Final Site Report

EVALUATION OF TRAVEL TIME METHODS TO SUPPORT MOBILITY PERFORMANCE MONITORING

PEACE BRIDGE

To

Office of Freight Mgt. and Operations

Federal Highway Administration

U.S. Department of Transportation

Washington, DC 20590

Battelle
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April 2002

Border Crossing Freight Delay Data Collection and Analysis
FY 2001 Data Collection – Peace Bridge

Site Description

The Peace Bridge connects Buffalo, New York with Fort Erie, Ontario and crosses the Niagra River. The bridge links the Queen Elizabeth Way (QEW) in Canada and provides with I-190 and other major roadways in the U.S. The QEW extends to Toronto, Ontario and also links with Highway 401, one of the major East-West Canadian expressways. I-190 provides a link to I-90, the main artery of the New York State Thruway, connecting the area to the major population centers on the East Coast. The bridge operates 24 hours a day, seven days a week.

The Peace Bridge contains only a single, three-lane span. The center lane is reversible and can be used to ease congestion during peak travel conditions. The bridge was built in 1927 and is 5,800 feet long. The bridge is governed by a ten-member board consisting of five members from New York State and five members from Canada. All capital improvements and operating expenses are funded by tolls and rentals of Peace Bridge-owned property and buildings, not public funds. While a single organization, the Buffalo and Fort Erie Public Bridge Authority manages two tightly linked groups of bridge operators and maintenance workers.

Figure 1. Area Map – The Peace Bridge

Data collection activities at the Peace Bridge occurred during May 22-24, 2001 and June 19-21, 2001. Truck travel times across the bridge in both directions were recorded on Tuesday through Thursday each week, for approximately 12 hours each day. The times of the data collection were staggered somewhat to obtain a broader picture of activity at the bridge.

