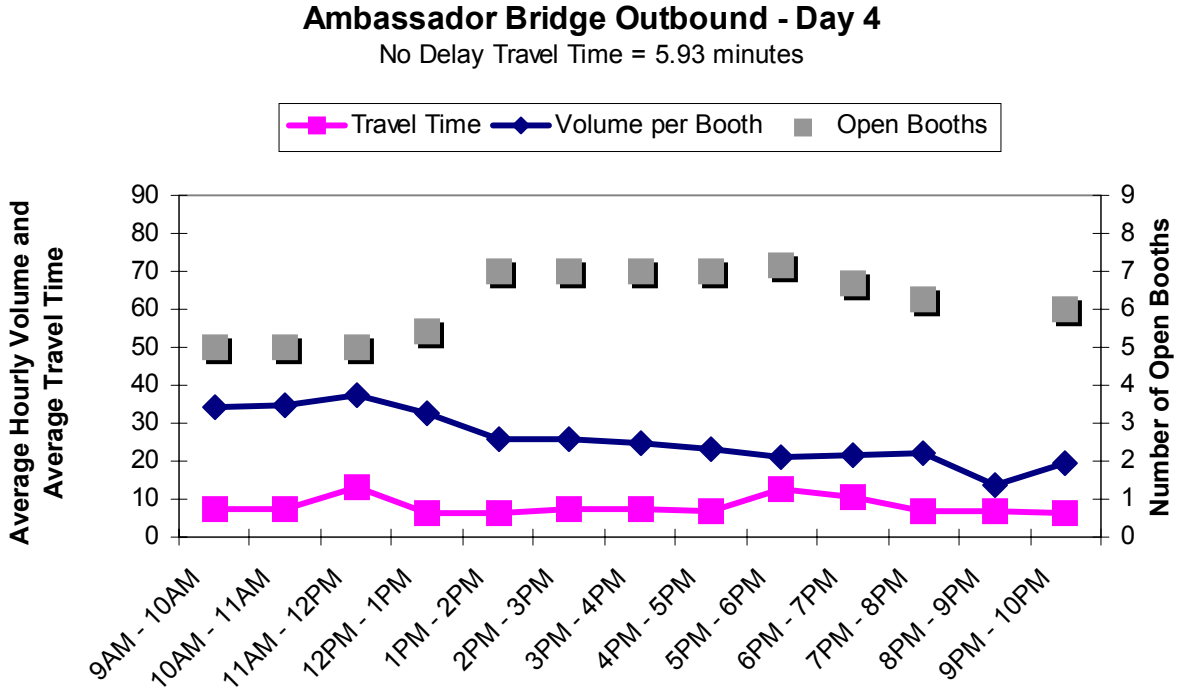


Figure A44

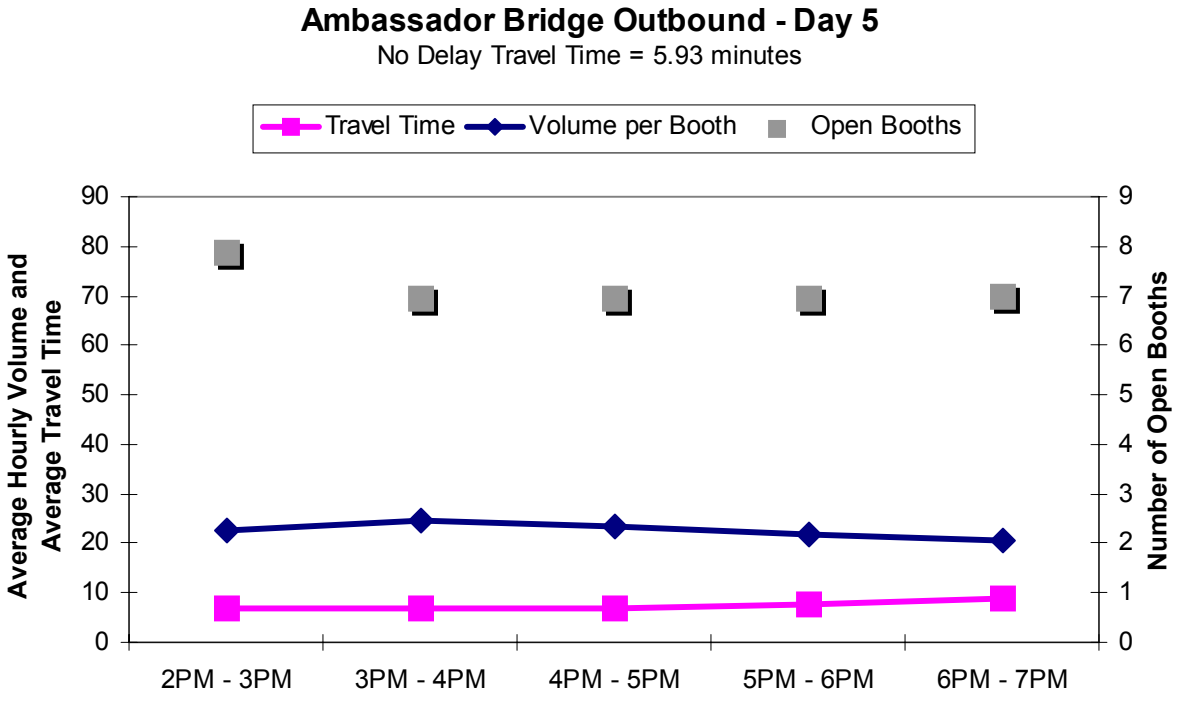


Figure A45

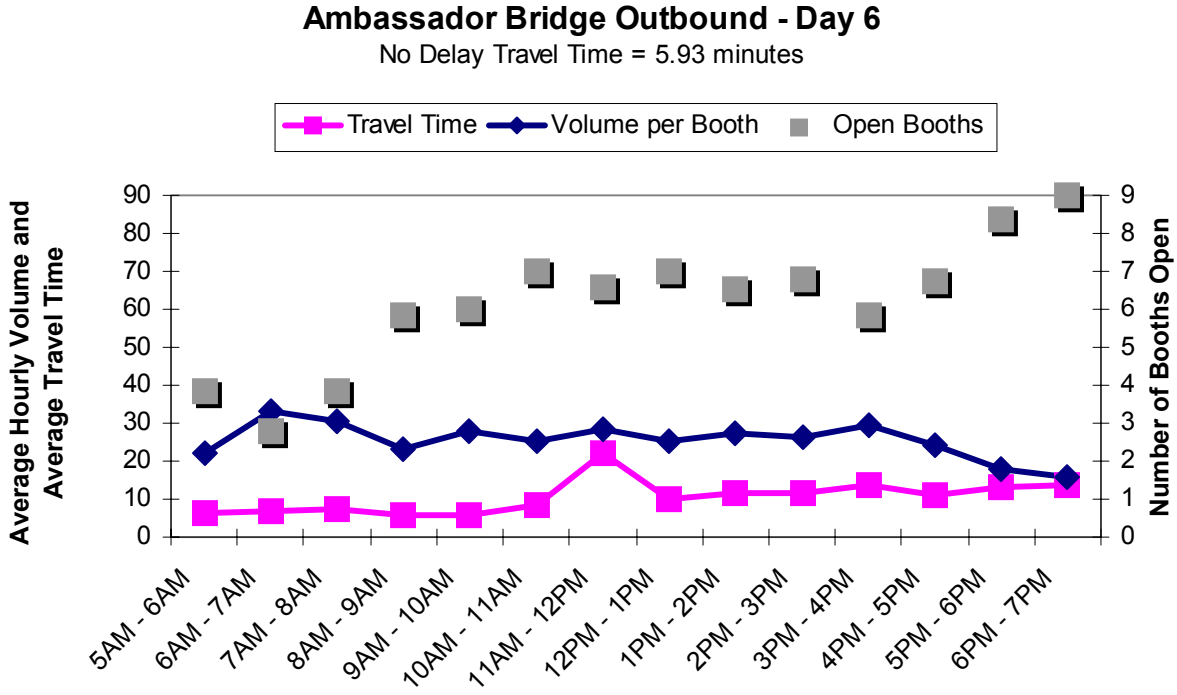


Figure A46

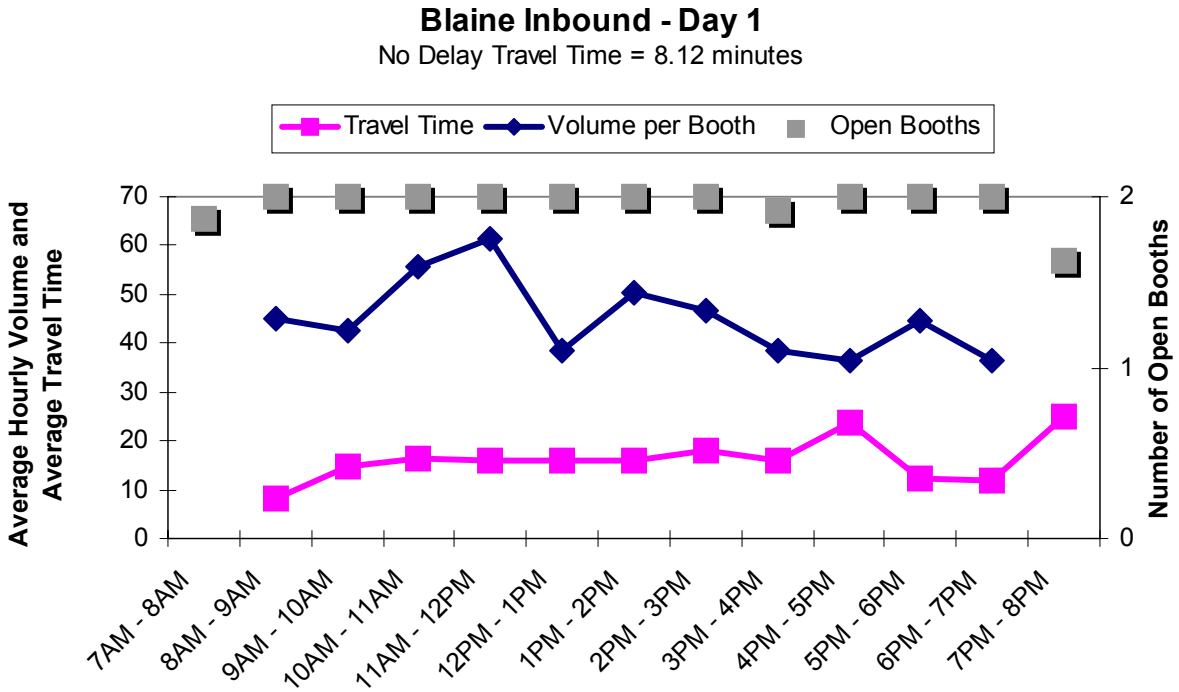


