Final Site Report

EVALUATION OF TRAVEL TIME METHODS TO SUPPORT MOBILITY PERFORMANCE MONITORING

OTAY MESA

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 – Otay Mesa Border Crossing

Site Description

The Otay Mesa Port of Entry (POE) connects San Diego, California and vicinity with Tijuana and Western Baja California, Mexico. On the U.S. side, the Otay Mesa crossing connects with State Route 905 (Otay Mesa Road), providing links to I-805 and I-5. The commercial traffic crossing the border at Otay Mesa includes a mix of agricultural products and supplies and finished products related to the Maquiladora (twin-plant) industry that is continuing to thrive.

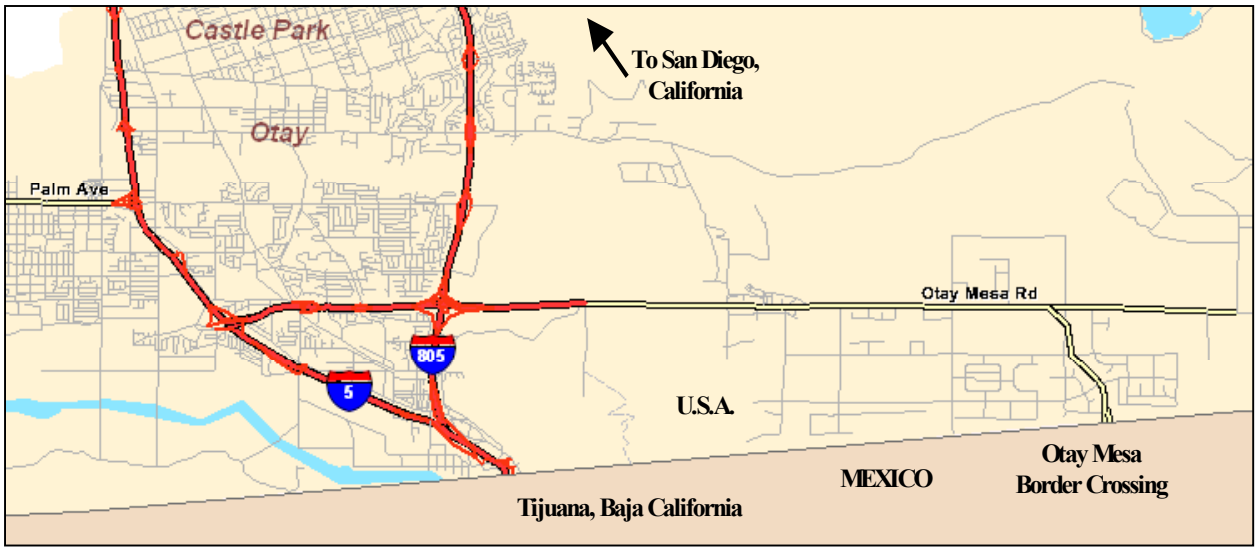

Figure 1. Area Map – Otay Mesa Border Crossing

Data collection activities at the Otay Mesa crossing occurred during July 17-19, 2001. Truck travel times across the bridge in both directions were recorded on Tuesday through Thursday each week, for the entire period during which the commercial crossing was open.