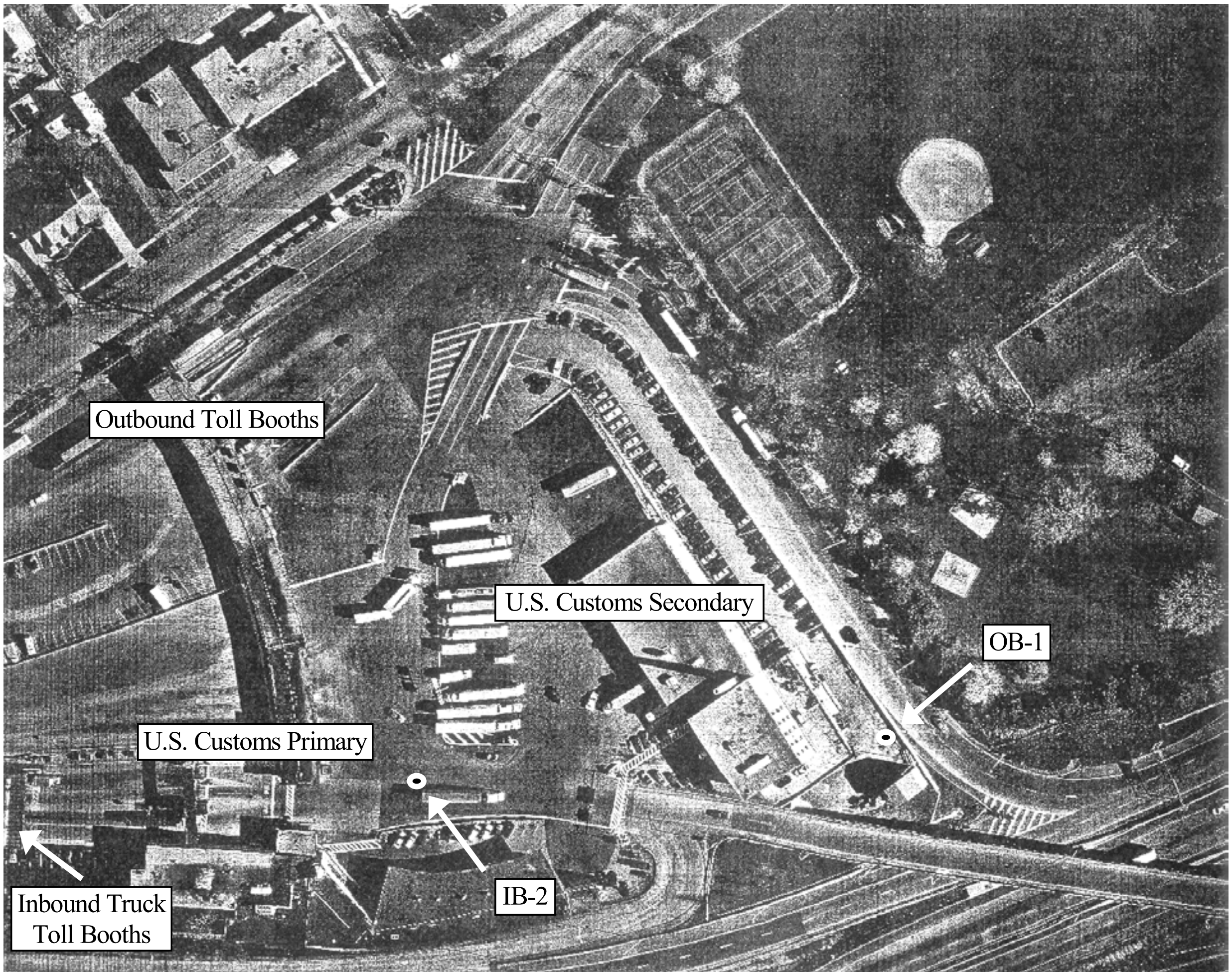

Figure 2. U.S. Plaza

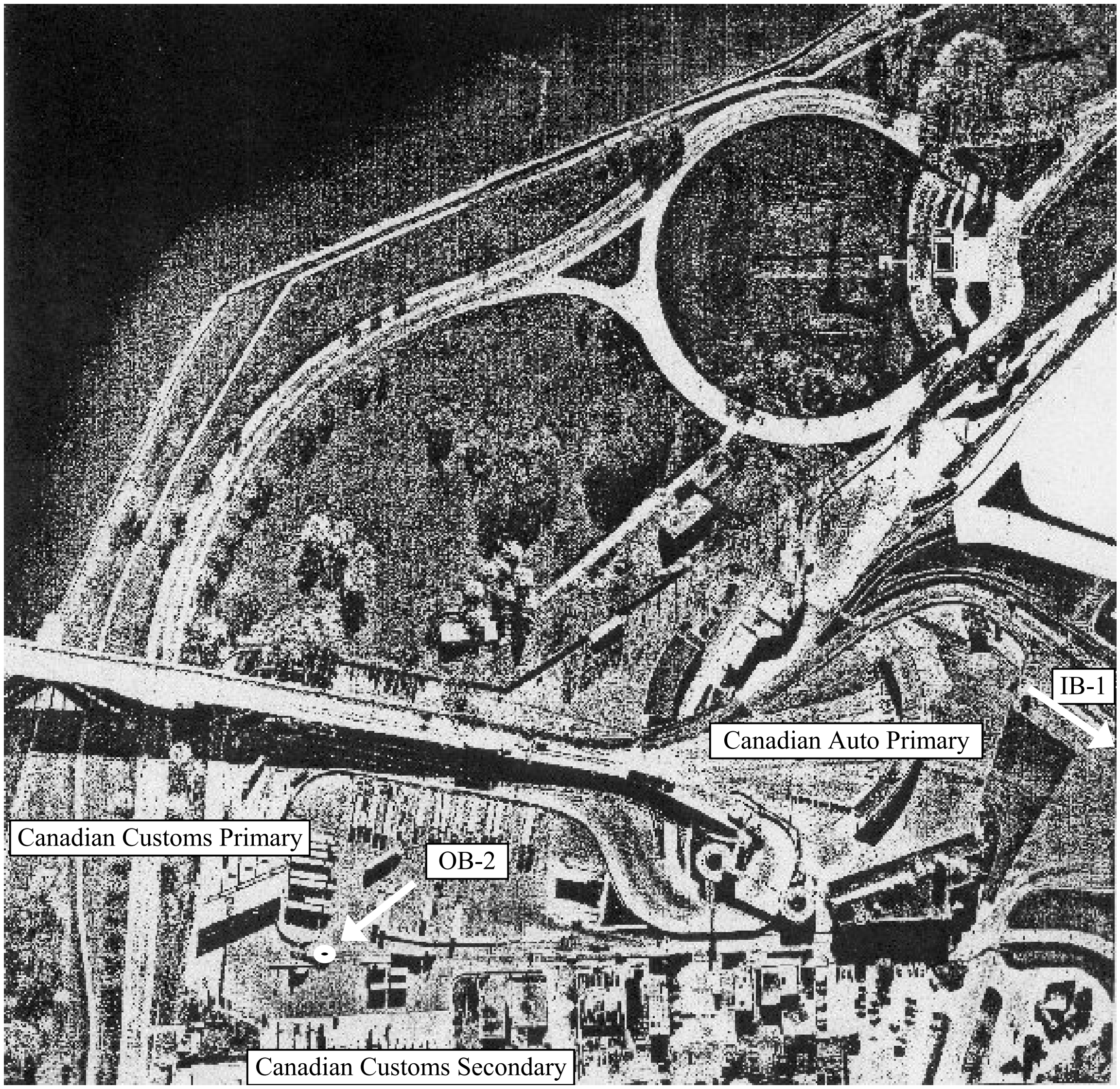

Figure 3. Canadian Plaza

Westbound traffic (outbound to Canada) approaches the bridge either from I-190 or from Porter Avenue, a four-lane arterial. On the U.S. side, typically two toll booths are used for trucks but another is available if needed (see Figure 5). Three lanes are typically open for autos. The Duty Free Shop is located on the bridge plaza beyond the toll booths. Once across the bridge, autos are directed to the left and trucks veer off to the right to pass through one of four primary Customs inspection booths. However, the fourth is used only occasionally. Trucks are either released from primary or must continue on to secondary inspection, which could include simply completing brokerage paperwork or physical inspections of the cargo. Trucks requiring physical inspections enter an area opposite the primary inspection booths. Exiting trucks and others whose drivers must interact with their broker make a sharp left turn after the inspection booths. Those released continue straight ahead and those needing to park turn left again and park in a reserved parking area. When these trucks are finally ready to depart, they must use the same roadway that trucks released from primary must use to exit the Customs compound.

Figure 4. U.S. Toll Booths

Eastbound traffic (inbound to the U.S.) approaches the bridge from the QEW. As vehicles approach the bridge, autos are directed to the left and trucks take a separate road to the right that loops around the Duty Free Shop. Beyond the Duty Free, trucks who have not yet been pre-cleared for U.S. Customs visit the Commercial Vehicle Processing Centre (CVPC). The CVPC reviews driver paperwork and, if not in order, holds the vehicle until the paperwork is complete. This reduces the number of vehicles that need to be sent to secondary inspection on the U.S. side and helps to alleviate congestion on the bridge and in the U.S. plaza.

Figure 5. Canadian Customs Primary Inspection Booths, Showing the OB-2 Collection Location

The inbound toll booths are located immediately before the U.S. primary Customs inspection booths on the U.S. side. There are three booths to process commercial vehicles for U.S. Customs primary inspection; however, a fourth is being constructed in the near future. Any truck not released from primary must enter the same secondary inspection compound. There are areas to park for drivers who need to visit their brokers as well as docks where physical secondary inspections can be conducted. As with the Canadian side, trucks exiting from secondary must pass through the area used by trucks exiting the primary inspection booths. In addition, these truck movements intersect with those of passenger autos leaving both primary and secondary inspection.

Data Collection Process

For this study, two data collection locations were used in each direction. The "number 1" location was immediately before the toll booths and the "number 2" location was immediately after the primary inspection booths. 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). Westbound movement from the U.S. into Canada was referred to as outbound. Conversely, inbound was used to refer to eastbound movement from Canada to the U.S. The Outbound 1 (OB-1) position; therefore, is in the U.S. plaza, before the toll booths. The Outbound 2 (OB-2) position was after the Canadian Customs booths. The Inbound 1 (IB-1) position was located immediately after the Duty Free Shop, but before the CVPC (see Figure 6 – panel (a) shows the data collector and panel (b) shows the view toward the Duty Free Shop exit onto the truck-only roadway). Inbound 2 (IB-2) was located adjacent to the U.S. Customs booths.

Figure 6. IB-1 Collection Location

Each data collector would use a handheld computer to record partial 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 for each vehicle that was recorded at *both* locations.

For the data collection, the on-site team included four data collectors and one supervisor. As previously mentioned, the hours during which data were collected were varied during each week to ensure the greatest possible coverage of conditions, including periods of low and high traffic volume. Table 1 shows the data collection hours for each day during the two site visits. As each data collector actually worked about 12 hours, the supervisor could collect data during their 30-minute meal break during the day, resulting in approximately 12-½ hours of data collection.

Table 1. Hours of Data Collection

Date	Start	End
5/22/01	6:00 am	6:30 pm
5/23/01	9:00 am	9:30 pm
5/24/01	9:30 am	10:00 pm
6/19/01	9:30 am	10:00 pm
6/20/01	9:30 am	10:00 pm
6/21/01	6:00 am	6:30 pm

While an extremely smooth process, it took considerable time to schedule and arrange the initial site visits to coordinate the data collection activities. Three separate meetings were held at the bridge. One meeting was held with the General Manager, the Manager of Information Technology, and a Toll/Traffic Supervisor at the U.S. side of the Buffalo and Fort Erie Public Bridge Authority. Another was held with the Chief U.S. Customs Inspector. A third meeting was held with the Divisional Program Services Officer at Canada Customs and Revenue Agency. Also in attendance at the third meeting were representatives from the headquarters office of Canada Customs who were interested in the project. It was determined that we would need to obtain visitor passes from the bridge authority shift supervisor when we arrived for the data collection.

Initial contacts with Canadian Immigration while at the bridge indicated that work permits were needed to conduct the data collection. However, consultations with Canadian Consular officials in Buffalo indicated that that would not be necessary. An e-mail was provided by the Canadian Consulate to document that they had arranged approvals for the data collection through the local Canadian Immigration office. On only one occasion was the documentation insufficient for the Customs agent at the primary auto inspection booth and Battelle's supervisor was required to briefly speak with an Immigration official prior to entering Canada on one of his frequent trips across the border.

Informal approval for data collection on the QEW, should that be necessary due to the formation of a queue, was arranged through the Canadian Customs officials. While there was no problem with data collection on the New York State Thruway (I-190), future data collection will require a work permit from the Thruway Authority.

Table 2 contains a list of the individuals who were contacted and their telephone and e-mail information. Future data collection for this project should be able to be organized and authorized with much less effort. However, any new project would require additional time to explain the data collection objectives to the involved parties and gain their approval.