Figure A47

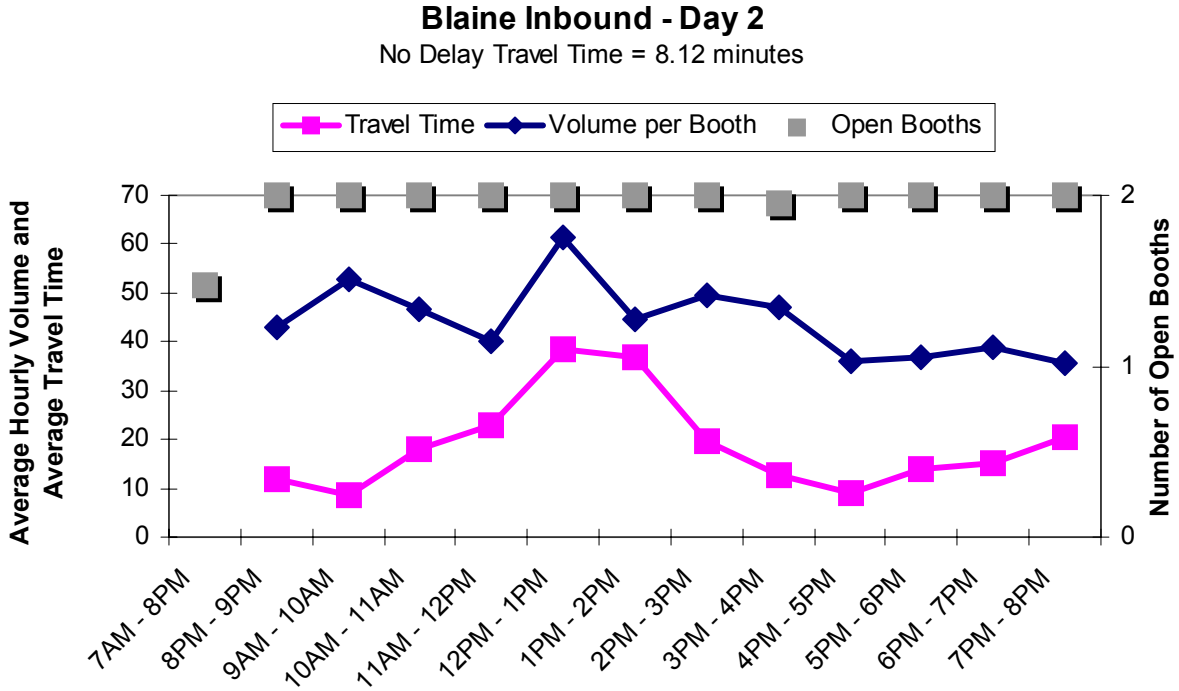


Figure A48

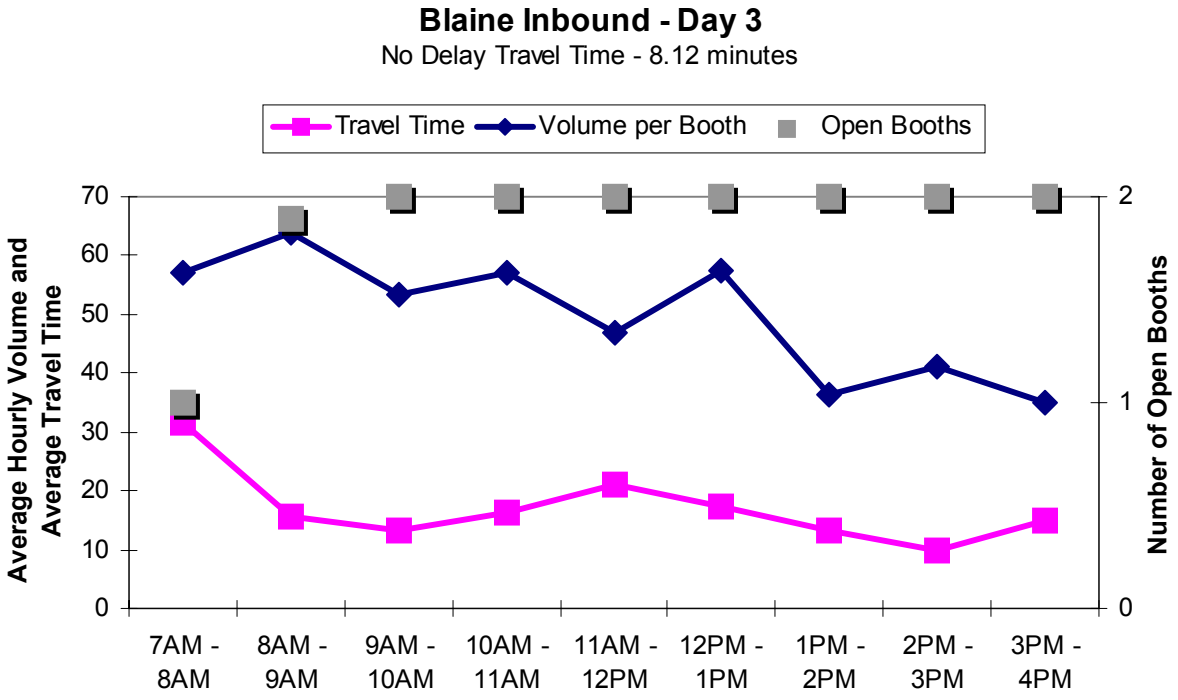


Figure A49

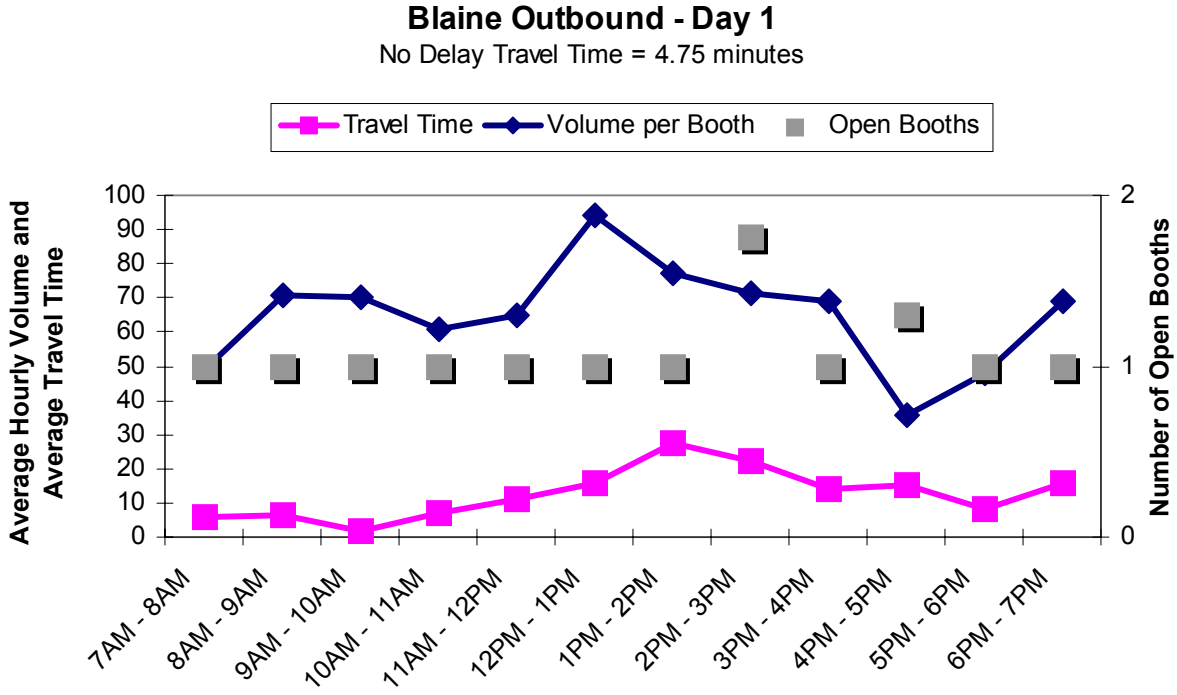


Figure A50

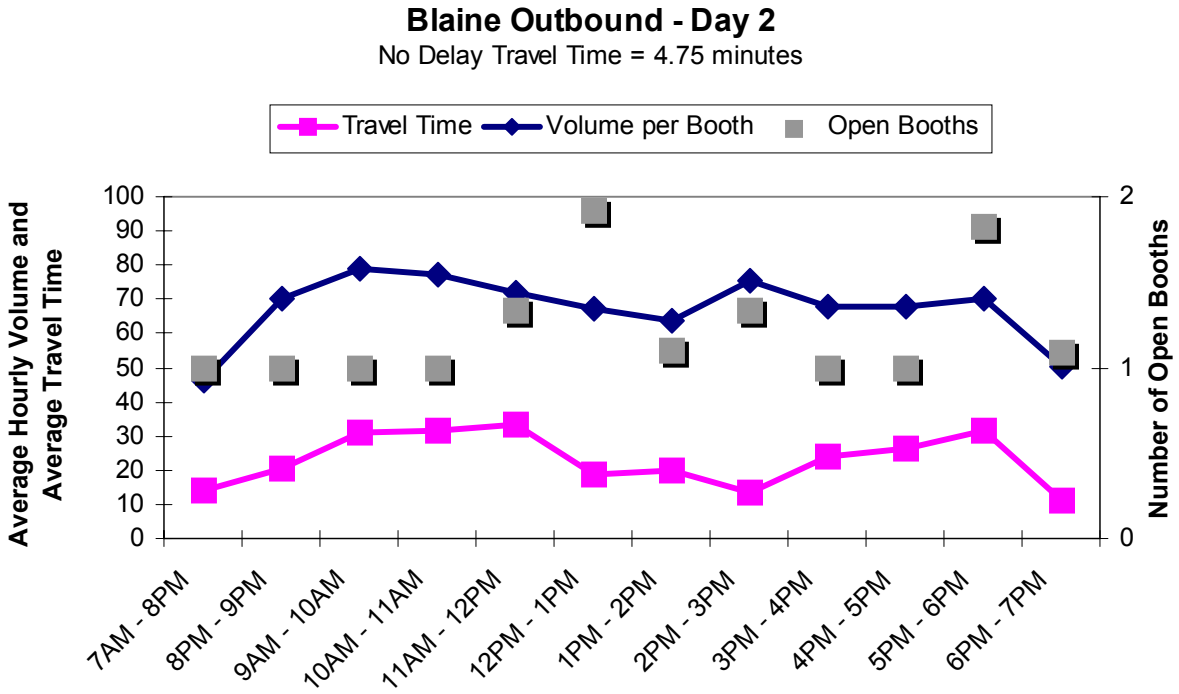