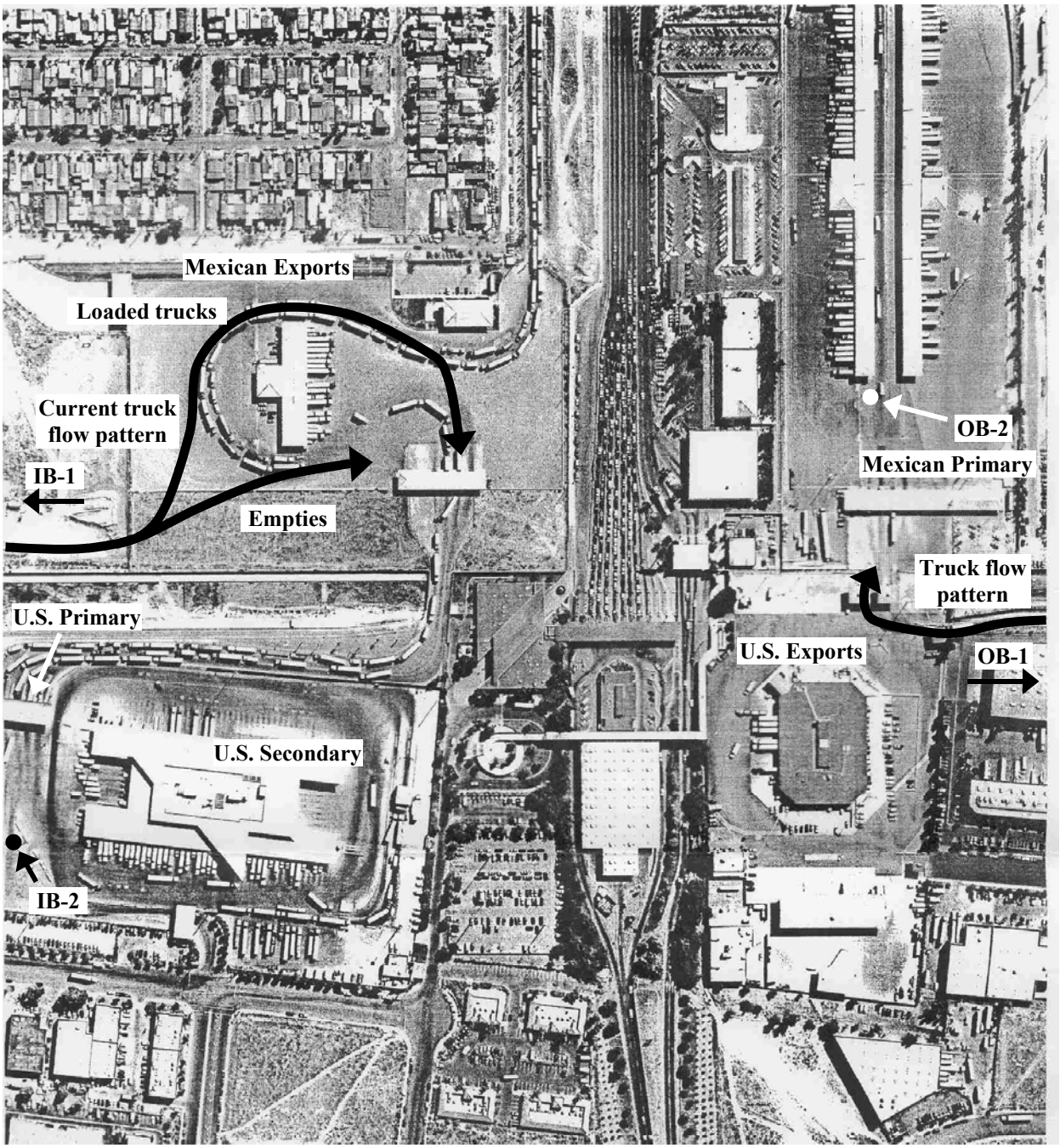

Figure 2. Otay Mesa Customs Plazas

Northbound (inbound) traffic heading to the U.S. travels westbound along Avenida Internacional, parallel to the border, as it approaches the Mexican Customs export compound. Once at the export compound, empty vehicles stay to the right while loaded vehicles loop around the secondary inspection facility to the left and pass through the primary export inspection. A small percentage of vehicles are sent back to the secondary export inspection. Only empty vehicles are processed from 6 am through 8 am during the week; all vehicles are processed from

8 am to 5:30 pm, while loaded vehicles are given priority; and from 6 until 8 pm, only empty vehicles are again processed.

When vehicles cross the border into the U.S., they then pass through the primary U.S. Customs inspection (see Figure 3). The two far right booths (as the trucks approach – to the left in Figure 3) are used to process both empties as well as certain pre-cleared vehicles. Up to five additional booths were used to process incoming vehicles. Trucks are then either released or sent to secondary inspection, which can include agricultural, immigration, as well as Customs inspection. In many cases, trucks are sent to secondary to complete the required brokerage paperwork and not for a physical inspection. Periodically, trucks leaving primary are detained in an area in front of the inspection booths in several lanes. Drug enforcement officers will move their dogs in and around the stopped trucks and then direct each lane to the exit or to secondary for additional inspection. After being cleared through the exit booths, all trucks pass through the state commercial vehicle enforcement facility. The California Highway Patrol maintains this facility but it also houses additional state inspection agencies.

Figure 3. U.S. Customs Primary Inspection Booths

Southbound (outbound) vehicles head south on La Media road toward the border where they make a left turn and travel adjacent to the border until they reach the U.S. Customs export facility. Certain vehicles, including tankers that need to be weighed, enter the export facility while others turn right and head directly through the U.S. export booths and into Mexico. On the Mexican side, they travel through the primary inspection booths (see Figure 4), where they are either cleared for release or sent to secondary inspection. Hours of operation for the Mexican commercial import facility are from 9 am to 5 pm. In-bond vehicles first visit a special,

segregated area for processing before they pass through the primary Mexican Customs inspection booths. They may remain in the in-bond area for hours, days, or occasionally, even weeks.

Figure 4. Mexican Customs Primary Inspection Booths

Data Collection Process

For this study, two data collection locations were used in each direction. The "number 1" location was at a point upstream from the first point where trucks might experience delay in approaching the border 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). Southbound movement from the U.S. into Mexico was referred to as outbound. Conversely, inbound was used to refer to northbound movement from Mexico to the U.S. The Outbound 1 (OB-1) position was at the intersection of Siempra Vivra and La Media Road and is approximately 1.5 miles from the crossing point (see Figure 5). The Outbound 2 (OB-2) position was after the primary Mexican Customs booths. The Inbound 1 (IB-1) position was where Avenida Internacional becomes a one-way, four-lane road toward the Mexican export compound (see Figure 6) and the Inbound 2 (IB-2) position was after the primary U.S Customs booths. IB-1 is approximately 1.75 miles from the crossing point. IB-2 and OB-2 are shown in Figure 2.