Table 2. Agency Contacts

Contact	Agency	Phone/Fax	E-mail
Anthony Braunscheidel Manager – Info. Tech.	Buffalo and Fort Erie Public Bridge Authority	716-884-6744 ext.242 716-884-2089 (fax)	abraunschedel@ peacebridge.com
Christopher Bonn Toll/Traffic Supervisor	Buffalo and Fort Erie Public Bridge Authority	716-884-6744 ext.269 716-884-2089 (fax)	
Stephen Mayer General Manager/Operations	Buffalo and Fort Erie Public Bridge Authority	716-884-6744 ext.224 716-884-2089 (fax)	smayer@ peacebridge.com
Mark MacVittie Chief Inspector	U.S. Customs	716-881-4447 716-883-0582 (fax)	mark.l.macvittie@ customs.treas.gov
Ken Seebach Div. Program Services Officer	Canada Customs	905-994-6532 905-994-6010 (fax)	ken.seebach@ ccra-adrc.gc.ca
Mary Keefe	Canadian Consulate	716-858-9515	mary.keefe@ dfait-maeci.gc.ca

Data Collection Details

The Buffalo and Fort Erie Public Bridge Authority provided border crossing statistical data. This data was evaluated for an assessment of the variability in travel conditions at the Peace Bridge. The goal of this analysis process was to obtain statistically useful data with as few data collection days as possible. In order to customize the data collection activities to the Peace Bridge, the following steps were conducted:

- Define significant "seasonal" variations,
- Define significantly different days of the week,
- Identify traffic streams that experience significantly different conditions, and
- Estimate the number of days needed for the data collection survey.

As shown in Table 3, there is some variation in the commercial traffic by month. Due to project constraints, data collection needed to occur between late May and early September 2001. From Table 3, the two months with the greatest average volumes during this data collection window were May and June.

Table 3. Monthly Traffic Distribution of Commercial Vehicles

Month	1998	1999	2000	1998-2000 Average
January	109,461	101,203	118,865	109,843
February	108,576	111,860	119,572	113,336
March	121,182	130,347	138,266	129,932
April	119,711	126,059	120,066	121,945
May	118,118	127,127	130,936	125,394
June	120,477	135,313	125,779	127,190
July	107,544	116,497	119,393	114,478
August	113,480	129,938	126,537	123,318
September	119,902	128,161	117,043	121,702
October	121,235	127,332	125,772	124,780
November	113,007	128,388	112,952	118,116
December	108,803	117,812	98,148	108,254
Total	1,381,496	1,480,037	1,453,329	1,438,287

Source: Texas Transportation Institute

Tables 4 and 5 show that there is a significant difference in commercial traffic between weekdays and weekends and, further, there is a significant difference between Monday and Friday and the three mid-week days. Weekend traffic is 39 percent of typical weekday traffic and Monday/Friday traffic is 85 percent of typical Tuesday/Wednesday/Thursday traffic. In general, it was noted that inbound traffic increased from Tuesday through Thursday and outbound traffic decreased from Tuesday through Thursday. It was determined that collecting three days of data, from Tuesday through Thursday, would provide an adequate number of data samples to represent "typical" conditions.

Table 4. Sample Month – Daily Traffic Distribution of Commercial Vehicles for May 2000

Day	Day of Week	Outbound	Inbound
1	Thursday	2010	2684
2	Friday	2737	2782
3	Saturday	2952	2930
4	Sunday	3051	2789
5	Monday	2816	1802
6	Tuesday	1174	651
7	Wednesday	465	1343
8	Thursday	2086	2831
9	Friday	2848	2868
10	Saturday	2989	2889
11	Sunday	3073	2910
12	Monday	2863	1930
13	Tuesday	1135	684
14	Wednesday	458	1277

Day	Day of Week	Outbound	Inbound
15	Thursday	2118	2834
16	Friday	2935	2877
17	Saturday	3021	2976
18	Sunday	2879	2748
19	Monday	2683	1712
20	Tuesday	1036	576
21	Wednesday	357	1150
22	Thursday	1353	1643
23	Friday	2461	2664
24	Saturday	2902	2841
25	Sunday	2852	2795
26	Monday	2763	1696
27	Tuesday	1156	469
28	Wednesday	372	476
29	Thursday	660	1897
30	Friday	2393	2827
31	Saturday	2918	2820
Total		65,516	65,371

Source: Buffalo and Fort Erie Public Bridge Authority

Table 5. Averages for Sample Month – Daily Traffic Distribution of Export Commercial Vehicles for May 2000

Day of Week	Week 1	Week 2	Week 3	Week 4	Week 5	Average
Sunday		2766	2229	2203	2210	2352
Monday		6054	5517	5619	5425	5654
Tuesday		6550	6263	6253	6020	6272
Wednesday		6643	6368	6204	6219	6359
Thursday	6520	6465	6318	6207	5640	6230
Friday	5712	5250	5211	5071	4157	5080
Saturday	2674	2208	2081	2077		2260

Source: Buffalo and Fort Erie Public Bridge Authority

From discussions with the Buffalo and Fort Erie Public Bridge Authority, it was learned that backups typically did not occur on the U.S. side and, when they did, they did not grow very long. However, on the Canadian side, backups occurred fairly frequently and could stretch for several miles along the QEW. On the Canadian side, the backups would often occur by late afternoon and could stretch into the late evening or early morning hours.

Data Collection Procedures

The data collection stations selected for the crossing were chosen because of the particular actions that occur at each site. Segments defined by the data collection stations were used to determine the commercial vehicle travel times and freight delay. As illustrated in Figures 2 and 6, the data collection sites were located at:

- An advance station located upstream of the commercial vehicle queue – OB-1 and IB-1.
- The import station (primary inspection booths before detailed, or secondary, inspection) – OB-2 and IB-2.

Data collection was conducted by recording commercial vehicle license plates as vehicles crossed fixed points within the data collection sites. Survey individuals or teams, were placed at each of the four data collection sites to record commercial vehicle license plate data. Figures 2 and 3 show the facilities on both sides of the border, including station locations and major points of inspection.

Collectors at these locations would record the last five characters of the front, lower-left license plate of as many trucks as possible that passed their location. When trucking firms register many vehicles at once, they often get assigned sequential license plate numbers. Using the last five characters helps to ensure that as different trucks operated by the same firm travel across the bridge that they are uniquely identified. License plate information was entered into handheld computers with a special application designed for this project. Each entry was time-stamped with the current date and time. Prior to each day's collection, all handheld computers were synchronized to the same time. Prior experience indicated that recording the entire license plate was too time consuming and that entering only the last four characters did not provide adequate distinction between different vehicles, so the project team chose to record the last five characters.

Typically, the queue of trucks crossing the border would not extend beyond the bridge plaza. However, on occasion the queue would extend onto the highway system. When this occurred, the data collector at the #1 location would have to move further from the bridge to a point beyond the end of the queue. In this way, they could continue to record trucks before they began their wait at the end of the line. When this or any other event of interest occurred, the collectors would use an "EVENT" feature of the PDA software to record it.

For each #1 location, the supervisor would record the distance from any data collection point other than the original position (which would be in the bridge plaza). During post-processing, the data from all locations nearer to the bridge than the *farthest* location would be adjusted to include the additional travel time from the farthest location to the original location. The travel time would be computed at free-flow speeds, since there would have been no queue at the times that the data were collected at these closer locations. In this way, the data all would appear to be collected from the same location, the one most distant from the bridge.

The data collection team used cell phones to maintain in touch with each other. This was particularly important when the queues lengthened such that a collector had to move farther upstream. The supervisor could be kept informed without repeated trips to each data collection location. This was also useful at the end of the day when the #1 collectors would inform the #2 collectors of the last truck they recorded, so the #2 collectors would know when to stop. While cell tower locations created some problems with reception, each collector was usually able to reach whomever they needed to speak with.

Data Collection Sample Size

Sample sizes are typically not a concern with videotape or handheld data entry devices, because the data collection includes a large number of vehicles. However, minimum sample sizes should be verified with variability values from field data. Early research found that sample sizes from 25 to 100 license matches were necessary for a given roadway segment and time period (Turner, et. al.). In most cases, there were sufficient records to meet this requirement. The number of matches was significantly higher in the inbound direction as all vehicles had to travel slowly and in single file past the data collector. In addition, the use of improved data collection equipment, described in the following section, increased the number of matches during the second week of data collection.