Figure A51

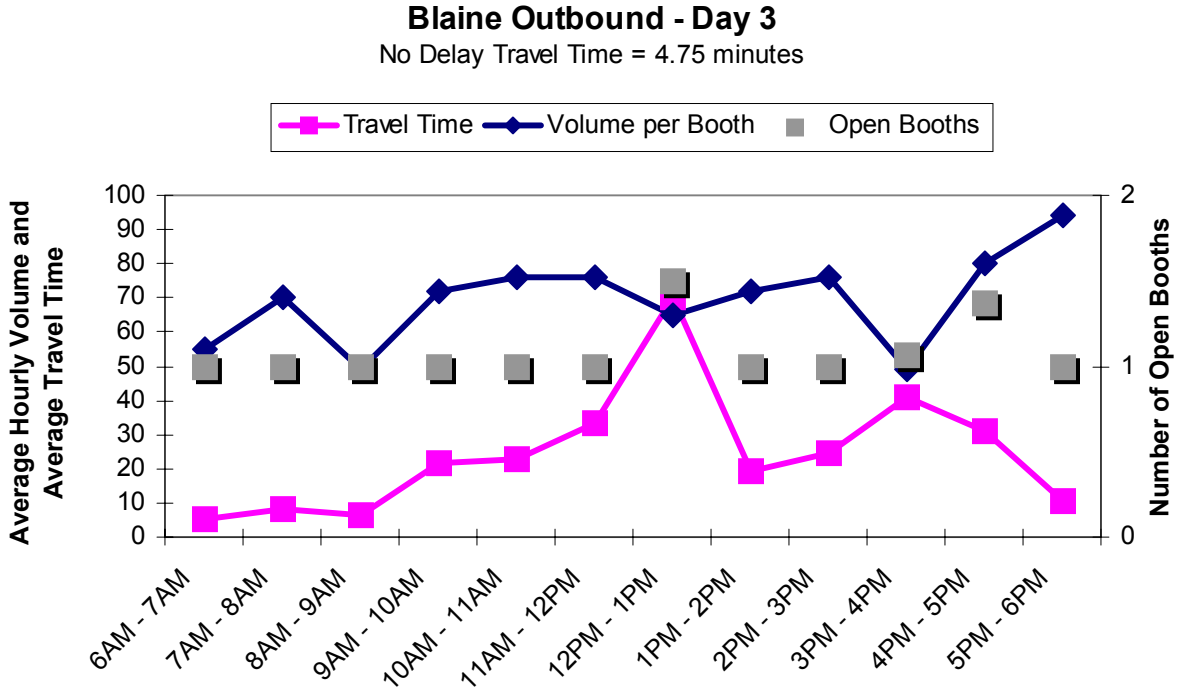


Figure A52

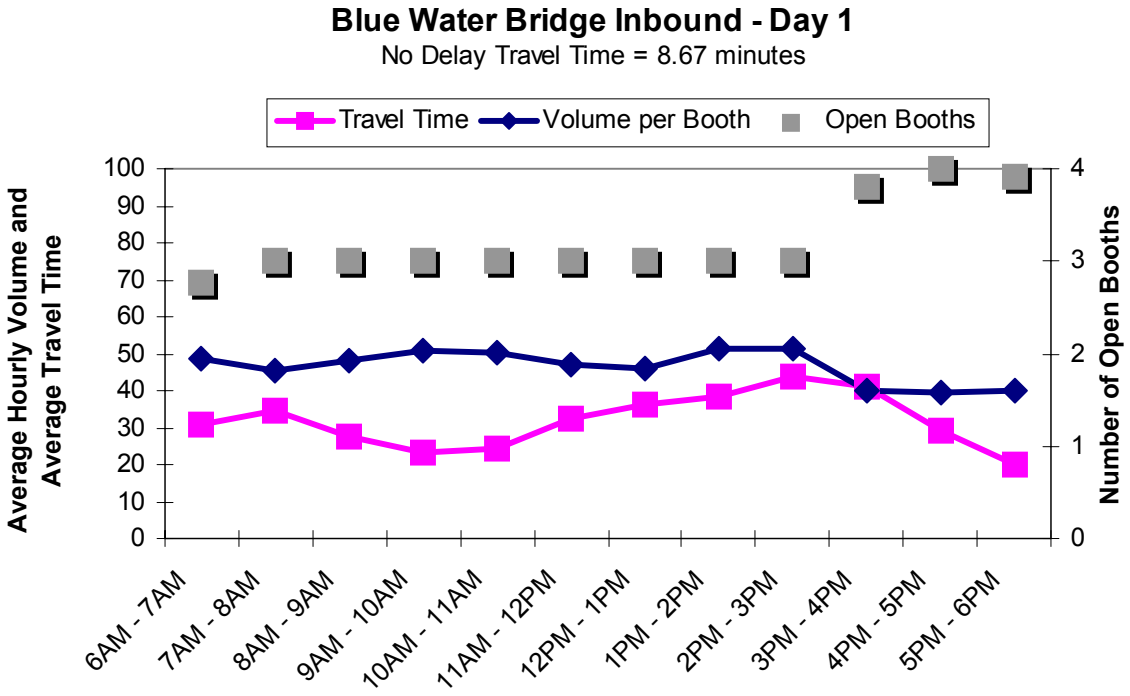


Figure A53

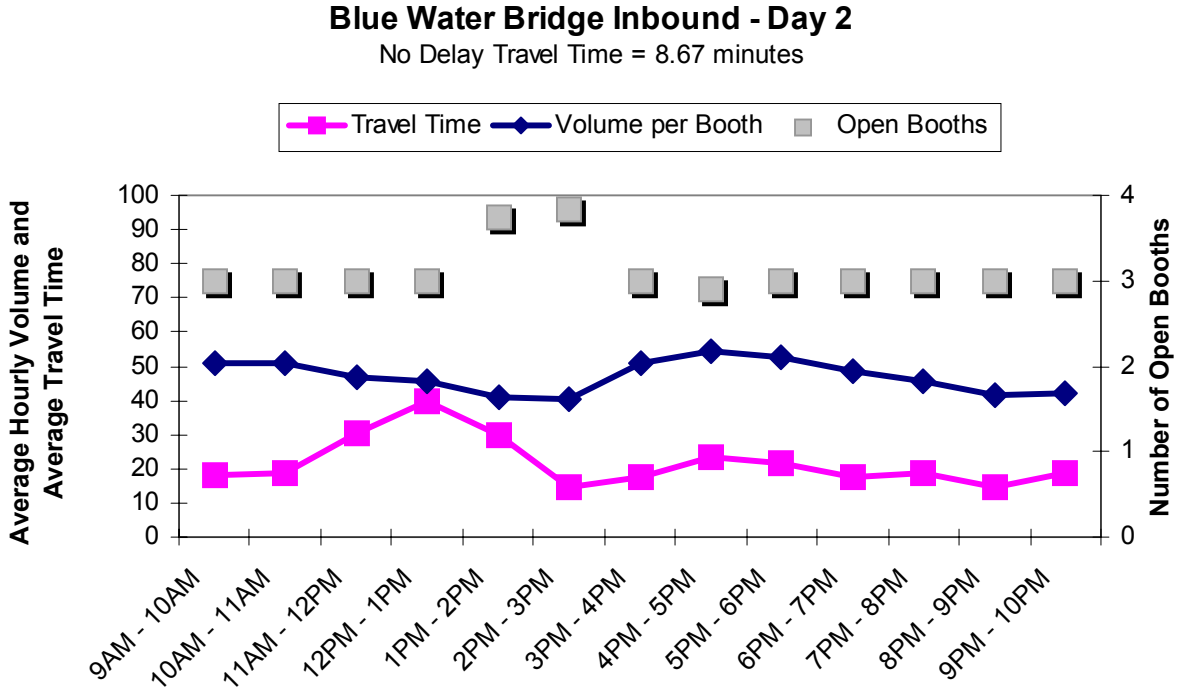


Figure A54

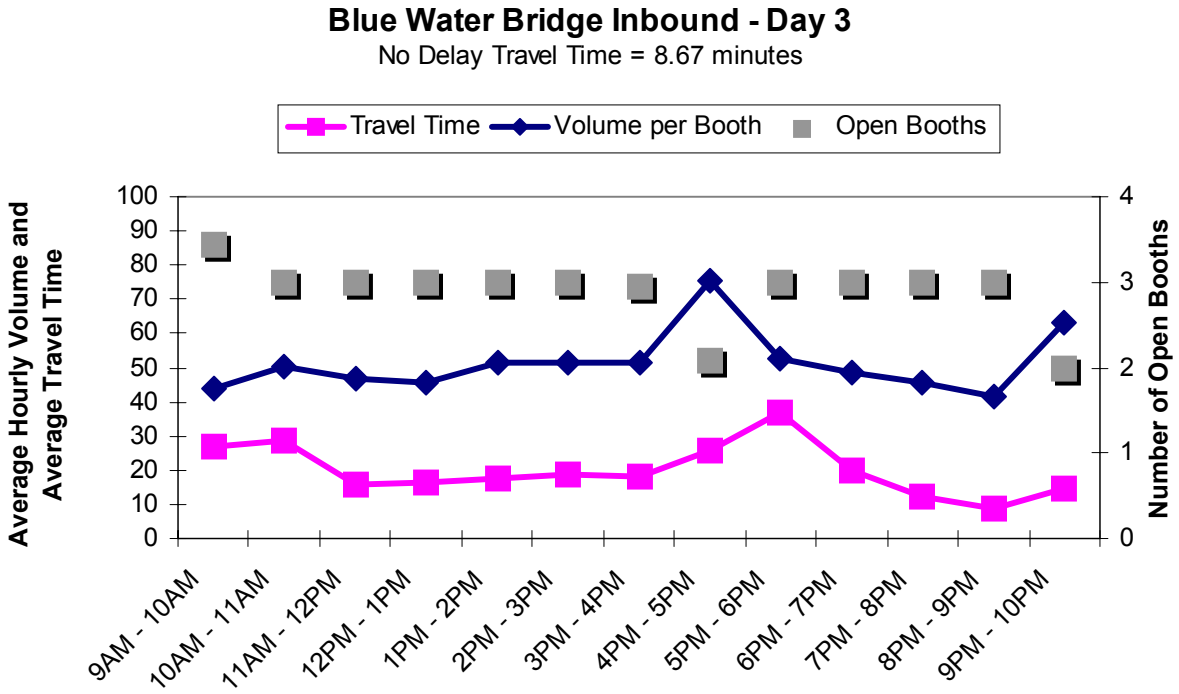