Data Collection Equipment

As outlined in the "Data Collection Procedures" section above, handheld computers were used as the data entry device and proved adequate to the task. For the first week of data collection, Palm m100 model handheld computers were used. It was decided, however, that subsequent data collection should be done with Handspring Visors. The Handspring Visors use the same Palm OS (operating system) and have faster processing speeds (at least in side-by-side comparison with this application) and larger screen sizes than the m100 models from Palm Computing. Low-end models with 2 Mb of storage capacity were selected as the application and data size were projected to be well below this limit.

A custom application was developed for the Palm OS, which allowed the data collectors to identify their locations (e.g., OB-1, IB-2), the number of open booths (primarily used for the customs inspection booths), special events or other comments, and license plate information. A screen shot of the application interface is shown in Figure 7.

Figure 7. Data Collection Device and Software Application

The data were downloaded via a serial cable directly from the application into a text file on the field laptop computer, which was a Dell Latitude CPx H running with a 500 MHz Pentium III processor.

After analyzing the data from the first two days of collection during the first week indicated that there might be a problem with the download process. To ensure no loss of data, it was decided to record data manually on the third and last day of collection that week. The collectors used synchronized digital watches and recorded the time in addition to the license plate information. This data was later transcribed for processing. The original Palm m100s were used as backup devices for the second week of data collection, but they did not need to be used.

Data Collection Summary

Table 6 shows the number of commercial vehicle license plates recorded for each of the stations on each of the data collection days. Table 7 shows the average daily traffic volume as recorded by the Buffalo and Fort Erie Public Bridge Authority. Hourly volumes are used in the calculation of delay; those are shown with the delay calculations in Tables 8 through 19.

Table 6. Number of Commercial Vehicle License Plates Collected

Station	5/22/01	5/23/01	5/24/01	6/19/01	6/20/01	6/21/01
OB-1	796	1133	1045	1045	1409	1342
OB-2	590	936	870	870	1533	1454
IB-1	1032	1005	1103	1309	1235	1456
IB-2	1382	1477	1388	1298	1309	1437
Total	3800	4551	4406	4522	5486	5689

Table 7. Average Daily Traffic at the Peace Bridge

Direction	5/22/01	5/23/01	5/24/01	6/19/01	6/20/01	6/21/01
Outbound	2305	2720	2783	2633	2675	2674
Inbound	2236	2852	2731	2526	2559	2641
Total	4541	5572	5514	5159	5234	5315

Data Quality Steps

At the end of each day of data collection, the supervisor would collect the PDAs and download the data into the field laptop computer where it was stored on the hard drive. The data would be examined for any anomalies and transferred across the Internet to a secondary location for backup purposes. The OB-1 and OB-2 data would be merged together and license plates from the two locations would be "matched" using a spreadsheet developed in Microsoft Excel. As it is easy to mistake certain characters, particularly letters that looked like numbers, the license plate data was pre-processed. All 'I's were replaced with '1's; all 'O's, 'D's, and 'Q's were replaced with '0's; all 'S's were replaced with '5's; and all 'Z's were replaced with '2's. In addition, the data collectors were instructed to always use '1's for 'I's and '0's for 'O's (i.e., to use the digit, rather than the letter).

Occasionally, collectors would be unsure about a license plate and would append "QQQ" to their entry. This would typically occur when several trucks passed the collector in rapid succession or if one truck blocked the license plate of another and he or she could only manage a quick glimpse. This would allow the supervisor to search the downloaded data for a potential match by using the travel times of other trucks that were recorded in the same general time frame. During this process, the supervisor could also identify the few records in which the data collector forgot to press "ENTER" after recording a license plate before recording the next one. These ten-character entries could be split into two and the time for the first interpolated from the adjacent entries if they were less than a minute or so apart.

During the first week of data collection, it was determined that a problem with the download process might preclude accessing all the data collected during the third day. It was, therefore, decided to employ a manual data collection approach for that third day. The collectors used pads of paper and synchronized wrist watches to record both the license plate information and the time of day. This data was later transcribed and double-checked. For future data collections at other locations, backup handheld computers were provided to all data collectors to use if they felt that their primary device was not functioning properly.

Data post-processing also included a step to identify any anomalies in the data, including outliers. Outliers, records that indicated travel times significantly greater than typical for that time period, were most often caused by recording the license plate of a vehicle only some of the time as it made repeated trips across the border during a single day. This is because the matching algorithm uses the most recent time at the #1 position when matching to a record from a #2 location. For example, if the vehicle was recorded as it headed from Canada to the U.S. early in the morning, later returned to Canada, was missed as it re-entered the U.S. later in the day, and then recorded on its subsequent return to Canada, the #1 time from its first trip would be matched with it #1 time from the first trip (for a valid travel time) an also matched to the #2 time from its second trip (an invalid travel time). This invalid travel time would be easily identified by manual inspection of the data, aided by highlighting those travel times above a specific, but variable, threshold.

Freight Delay Analysis

The 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. Delay is measured relative to the travel time at low volume conditions, which will allow the processing time of the inspection to be accommodated outside of the measure. Estimating the average delay per truck for each hour where congestion is present and then applying the average hourly truck volume produces an estimate of total delay.

The average delay per truck for each hour is the difference between the travel time at low volume conditions and the travel time each hour. Travel time is also affected by the number of open inspection booths and this information was recorded on all days as it changed. To determine the average travel time for each road segment, the matched license plate data in the database is used. The number of matches are noted for statistical analysis and the travel time is noted for each hour.   The travel time for each truck was assigned to the hour when they passed through the primary customs inspection location as this was the only location that remained consistent throughout the data collection. It should be noted, however, that the hourly volumes are obtained from the bridge operators and are measured at the toll booths.

The data are presented in Tables 8 through 19. The columns illustrate the key elements for estimating delay:

- No Delay 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 three-day data collection period.
- Average Number of Open Booths – The average number of primary Customs commercial vehicle inspection booths open and available for processing trucks. This figure is not used to compute delay but is useful to help understand the relationship between booths, traffic volume, and delay.

- Number of Matched Vehicles – The number of vehicle observation used to estimate the travel time for each hour.
- Average Travel Time – The amount of travel time from entry to exit for trucks entering the system each hour (use the time the vehicle passes the advance point as the determinant of 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. For both weeks of data collection, the applicable season is March through June. Also, the average traffic volumes shown are computed for only Tuesdays, Wednesdays, and Thursdays during the four-month season.
- Total Delay – The product of the hourly truck volume and delay per trip.

Table 8. Total Delay – 5/22/2001 – Outbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
6:00 – 7:00 AM	9.73	2.00	1	15.73	6.00	105	629.31
7:00 – 8:00 AM	9.73	1.35	13	12.62	2.89	104	300.99
8:00 – 9:00 AM	9.73	1.00	18	21.80	12.07	119	1,430.30
9:00 – 10:00 AM	9.73	1.25	23	32.80	23.07	112	2,591.38
10:00 – 11:00 AM	9.73	2.00	15	32.63	22.90	122	2,788.92
11:00 – 12:00 PM	9.73	2.00	30	19.08	9.35	132	1,232.66
12:00 – 1:00 PM	9.73	2.00	4	15.12	5.39	138	742.95
1:00 – 2:00 PM	9.73	2.00	36	13.38	3.65	138	505.57
2:00 – 3:00 PM	9.73	2.00	18	10.80	1.07	141	150.62
3:00 – 4:00 PM	9.73	2.00	32	11.80	2.07	136	280.88
4:00 – 5:00 PM	9.73	2.00	2	22.10	12.37	133	1,643.54
5:00 – 6:00 PM	9.73	2.00	25	14.27	4.54	124	560.28
6:00 – 7:00 PM	9.73	1.36	9	16.88	7.15	119	847.81

Table 9. Total Delay – 5/23/2001 – Outbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
9:00 – 10:00 AM	9.73	2.00	11	9.73	0.00	112	0.00
10:00 – 11:00 AM	9.73	2.00	19	12.43	2.70	122	328.78
11:00 – 12:00 PM	9.73	2.00	32	15.33	5.60	132	738.02
12:00 – 1:00 PM	9.73	2.00	38	21.05	11.32	138	1,560.83
1:00 – 2:00 PM	9.73	2.00	16	17.73	8.00	138	1,107.08
2:00 – 3:00 PM	9.73	2.00	43	12.63	2.90	141	408.23
3:00 – 4:00 PM	9.73	2.00	33	15.30	5.57	136	755.35
4:00 – 5:00 PM	9.73	2.00	34	19.17	9.43	133	1,253.36
5:00 – 6:00 PM	9.73	2.00	36	17.02	7.28	124	899.49
6:00 – 7:00 PM	9.73	2.00	29	15.28	5.55	119	657.78
7:00 – 8:00 PM	9.73	2.00	59	23.42	13.68	122	1,670.68
8:00 – 9:00 PM	9.73	2.00	28	20.77	11.03	125	1,376.62

Table 10. Total Delay – 5/24/2001 – Outbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
10:00 – 11:00 AM	9.73	3.00	8	36.65	26.92	122	3,278.03
11:00 – 12:00 PM	9.73	3.00	11	35.85	26.12	132	3,442.31
12:00 – 1:00 PM	9.73	3.00	12	37.32	27.59	138	3,804.84
1:00 – 2:00 PM	9.73	3.00	12	48.92	39.19	138	5,422.83
2:00 – 3:00 PM	9.73	3.00	25	38.37	28.64	141	4,031.16
3:00 – 4:00 PM	9.73	3.00	36	16.28	6.55	136	889.24
4:00 – 5:00 PM	9.73	3.00	37	17.80	8.07	133	1,072.22
5:00 – 6:00 PM	9.73	3.00	36	13.92	4.19	124	517.05
6:00 – 7:00 PM	9.73	3.00	22	18.53	8.80	119	1,043.36
7:00 – 8:00 PM	9.73	3.00	43	23.57	13.84	122	1,689.40
8:00 – 9:00 PM	9.73	3.00	28	17.22	7.49	125	934.11
9:00 – 10:00 PM	9.73	3.00	3	11.87	2.14	118	252.70

Table 11. Total Delay – 6/19/2001 – Outbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
10:00 – 11:00 AM	8.98	3.00	8	35.52	26.53	122	3,230.94
11:00 – 12:00 PM	8.98	3.00	11	35.33	26.35	132	3,472.63
12:00 – 1:00 PM	8.98	3.00	12	36.75	27.77	138	3,829.66
1:00 – 2:00 PM	8.98	3.00	12	47.88	38.90	138	5,383.16
2:00 – 3:00 PM	8.98	3.06	25	37.47	28.48	141	4,009.58
3:00 – 4:00 PM	8.98	4.00	36	15.15	6.17	136	836.77
4:00 – 5:00 PM	8.98	2.79	37	16.67	7.68	133	1,020.85
5:00 – 6:00 PM	8.98	3.00	36	12.78	3.80	124	469.30
6:00 – 7:00 PM	8.98	2.69	22	17.40	8.42	119	997.54
7:00 – 8:00 PM	8.98	2.79	43	22.63	13.65	122	1,666.61
8:00 – 9:00 PM	8.98	3.00	28	16.08	7.10	125	885.86
9:00 – 10:00 PM	8.98	3.00	3	10.73	1.75	118	206.97

Table 12. Total Delay – 6/20/2001 – Outbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
9:00 – 10:00 AM	8.98	3.00	25	10.03	1.05	112	117.94
10:00 – 11:00 AM	8.98	3.00	79	15.67	6.68	122	813.82
11:00 – 12:00 PM	8.98	3.00	93	19.05	10.07	132	1,326.67
12:00 – 1:00 PM	8.98	3.00	105	21.10	12.12	138	1,671.17
1:00 – 2:00 PM	8.98	3.00	103	14.72	5.73	138	793.41
2:00 – 3:00 PM	8.98	2.79	83	14.70	5.72	141	804.73
3:00 – 4:00 PM	8.98	3.00	86	25.78	16.80	136	2,279.63
4:00 – 5:00 PM	8.98	3.00	119	20.50	11.52	133	1,530.17
5:00 – 6:00 PM	8.98	3.00	95	9.48	0.50	124	61.75
6:00 – 7:00 PM	8.98	3.00	98	8.98	0.00	119	0.00
7:00 – 8:00 PM	8.98	3.00	100	9.68	0.70	122	85.47
8:00 – 9:00 PM	8.98	2.77	67	21.60	12.62	125	1,574.17
9:00 – 10:00 PM	8.98	3.00	71	18.42	9.43	118	1,115.67

Table 13. Total Delay – 6/21/2001 – Outbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
6:00 – 7:00 AM	8.98	2.00	28	9.03	0.05	105	5.24
7:00 – 8:00 AM	8.98	2.00	64	13.97	4.98	104	519.61
8:00 – 9:00 AM	8.98	2.00	73	11.40	2.42	119	286.38
9:00 – 10:00 AM	8.98	2.32	81	21.12	12.13	112	1,362.90
10:00 – 11:00 AM	8.98	3.00	107	20.13	11.15	122	1,357.73
11:00 – 12:00 PM	8.98	3.00	73	31.05	22.07	132	2,908.13
12:00 – 1:00 PM	8.98	3.63	116	36.25	27.27	138	3,760.70
1:00 – 2:00 PM	8.98	3.01	101	29.50	20.52	138	2,839.19
2:00 – 3:00 PM	8.98	3.00	85	33.68	24.70	141	3,477.00
3:00 – 4:00 PM	8.98	2.82	18	33.42	24.43	136	3,315.42
4:00 – 5:00 PM	8.98	2.90	71	44.77	35.78	133	4,754.37
5:00 – 6:00 PM	8.98	3.44	91	31.08	22.10	124	2,729.35
6:00 – 7:00 PM	8.98	3.00	67	25.50	16.52	119	1,957.54

Table 14. Total Delay – 5/22/2001 – Inbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
6:00 – 7:00 AM	7.32	2.00	4	7.32	0.00	74	0.00
7:00 – 8:00 AM	7.32	1.82	42	9.15	1.83	82	150.26
8:00 – 9:00 AM	7.32	2.00	54	9.02	1.70	115	196.15
9:00 – 10:00 AM	7.32	2.00	60	8.50	1.18	137	161.75
10:00 – 11:00 AM	7.32	2.00	58	10.27	2.95	145	427.69
11:00 – 12:00 PM	7.32	2.94	53	8.40	1.08	142	153.75
12:00 – 1:00 PM	7.32	3.00	9	8.27	0.95	136	128.93
1:00 – 2:00 PM	7.32	3.00	84	9.65	2.33	134	313.16
2:00 – 3:00 PM	7.32	3.00	95	11.12	3.80	139	527.40
3:00 – 4:00 PM	7.32	2.97	92	9.52	2.20	133	291.50
4:00 – 5:00 PM	7.32	3.00	67	11.73	4.42	135	595.91
5:00 – 6:00 PM	7.32	3.00	70	14.43	7.12	134	954.45

Table 15. Total Delay – 5/23/2001 – Inbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
9:00 – 10:00 AM	7.32	2.78	36	7.32	0.00	137	0.00
10:00 – 11:00 AM	7.32	3.00	68	7.97	0.65	145	94.24
11:00 – 12:00 PM	7.32	3.00	90	8.73	1.42	142	201.06
12:00 – 1:00 PM	7.32	3.00	68	8.55	1.23	136	167.38
1:00 – 2:00 PM	7.32	3.00	3	15.18	7.87	134	1,055.80
2:00 – 3:00 PM	7.32	3.00	106	14.60	7.28	139	1,010.84
3:00 – 4:00 PM	7.32	3.00	80	11.70	4.38	133	580.79
4:00 – 5:00 PM	7.32	3.00	79	12.52	5.20	135	701.60
5:00 – 6:00 PM	7.32	3.00	57	20.15	12.83	134	1,721.15
6:00 – 7:00 PM	7.32	3.00	3	31.12	23.80	140	3,333.37
7:00 – 8:00 PM	7.32	3.00	ND	ND	-	145	-
8:00 – 9:00 PM	7.32	3.00	50	16.53	9.22	132	1,213.76
9:00 – 10:00 PM	7.32	3.00	42	25.70	18.38	127	2,343.52