Figure A55

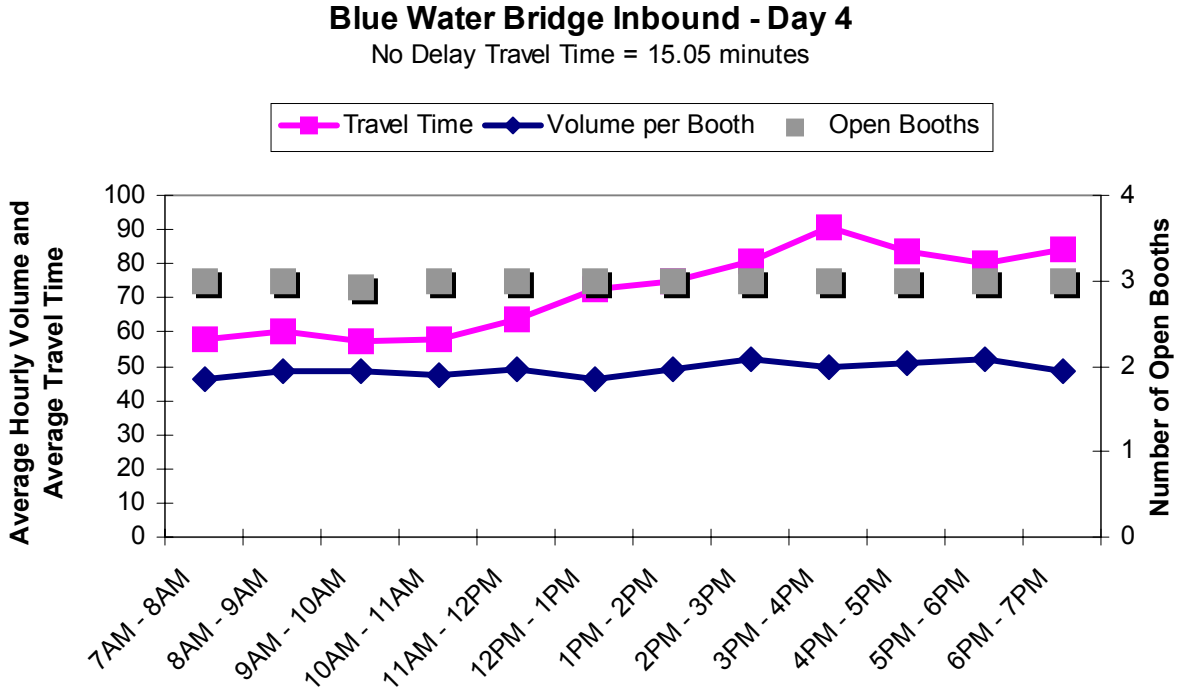
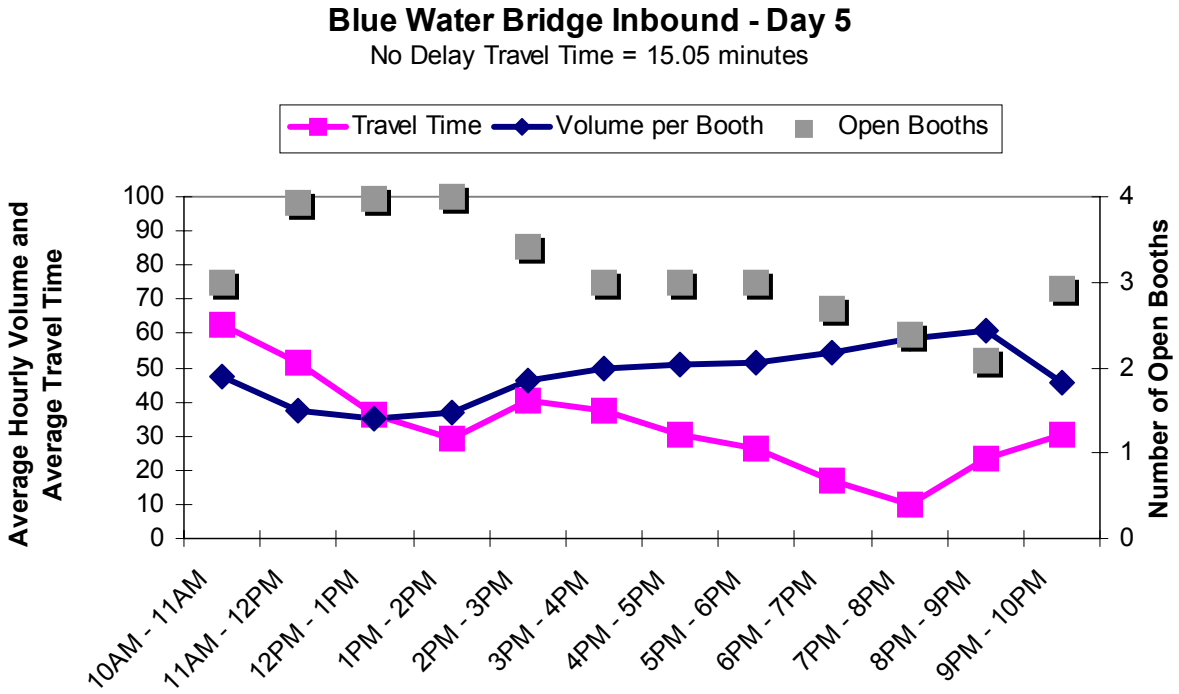


Figure A56



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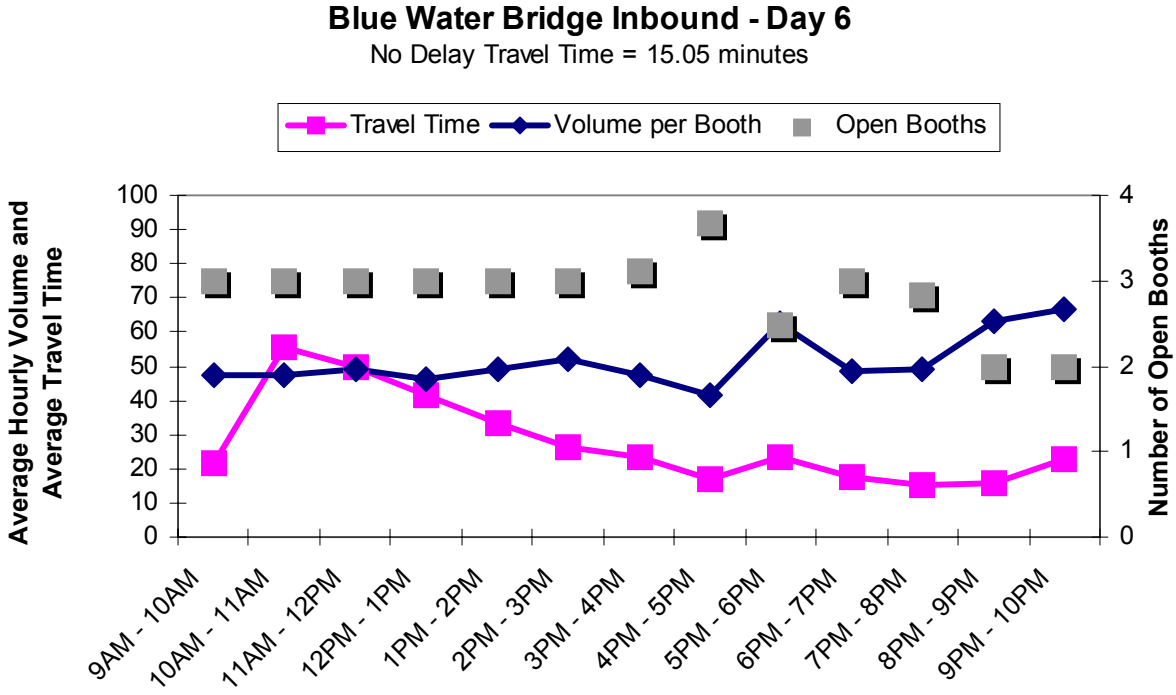

Figure A58

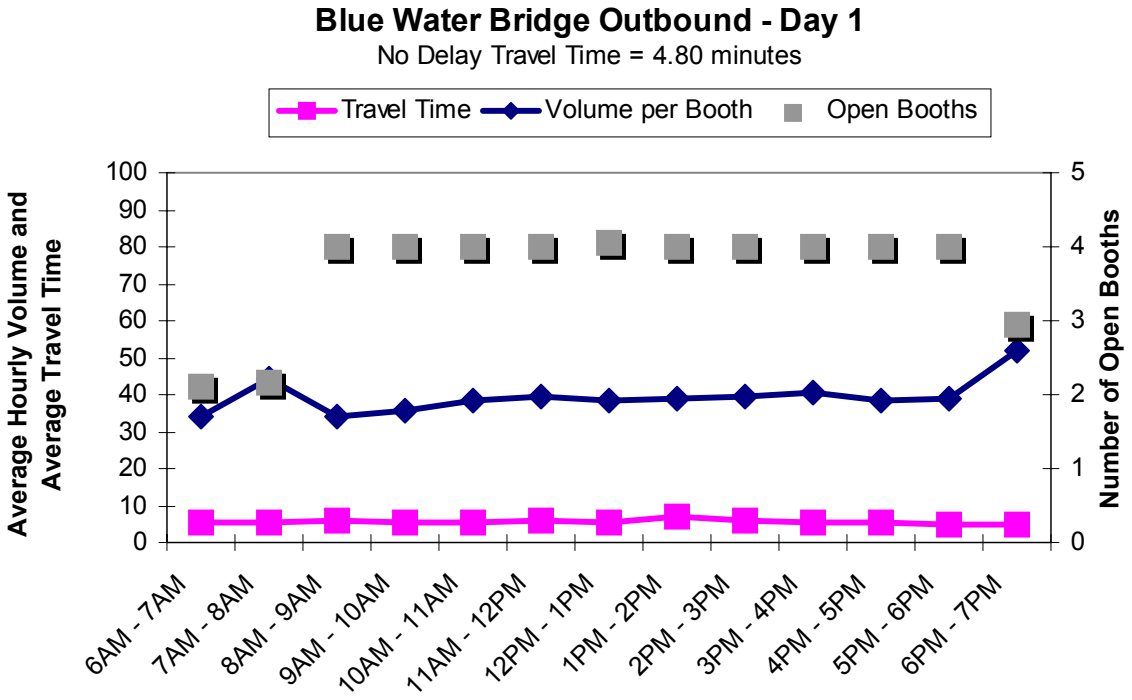

Figure A59

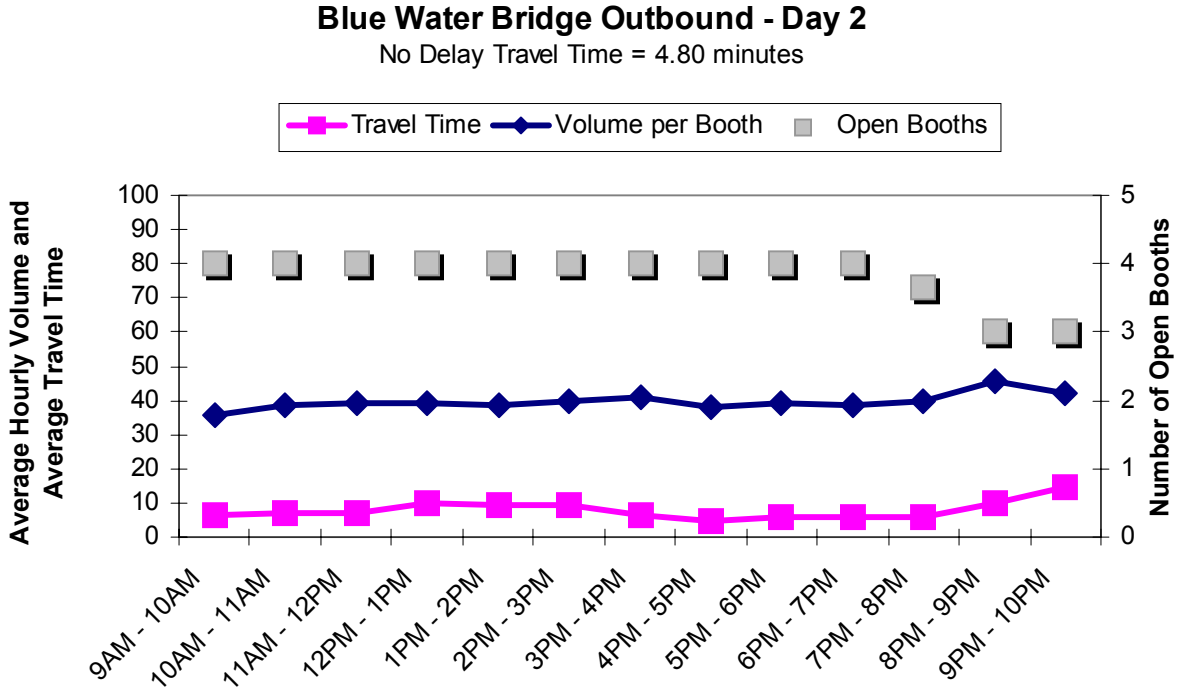

Figure A60

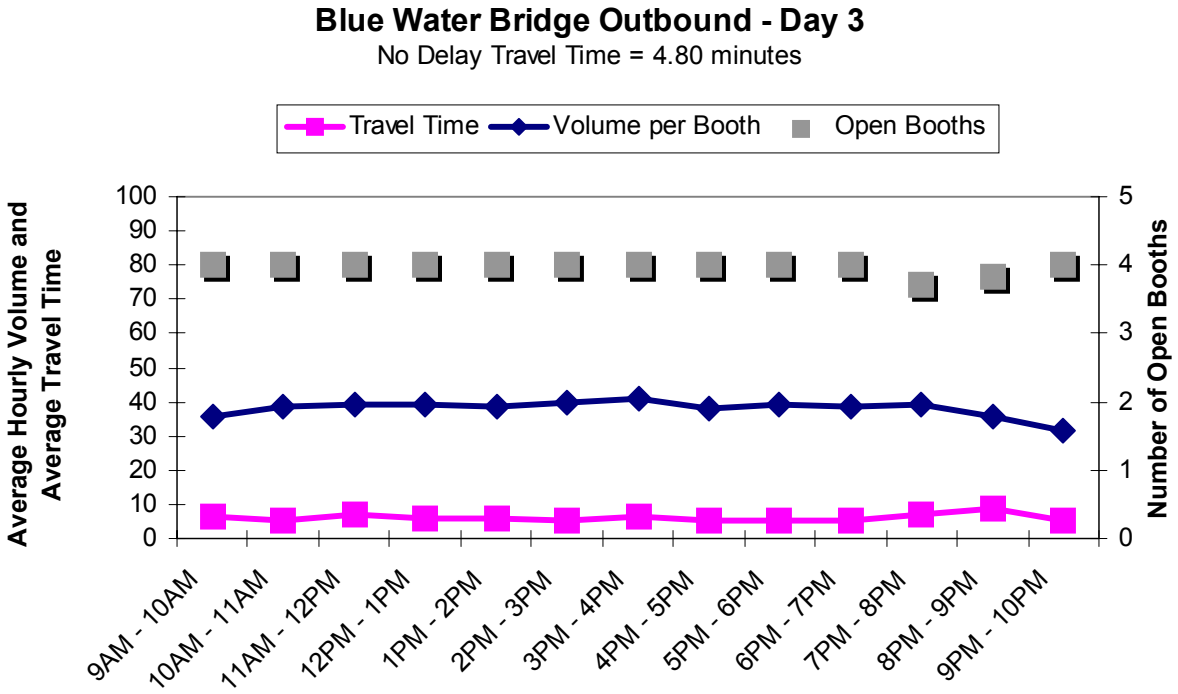

Figure A61

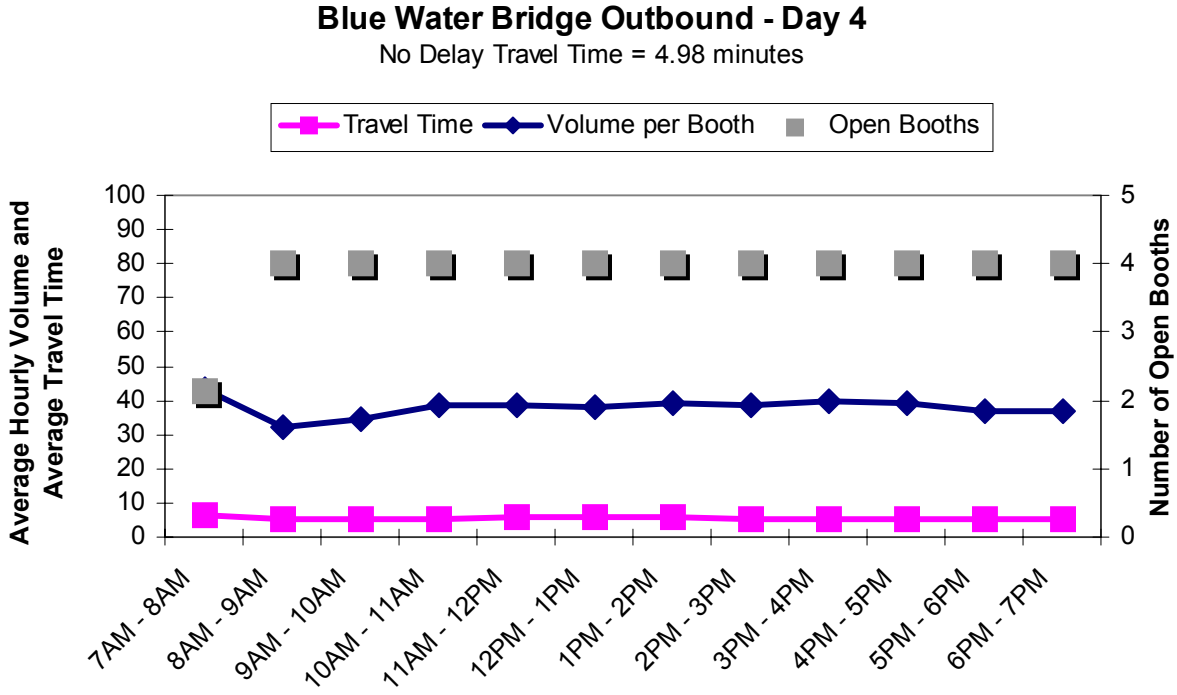

Figure A62