ND – No data were recorded

Table 16. Total Delay – 5/24/2001 – Inbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
10:00 – 11:00 AM	7.32	3.00	41	11.58	4.27	145	618.58
11:00 – 12:00 PM	7.32	3.00	88	12.37	5.05	142	716.71
12:00 – 1:00 PM	7.32	3.00	88	10.95	3.63	136	493.09
1:00 – 2:00 PM	7.32	3.00	61	9.85	2.53	134	340.00
2:00 – 3:00 PM	7.32	3.00	37	12.83	5.52	139	765.65
3:00 – 4:00 PM	7.32	3.00	57	23.35	16.03	133	2,124.42
4:00 – 5:00 PM	7.32	3.00	53	30.48	23.17	135	3,125.72
5:00 – 6:00 PM	7.32	3.00	51	30.28	22.97	134	3,080.18
6:00 – 7:00 PM	7.32	3.00	75	20.03	12.72	140	1,781.07
7:00 – 8:00 PM	7.32	3.00	75	8.67	1.35	145	195.70
8:00 – 9:00 PM	7.32	3.00	70	10.60	3.28	132	432.39
9:00 – 10:00 PM	7.32	3.00	36	12.22	4.90	127	624.66

Table 17. Total Delay – 6/19/2001 – Inbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
9:00 – 10:00 AM	8.98	1.99	29	11.97	2.98	137	407.80
10:00 – 11:00 AM	8.98	2.11	65	12.45	3.47	145	502.60
11:00 – 12:00 PM	8.98	2.97	66	16.25	7.27	142	1,031.31
12:00 – 1:00 PM	8.98	2.88	108	12.18	3.20	136	434.28
1:00 – 2:00 PM	8.98	3.00	87	15.45	6.47	134	867.90
2:00 – 3:00 PM	8.98	3.00	80	21.22	12.23	139	1,697.85
3:00 – 4:00 PM	8.98	3.00	95	19.60	10.62	133	1,406.71
4:00 – 5:00 PM	8.98	2.22	63	23.38	14.40	135	1,942.89
5:00 – 6:00 PM	8.98	2.00	56	50.75	41.77	134	5,601.55
6:00 – 7:00 PM	8.98	2.00	36	72.88	63.90	140	8,949.69
7:00 – 8:00 PM	8.98	2.00	36	96.83	87.85	145	12,734.87
8:00 – 9:00 PM	8.98	2.00	43	101.37	92.38	132	12,166.17

Table 18. Total Delay – 6/20/2001 – Inbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
9:00 – 10:00 AM	8.98	3.00	27	17.93	8.95	137	1,223.40
10:00 – 11:00 AM	8.98	3.00	90	10.48	1.50	145	217.47
11:00 – 12:00 PM	8.98	3.00	97	12.82	3.83	142	544.04
12:00 – 1:00 PM	8.98	3.00	86	20.13	11.15	136	1,513.18
1:00 – 2:00 PM	8.98	3.00	109	19.97	10.98	134	1,474.09
2:00 – 3:00 PM	8.98	3.00	86	20.63	11.65	139	1,616.89
3:00 – 4:00 PM	8.98	3.00	87	26.82	17.83	133	2,362.92
4:00 – 5:00 PM	8.98	3.00	48	32.77	23.78	135	3,208.92
5:00 – 6:00 PM	8.98	3.00	19	62.10	53.12	134	7,123.76
6:00 – 7:00 PM	8.98	3.00	40	82.15	73.17	140	10,247.55
7:00 – 8:00 PM	8.98	3.00	55	71.73	62.75	145	9,096.34
8:00 – 9:00 PM	8.98	3.00	35	85.87	76.88	132	10,124.94
9:00 – 10:00 PM	8.98	3.46	34	90.97	81.98	127	10,451.30

Table 19. Total Delay – 6/21/2001 – Inbound

Time Period	(a) "No Delay" Travel Time	(b) Average No. of Open Booths	(c) Number of "Matched" Vehicles	(d) Average Travel Time	(e) Delay Per Trip (d - a)	(f) Average Traffic Volume	(g) Total Delay (f x e)
6:00 – 7:00 AM	8.98	2.00	43	11.73	2.75	74	203.87
7:00 – 8:00 AM	8.98	2.00	79	8.98	0.00	82	0.00
8:00 – 9:00 AM	8.98	2.00	75	18.07	9.08	115	1,048.08
9:00 – 10:00 AM	8.98	2.00	77	9.00	0.02	137	2.28
10:00 – 11:00 AM	8.98	2.00	80	10.07	1.08	145	157.06
11:00 – 12:00 PM	8.98	2.00	76	9.97	0.98	142	139.56
12:00 – 1:00 PM	8.98	2.00	101	12.07	3.08	136	418.44
1:00 – 2:00 PM	8.98	2.00	106	14.70	5.72	134	767.24
2:00 – 3:00 PM	8.98	2.00	98	18.37	9.38	139	1,302.30
3:00 – 4:00 PM	8.98	2.00	68	24.43	15.45	133	2,047.13
4:00 – 5:00 PM	8.98	2.00	87	23.70	14.72	135	1,985.62
5:00 – 6:00 PM	8.98	2.00	84	23.18	14.20	134	1,904.44
6:00 – 7:00 PM	8.98	2.00	35	21.67	12.68	140	1,776.40

From examination of the data, it appeared that there was a bimodal distribution of travel times in the inbound direction. A smaller group of trucks had longer travel times than most of the trucks moving through at a given time and most of the times for this smaller group were quite similar to each other. This is expected due to the additional processing time experienced by trucks that were processed at the CVPC. Canadian Customs officials indicated that a delay of 20 minutes or more was common for trucks needing to wait for proper authorization and this was consistent with the observed data. The data for these vehicles are presented in Tables 20 and 21. There were considerably less data per hour for vehicles likely passing through the CVPC than for other vehicles. While not containing sufficient sample sizes for detailed analysis, these data provide some additional insight to the overall experience of truck travel times at the Peace Bridge. It should also be noted that some vehicles included in this table could have spent an equivalent amount of time at the Duty Free Shop without visiting the CVPC.

Table 20. Data for Inbound Vehicles Likely Utilizing the CVPC – Week 1

Time Period	5/22/01		5/23/01		5/24/01	
	Matches	Average Travel Time	Matches	Average Travel Time	Matches	Average Travel Time
7:00 – 8:00 AM	1	36.68				
8:00 – 9:00 AM	4	37.72				
9:00 – 10:00 AM	ND	ND	1	33.32		
10:00 – 11:00 AM	4	45.82	8	42.50		
11:00 – 12:00 PM	3	42.78	8	46.28	7	46.90
12:00 – 1:00 PM	1	55.87	13	45.68	7	50.75
1:00 – 2:00 PM	5	45.78	3	66.18	10	47.27
2:00 – 3:00 PM	5	46.52	6	51.65	7	56.88
3:00 – 4:00 PM	4	43.12	15	46.13	2	49.23
4:00 – 5:00 PM	10	48.65	14	45.87	8	64.20
5:00 – 6:00 PM	13	50.45	9	57.40	25	60.55
6:00 – 7:00 PM	3	44.77	4	60.95	14	63.58
7:00 – 8:00 PM			ND	ND	20	48.87
8:00 – 9:00 PM			ND	ND	9	49.50
9:00 – 10:00 PM			10	66.48	5	60.32

ND – No data were recorded

Table 21. Data for Inbound Vehicles Likely Utilizing the CVPC – Week 2

Time Period	6/19/01		6/20/01		6/21/01	
	Matches	Average Travel Time	Matches	Average Travel Time	Matches	Average Travel Time
7:00 – 8:00 AM					14	45.40
8:00 – 9:00 AM					13	56.35
9:00 – 10:00 AM					16	56.98
10:00 – 11:00 AM	4	66.02			11	48.32
11:00 – 12:00 PM	7	53.95	7	46.58	10	56.75
12:00 – 1:00 PM	15	48.50	8	56.15	8	47.40
1:00 – 2:00 PM	3	47.67	17	53.45	9	49.07
2:00 – 3:00 PM	13	54.78	11	59.32	16	58.18
3:00 – 4:00 PM	14	52.33	18	65.13	11	53.45
4:00 – 5:00 PM	13	63.45	11	70.22	11	54.42
5:00 – 6:00 PM	14	85.48	1	101.65	15	59.12
6:00 – 7:00 PM	9	90.77	8	106.20	15	50.90
7:00 – 8:00 PM	ND	ND	8	119		
8:00 – 9:00 PM	3	126.45	9	124		
9:00 – 10:00 PM	3	149.40				

ND – No data were recorded

As previously mentioned, the number of open primary Customs inspection booths was also recorded. Examining the previous tables shows the relationship between the volume of trucks moving across the border and the number of open inspection booths on the travel times, particularly in the inbound direction.

At the Peace Bridge, data collectors had to relocate due to an increasing queue length in both the outbound and inbound directions. Heading into Canada, a location was selected at the next ramp down I-190 from the bridge, approximately 0.75 miles from the initial location. On several occasions, the data collector moved to the alternate location only to discover that the queue had already dissipated. This caused some additional small gaps in the data collection.

On 5/24/01, the OB-1 collector moved from the original location to the highway ramp for the first time at approximately 10:30 am and remained there for 50 minutes. At 11:50 am and 2:10 pm, the collector moved for a second and third time and remained there for about 20 minutes each time. The OB-1 collector moved for a fourth time at 6:50, but only for ten minutes.

During the second week of data collection, the OB-1 collector only moved once, on 6/21/01 from 3 to 5:15 pm. Earlier in the day, around 10:30 am, car traffic entering Canada inspection blocked the access of trucks to the approach to the commercial inspection booths periodically and for approximately 3 minutes all the commercial inspection booths were empty. Traffic across the bridge into Canada was allowed to use two of the three lanes for the entire distance but there car volumes were quite high keeping the congestion level high for much of the day. On 6/20/01, while the collector never had to move, the queue approached the end of the off-ramp from I-190 near the OB-1 location four times.

Heading into the U.S., several different locations along the QEW were chosen, depending on the current conditions. Of course, it was the easiest to record data at the initial location near the Canadian Duty Free Shop as trucks approached the bridge. Here, they were moving slowly and were most often single file. The next location was along the Concession Road ramp, approximately 0.45 miles from the initial location. The farthest point was at the Gilmore Road interchange, approximately 2.8 miles from the initial location. Here, trucks would pass at highway speeds and would often use both lanes, reducing the number of vehicles that could be effectively recorded. On several occasions, the queue actually approached quite close to the Gilmore Road location.

Of note on 5/22/01 was that some construction blocked the U.S. primary inspection booths for about 3 minutes shortly before 9 am. On 5/23/01, just before 5:30 pm, the IB-1 collector had to move to the highway location at Concession Road. Approximately 20 minutes later, the collector returned to the original location. On 5/24/01, the IB-1 collector again moved to Concession Road at 4 pm and remained there until about 5:30 pm.

The late afternoon and evening hours during the second week of data collection were more congested than during the first week of data collection. On 6/19/01, the IB-1 collector moved to Concession Road at 5:30 and then to Gilmore Road at 6 pm. The collector remained at the Gilmore Road location until the end of data collection at approximately 10 pm. On 6/20/01 the collector moved from the original location directly to Gilmore Road at around 4:30 pm and remained there until the 10 pm cut-off time. The collector did not have to move from the original location during the last day of collection, 6/21/01, which ended at 6:30 pm.

For all days of data collection, there were no weather conditions of note and the chosen locations for data collection proved to be well suited to the task. Of particular issue, however, was the difficulty in reading license plates beginning at early dusk. While the locations near the bridge facility provided ample lighting, the illuminated headlights of approaching trucks effectively blinded the data collectors until the split second before the truck passed their location. This proved particularly difficult for the IB-1 collector who was recording trucks passing in excess of 60 miles per hour. The binoculars that all data collectors used to some degree made the glare even more pronounced.

Statistics

Table 22 shows the baseline or "no delay" travel time, the average travel time, and three other measures that indicate the reliability of the travel time estimates. The baseline time (in minutes) is the time needed to travel the study distance (between the starting point in the exporting country and the initial inspection point in the importing country) in free-flow traffic conditions. The average time is computed from all vehicles measured during the data collection period over the study distance. The 95^{th} percentile time is the time (in minutes) within which 95 percent of all trucks can cross the border. The buffer time is the additional time above the average crossing time (in minutes) that it takes for 95 percent of all trucks to cross. The buffer index expresses the buffer time in terms of the average time and is the percentage of extra time that must be budgeted to cross the border within the 95^{th} percentile time. For example, if the average time was 10 minutes and the buffer time was 5 minutes, the buffer index would be 50 percent.

Table 22. Crossing Times

	Baseline Time	Average Crossing Time	95^{th} Percentile Time	Buffer Time	Buffer Index
Outbound	9.0	21.7	38.0	16.2	74.7
Inbound	8.3	21.5	83.4	61.9	265.7

From the table, it is apparent that, although the average travel time is similar in both directions, the reliability is significantly more favorable for outbound traffic than for inbound traffic.

Figure 8 illustrates the average travel time experienced for different truck volumes per lane per hour in each direction.

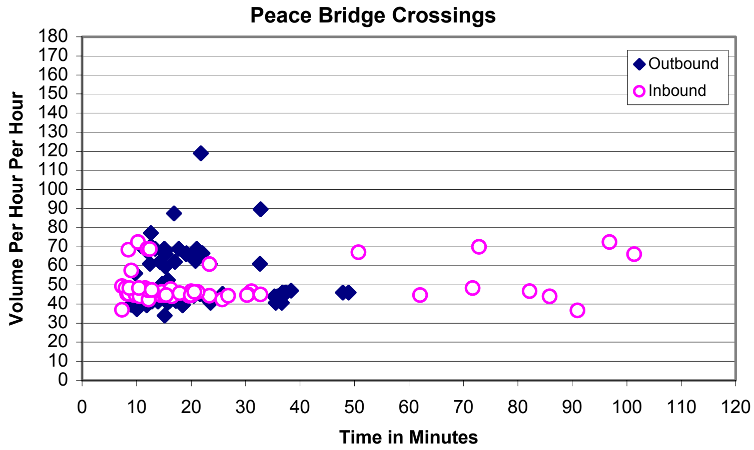

Figure 8. Average Travel Time for Different Hourly Volumes

Figures 9 and 10 show typical average hourly traffic volumes per booth for the study period as well as the measured average hourly travel times. In addition, the average number of open primary Customs booths in each direction is shown.