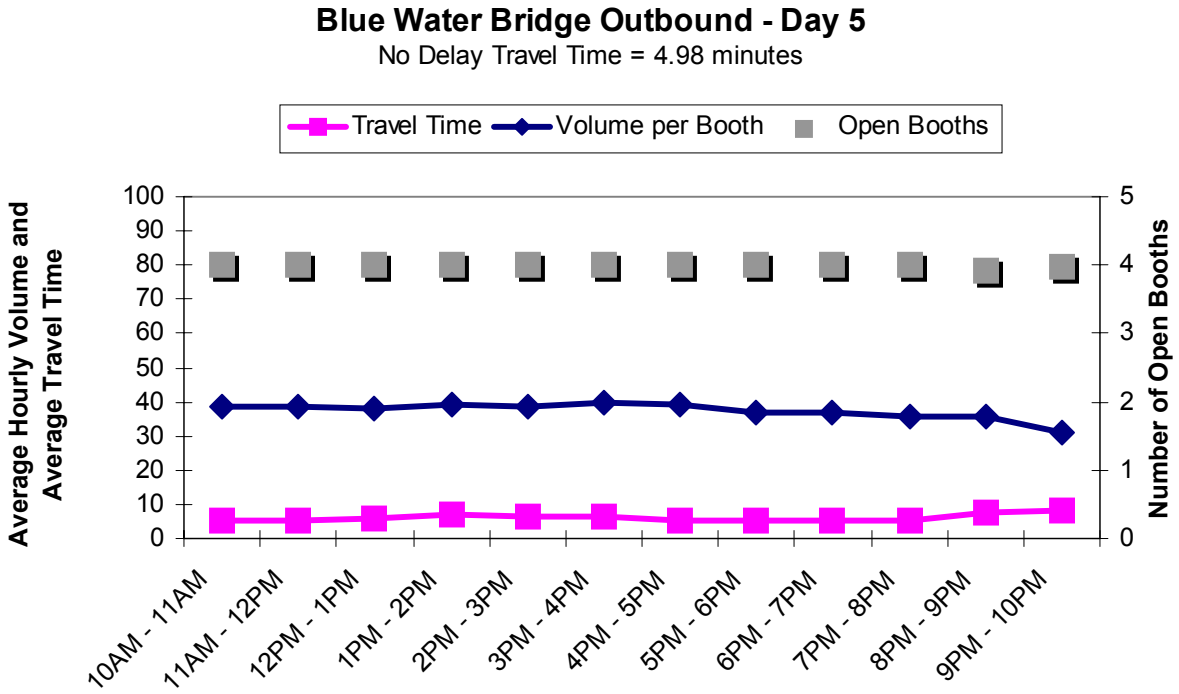

Figure A63

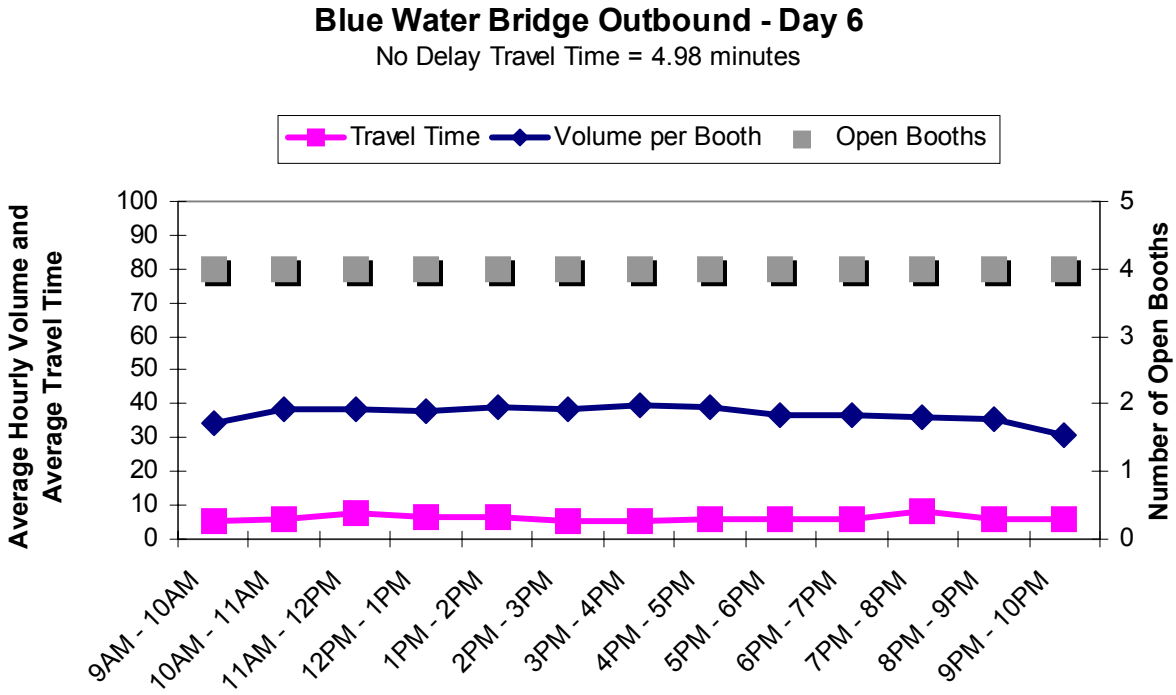

Figure A64

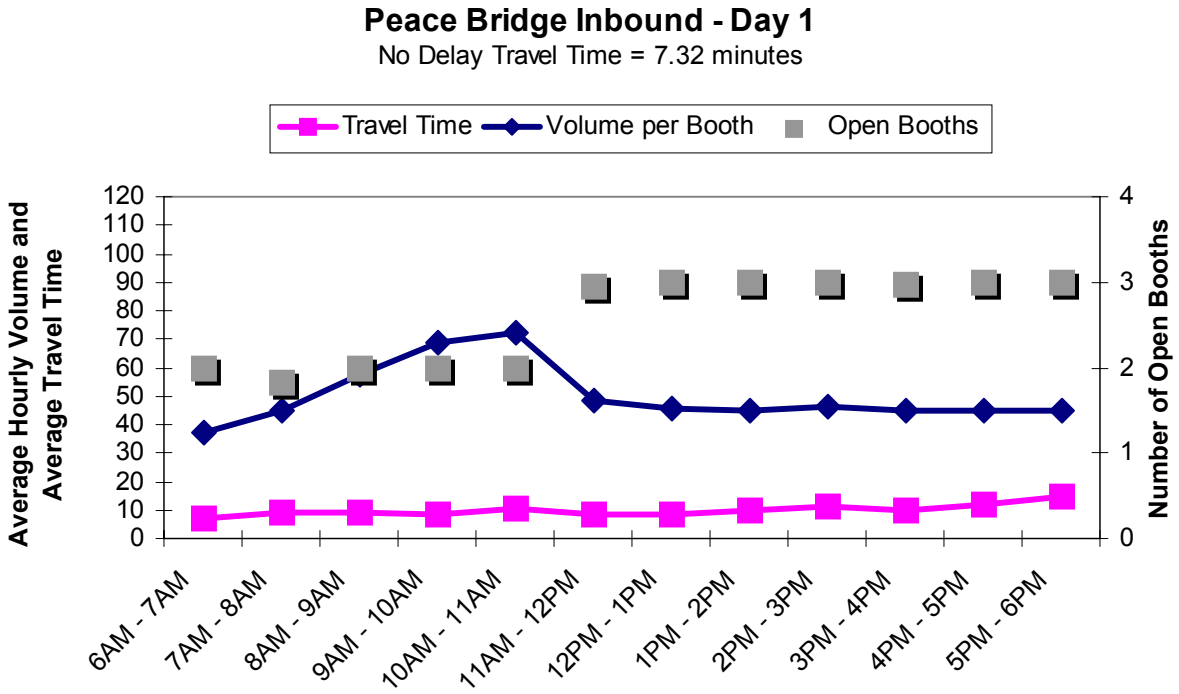

Figure A65

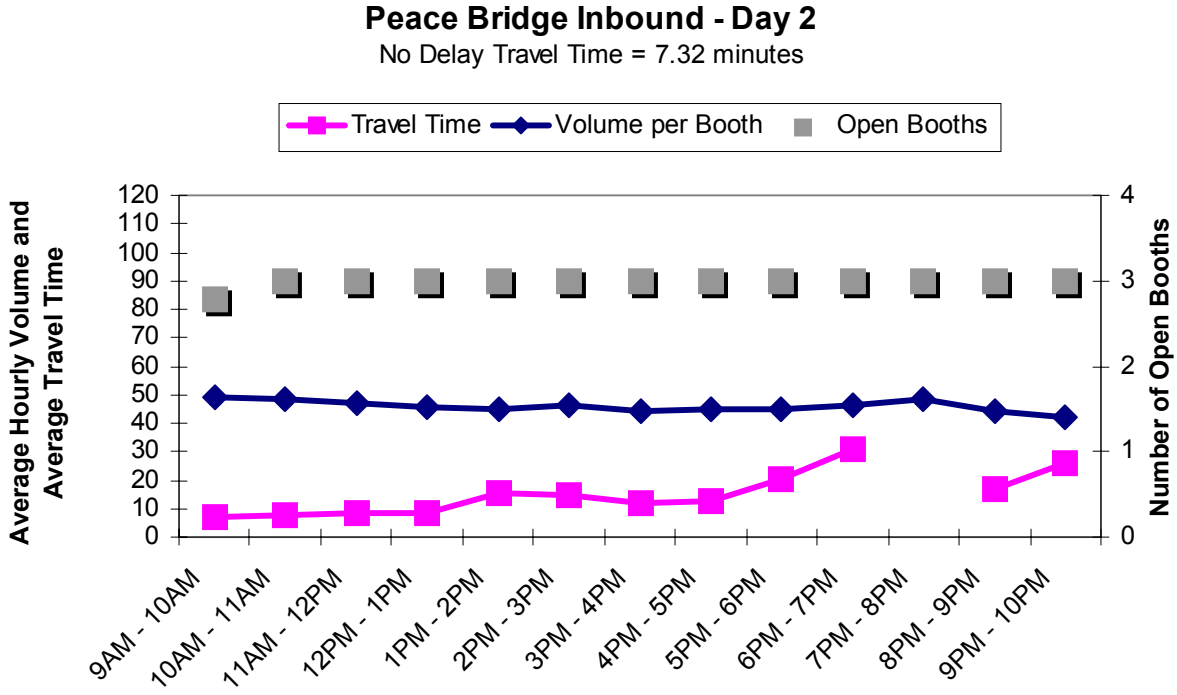

Figure A66

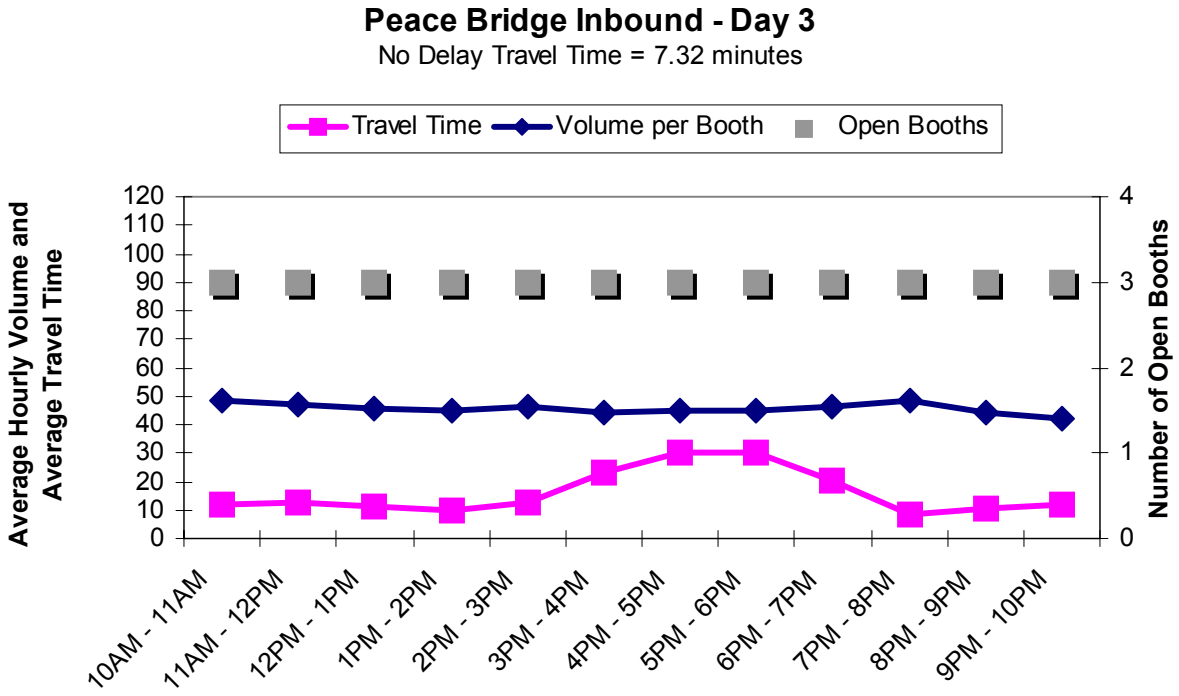