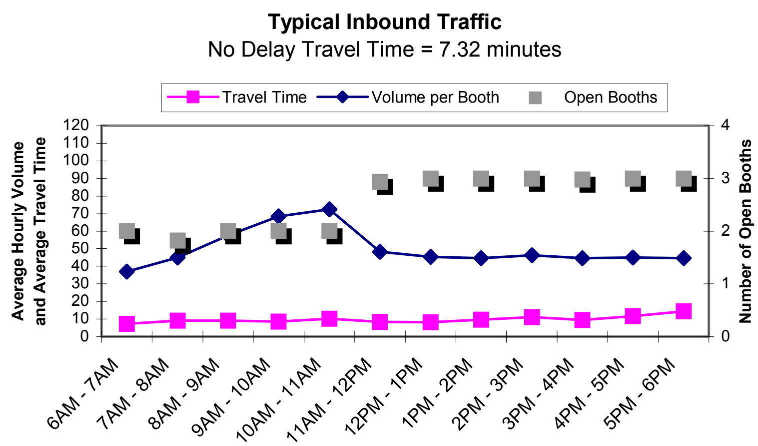

Figure 9. Typical Inbound Traffic

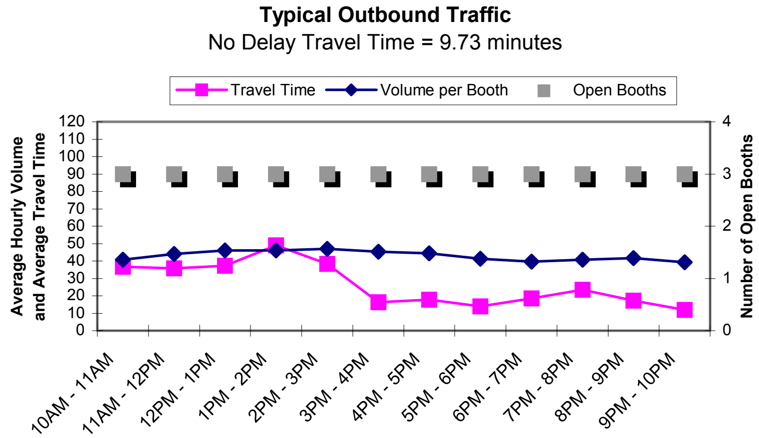

Figure 10. Typical Outbound Traffic

Conclusions

Lessons learned during data collection activities in this project at this site and at others along the Canadian and Mexican borders with the U.S. have identified several issues that should be taken into consideration to assist future data collection efforts. Some apply to advance planning and the initial site visit and others apply more specifically to the data collection activities themselves.

Planning and Site Visits

- Prior to conducting any data collection project, all jurisdictional and cooperating agencies should be made explicitly aware of the purpose and objectives of the study as well as all the details associated with the data collection project (e.g. dates, times, procedures to be followed during the data collection period, etc.). Failure to do so may result in confusion and possible delay of the study. This has been very time-consuming at some ports and should be adequately accounted for in the schedule. For some agencies, including U.S. Customs, it is important to contact both the federal and local levels. Some entities that should be contacted might not be readily apparent and can include construction companies working on public rights-of-way, state police, city officials, and Thruway Authorities. Some agencies provide verbal approval for the data collection and may even provide supporting documentation to their field staff, yet are reluctant to provide documentation for the data collectors to carry. Every effort should be made to obtain written authorization that can be carried by the data collectors, particularly from bridge authorities and immigration officials. Several times at some sites, the officer at the primary auto inspection booths asked data collectors to go to secondary inspection and speak with immigration officials. Although allowed to continue, this caused some unnecessary delay in the data collection.

- Prior to data collection activities, a general idea of traffic peak periods and conditions should be understood to optimize collection of appropriate traffic data and coverage of the appropriate times. This information should be obtained from discussions with knowledgeable officials and by examining historical traffic data.

- Any additional data needs should be discussed explicitly with the appropriate officials. At some crossings, for example, average hourly truck volumes are not normally recorded and maintained, but can be if special arrangements are made in advance. Alternatively, it may be appropriate to use other means to measure truck volumes, such as roadway counters or having the data collectors indicate the vehicles that pass without their license plates being recorded (assuming continuous data collection during each day). These additional traffic volumes could be used to corroborate data provided by the local authorities or used if their planned data collection did not occur or there was some other problem in providing the data.

- It is also important to be aware of special federal or local holidays on both sides of the border when scheduling data collections as these could affect traffic flows. Some minor holidays that occur on Mondays and Fridays, might not significantly affect traffic for a Tuesday through Thursday data collection period, but may increase the likelihood that key local officials will be on vacation and unavailable should any problems arise.

- When scheduling the data collection times, consider the availability of sunlight or high-powered lighting. It becomes increasingly difficult to read license plates at night as trucks approach with their headlights on (also a problem during rain) and entering the data into the PDAs also becomes more difficult when it is dark.

- Photographs of the border facilities and data collection locations should be taken during the site visits to assist in documenting the collection effort and to better inform the data collectors prior to their arrival on-site.

- Processing, data quality, and analysis of all traffic data require the largest portion of the study time.

<u>Data Collection Activities</u>

- Prior to data collection activities, an explanation and understanding of the procedures to be followed and logistics should be made clear to all members of the study team (e.g., number and location of license plate characters to be recorded, all commercial vehicles should be recorded, when and how to contact the on-site supervisor, etc.).

- Proper identification for all survey members and written documentation of authorization from all jurisdictional agencies should be carried at all times by all members of the study team, especially when conducting business in a foreign country.

- The supervisor should assess all conditions upon arrival for data collection to note any changes from the site visit or prior collection activities. Sometimes unplanned construction or other events may alter the preferred data collector locations or the truck flow patterns.

- While only one supervisor was originally planned for each data collection visit, it was determined that installing one supervisor on each side of the border was highly desired. One supervisor would be designated the overall site supervisor. This presented several benefits, the most important being added safety and security for the data collectors, particularly for a collector who needed to move to a remote location upstream from the border when the queue extended beyond their original location. Other benefits were increased awareness of current conditions and the origin of backups, the increased ability to relieve data collectors for breaks and lunch while maintaining continuous data collection, and assisting with data collection during exceptionally high-volume times or in difficult locations (such as remote spots along a highway when the vehicles were passing at free-flow speeds). Without the extra supervisor, a single supervisor would make repeated trips across the border to check on the collectors, relieve them, and provide them with food and drink if they were not conveniently located nearby. Border delays would often make this an extremely time-consuming process.

- For Mexican data collection, it is recommended that Mexican nationals be used, both as supervisors and as data collectors. This helps to enhance coordination with national, state, and local officials and to minimize the likelihood of immigration or other problems with federal, state, or local agencies.

- As mentioned above, the supervisors should be used to maintain nearly constant data collection during breaks. This improves data quality by ensuring the supervisors repeatedly observe each collector and can identify and correct any problems they might be having. Further, this improves the number of trucks matched at both the #1 and #2 locations, improving the sample size for analysis.

- Communication between the data collectors and their supervisors is crucial to an efficient and successful effort, particularly when one of the data collectors must move upstream past the end of a growing queue. Communication with the supervisor is also important when a data collector is having a problem with an official questioning their authority to do their work or when some other unexpected event occurs. For example, occasionally, there may be an anomaly with the data collection equipment and the collector can receive immediate instructions on how to proceed rather than having to wait until the supervisor next visits their location. Two-way radios (FRS-type with up to a two-mile range) and cell phones work adequately in most situations, but interference and range can limit their effectiveness. Cell phone service can be spotty near border areas. Additional longer-range communication options that do not require FCC approval should be considered for future collections. Obviously, when using cell phones, ensure that long-distance charges and roaming fees will not be significant costs.

- It is important to ensure that the data collectors are safe and comfortable during their long periods of collection. If their data collection locations cannot provide adequate cover from severe rains or heat, additional vehicles should be considered. Comfortable sport chairs with attachable beach umbrellas served to protect the collectors well during light rain and moderate sun. Ensure that the collectors have an adequate supply of water and that facilities are conveniently accessible. This becomes more difficult for the remote locations upstream from the border crossing.

REFERENCES

Turner, S.M., W.L. Eisele, R.J. Benz, and D.J. Holdener. *Travel Time Data Collection Handbook.Report.* No. FHWA-PL-98-035. Federal Highway Administration, Texas Transportation Institute, March 1998