Figure A67

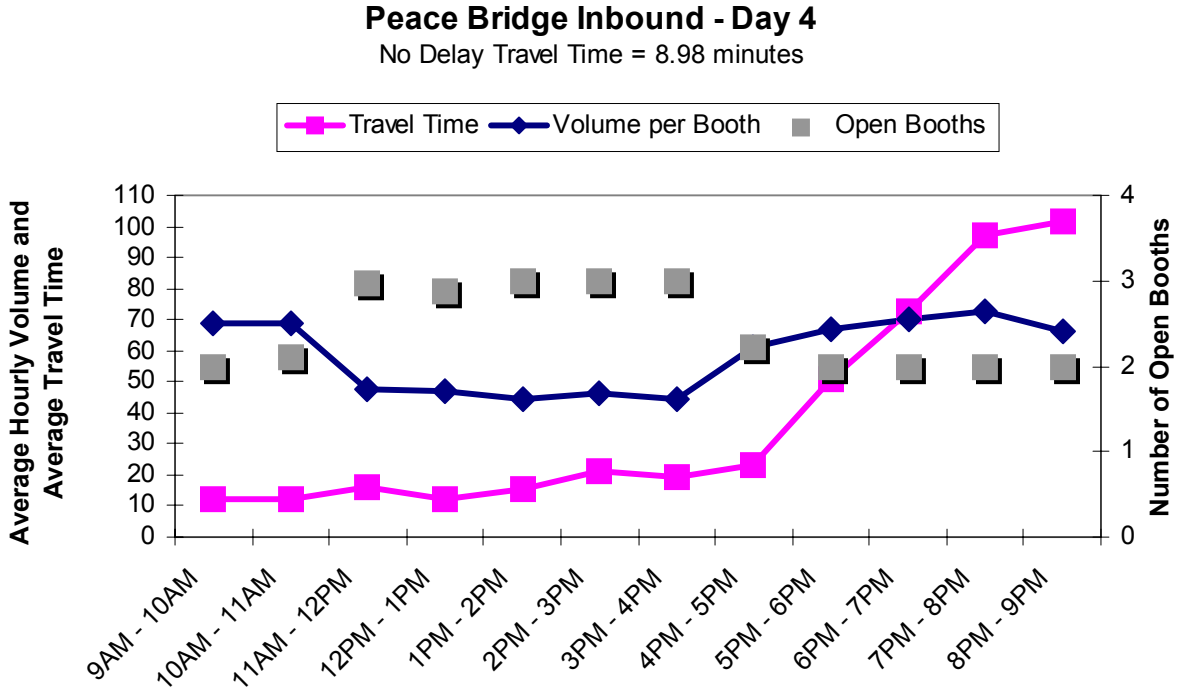

Figure A68

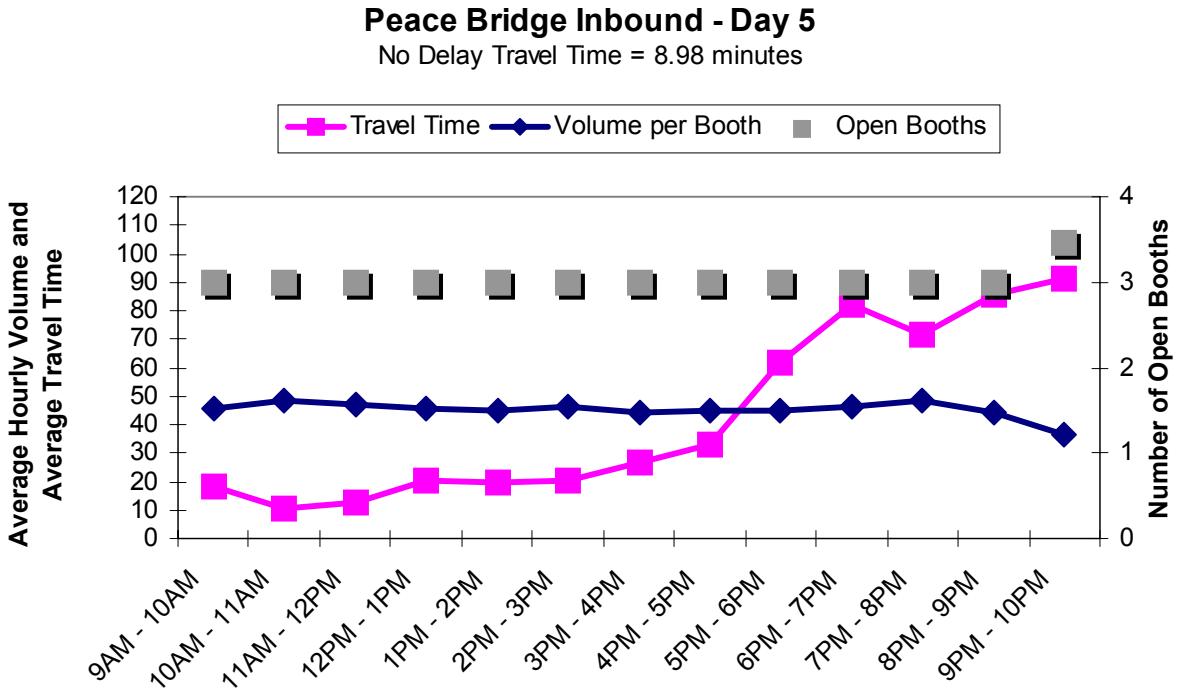

Figure A69

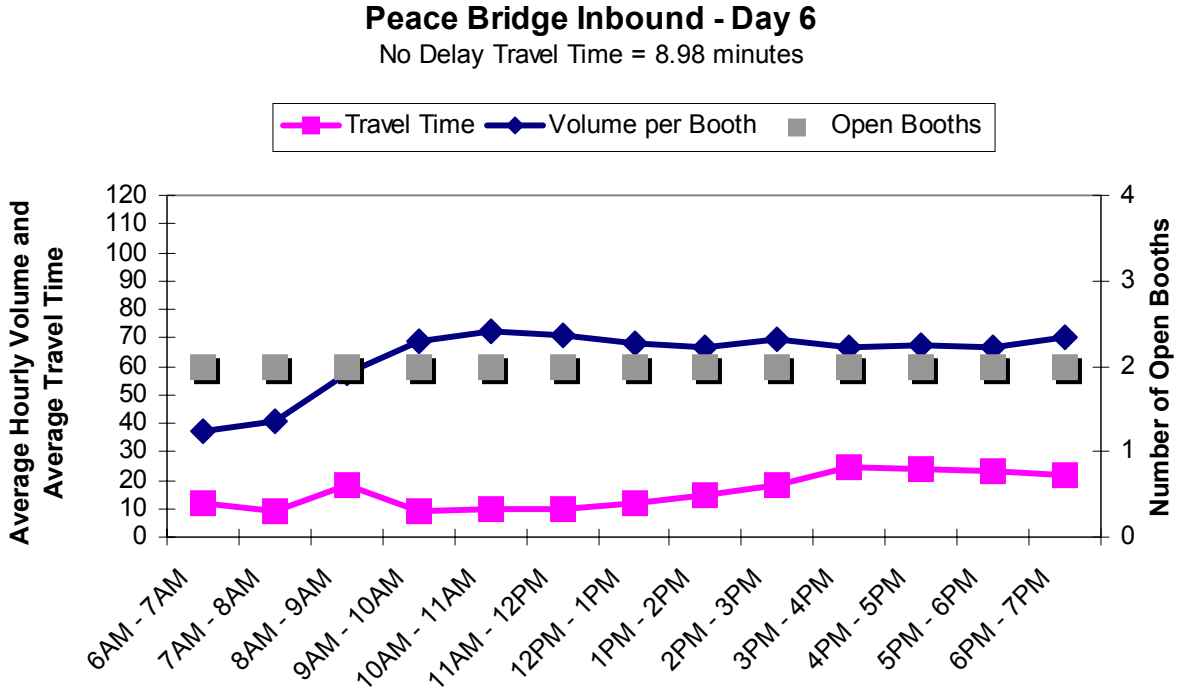

Figure A70

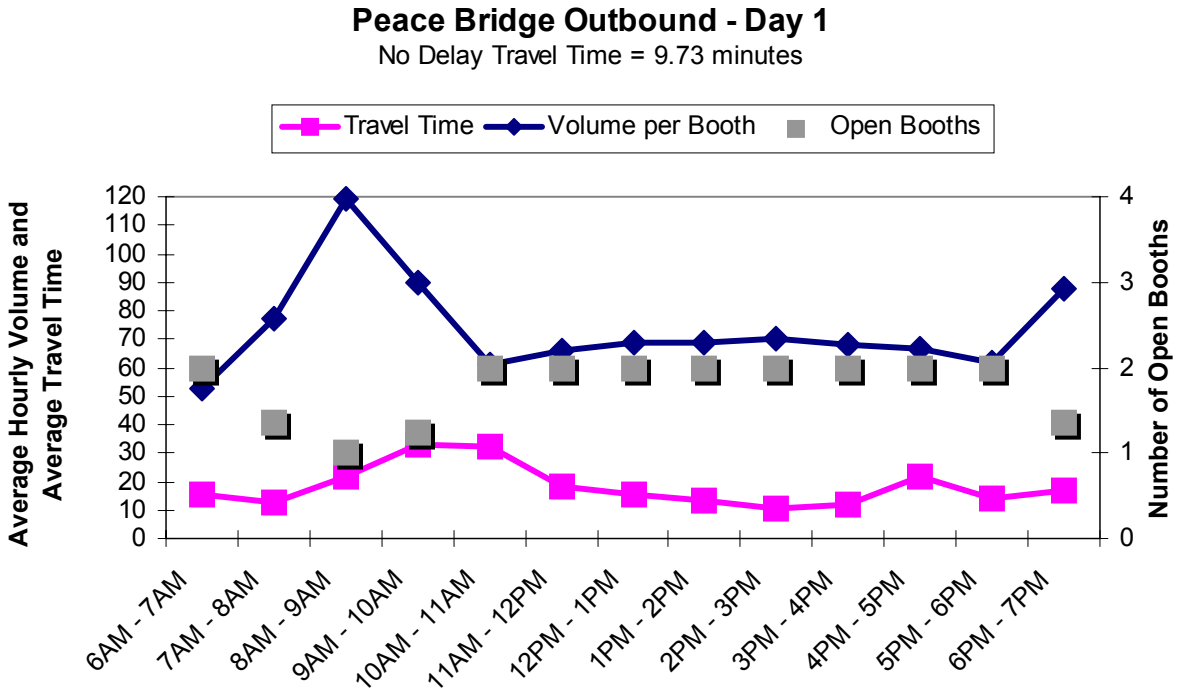

Figure A71

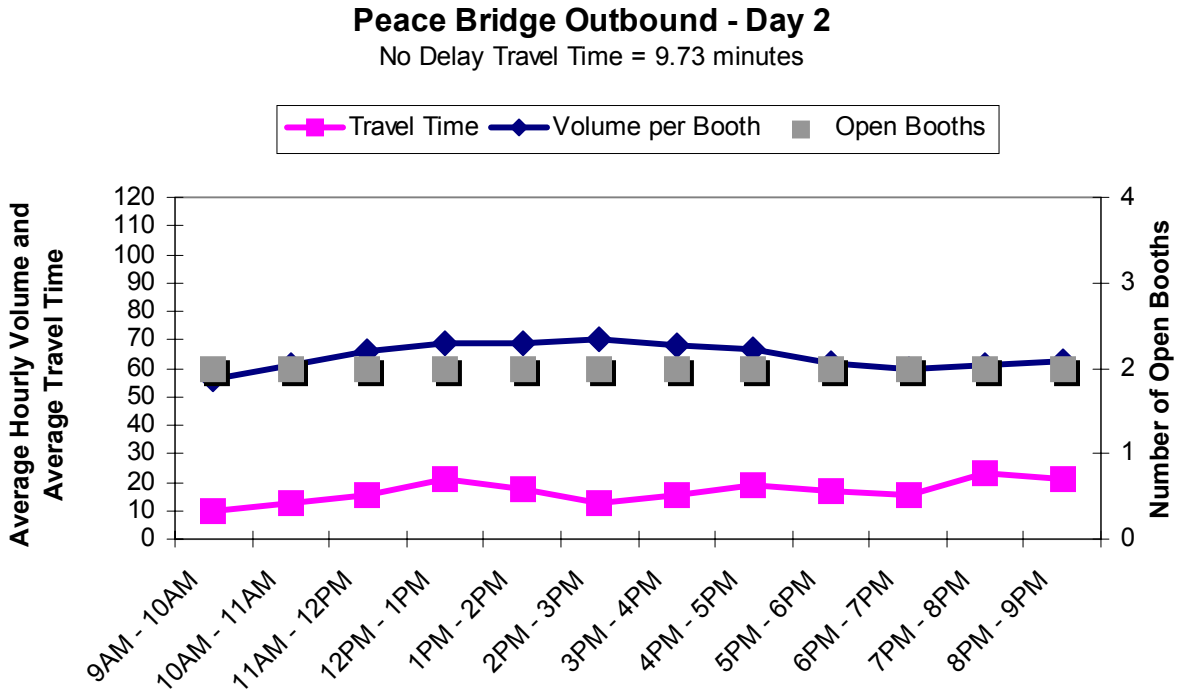

Figure A72

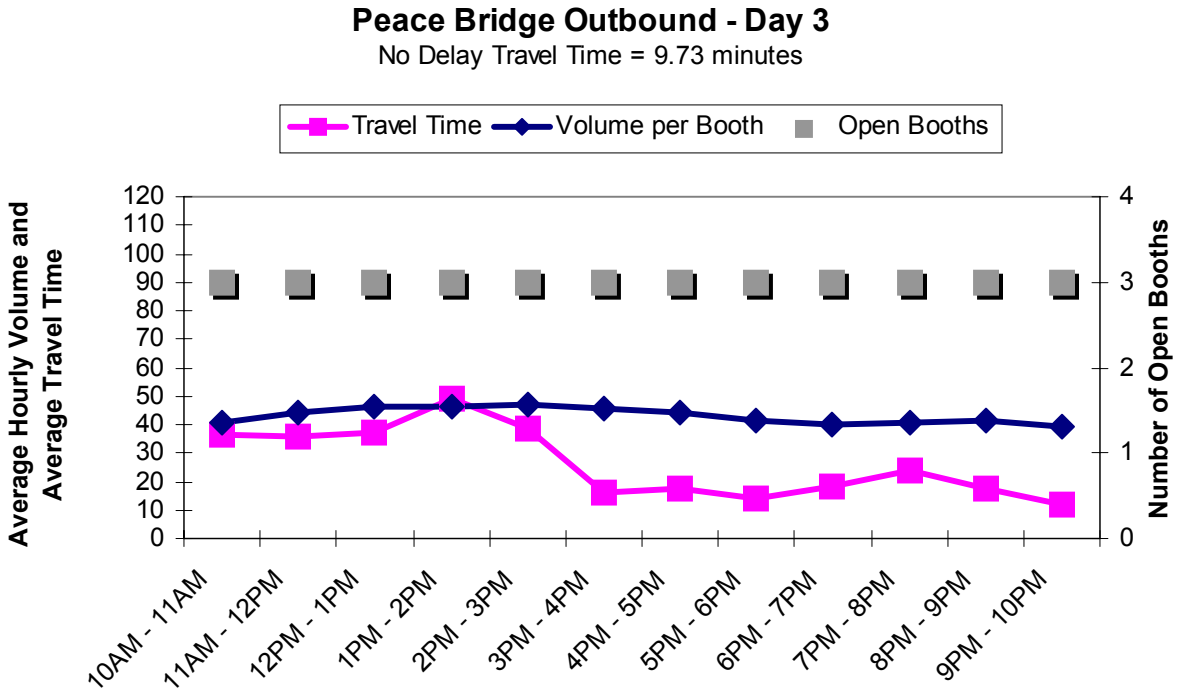

Figure A73

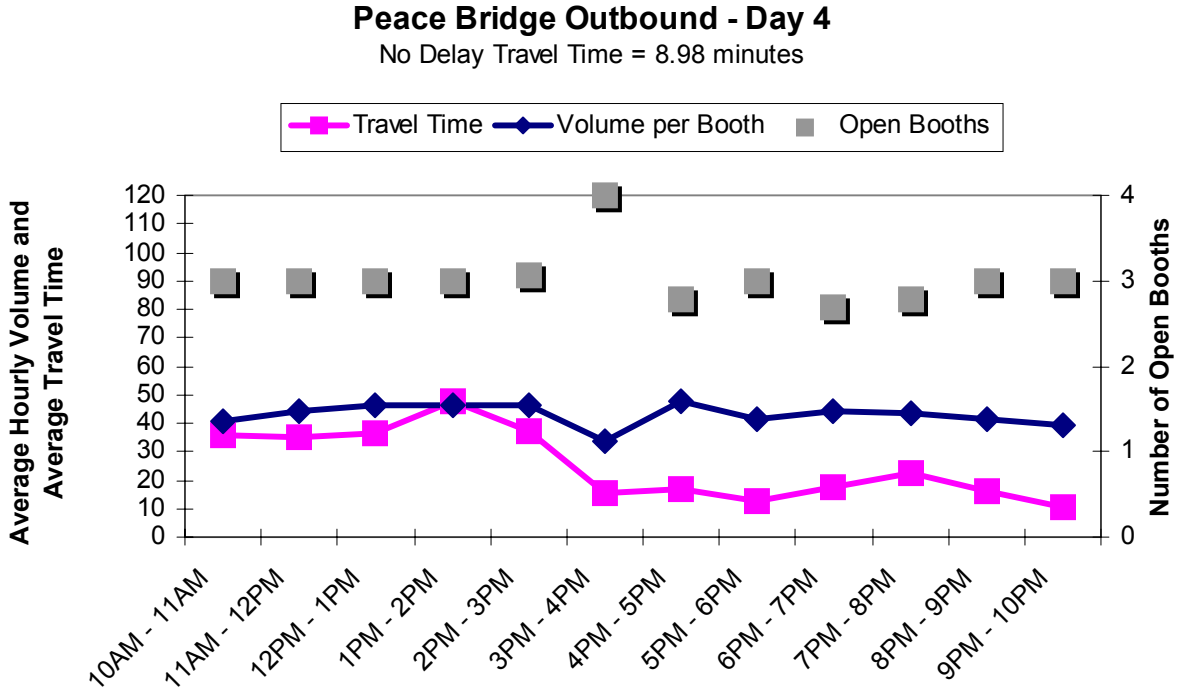

Figure A74

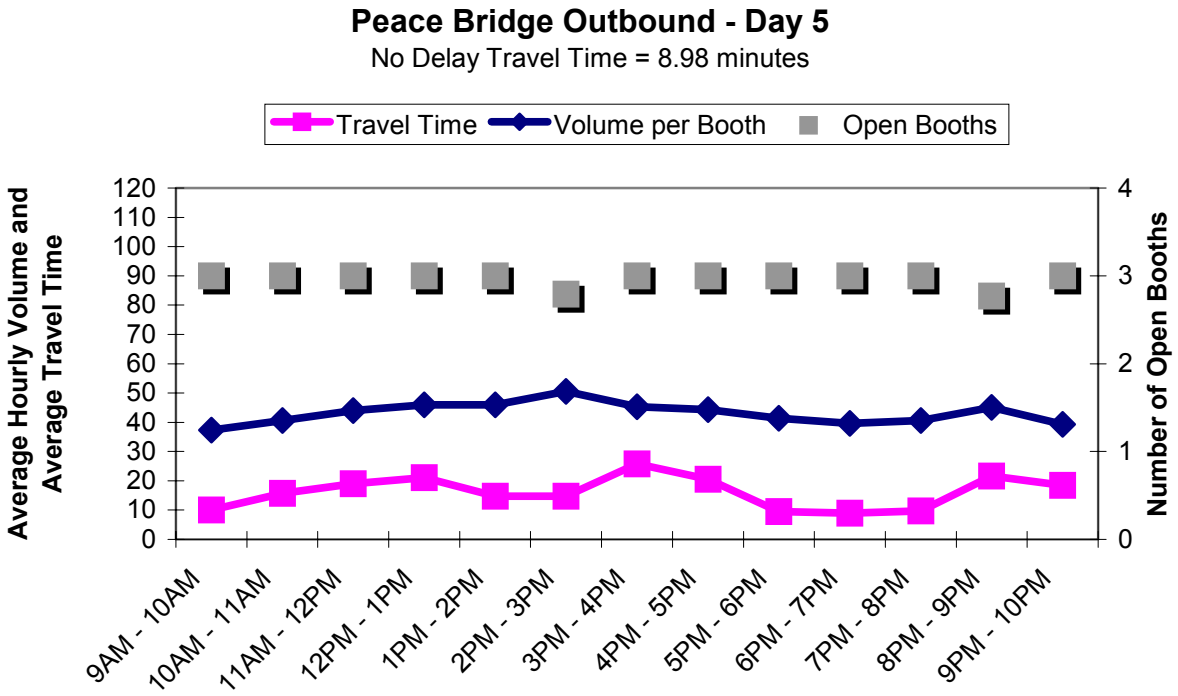

Figure A75

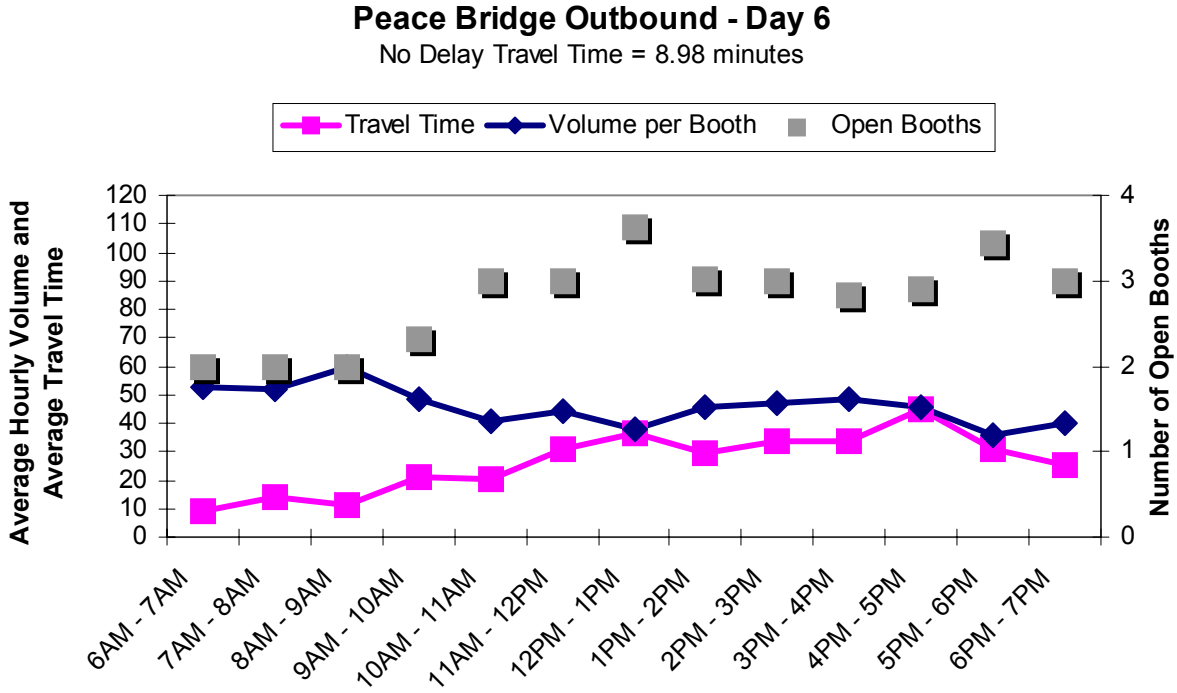

Figure A76