Figure 5. OB-1 Location, Facing South Toward the Mexican Border

Figure 6. IB-1 Location, Facing West Toward the Mexican Export Compound

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. Table 1 shows the data collection hours for each day during the two site visits. Each data collector actually worked about 12 hours, the supervisor could collect data during their 30-minute meal break during the day. However, the differing hours of operation for the two compounds allowed

the outbound collectors to relieve the inbound collectors after the outbound facilities closed each day. Data collection in the inbound direction on the third and last day was halted around 3:00 pm. This is discussed later in this report.

Table 1. Hours of Data Collection

Date	Start	End
Outbound		
7/17/01	9:00 am	5:00 pm
7/18/01	9:00 am	5:00 pm
7/19/01	9:00 am	5:00 pm
Inbound		
7/17/01	6:00 am	8:00 pm
7/18/01	6:00 am	8:00 pm
7/19/01	6:00 am	3:00 pm

While an extremely smooth process, it took considerable time to schedule and arrange the initial site visits to coordinate the data collection activities. The first meeting involved staff from Caltrans, where a similar data collection activity was discussed. A border liaison for Caltrans, Mr. Jose Ornelas, was instrumental in helping to coordinate two meetings with the U.S. and Mexican Customs officials, respectively, and additional follow ups.

It was determined that we would need to obtain GSA visitor passes for access to the U.S. compound and Mexican Customs visitor passes for access to the Mexican compound when we arrived for the data collection. We were assured that no additional authorization was required for the collectors who would be in Mexico from the senior Mexican Customs official; however, this was not the case, as will be explained later in this document.

The Caltrans Border Liaison assured that the regional U.S. Customs Management Center (CMC) was notified of our study and approved of it. He also arranged with the San Diego police department for permission to perform data collection at the IB-1 location and at a potential backup location at SR-905 should the queue of trucks back up past the initial location.

Table 2 contains a list of the individuals who were contacted and their telephone and e-mail information. Several individuals in Mexico who were not contacted for this study but who, it was learned, should be contacted for future collections are marked with an asterisk. However, any new project would require additional time to explain the data collection objectives to the involved parties and gain their approval. Also, Mr. Blackburn, the primary U.S. Customs contact, has since been promoted and is no longer at Otay Mesa.

Table 2. Agency Contacts

Contact	Agency	Phone/Fax	E-mail
Jose Ornelas Border Liaison	Caltrans	(619) 557-5360 ext.183 (619) 557-6188 (fax)	Jose_Ornelas@ dot.ca.gov
Stephen Blackburn Supervisory Inspector	U.S. Customs	(619) 671-8934 (619) 661-8115 (fax)	stephen.p.blackburn@ customs.treas.gov
Tom Carson	GSA	(619) 661-3238 (619) 661-3099 (fax)	tom.carson@gsa.gov
Lic. Julio Lamas Lamas Gracia Subadministrador de Operacion Aduanera	Aduana de Tijuana (Mexican Customs)	+52 624 22 00	
Antonia Rivera* Secretaria Gobernador	Immigration Dept. Tijuana	+66 83+61+01	
Ramon Madrigal*	Auth. Federal Vehicolos Legals, Tijuana		

* Should be contacted for future collection activities.

Data Collection Details

The U.S. Customs provided Border crossing statistical data. This data was evaluated for an assessment of the variability in travel conditions at the crossing. 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 Otay Mesa crossing, 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.

Due to project constraints, data collection needed to occur between late May and early September 2001. The FY 2000 data collection site report prepared by Caltrans indicated that July and September had the highest volumes and July was selected for the FY 2001 data collection. Subsequently obtained data, shown in Table 3, indicates there is some variation in the commercial traffic by month, with the lowest volumes in the winter months and the highest volumes in the summer months. Table 3 shows that the two months with the greatest average volumes during this data collection window were June and August with July having the third highest monthly volume.

Table 3. Monthly Traffic Distribution of Inbound Commercial Vehicles

Month	Truck Volumes
October, 1999	57,716
November, 1999	54,228
December, 1999	50,000
January, 2000	49,378
February, 2000	53,896
March, 2000	58,836
April, 2000	54,239
May, 2000	59,955
June, 2000	63,547
July, 2000	60,484
August, 2000	62,780
September, 2000	58,640
Total	683,699

Source: U.S. Customs data provided by Caltrans

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 the rest of the weekdays. Weekend traffic is 20.4 percent of typical weekday traffic and Monday traffic is 89.6 percent of typical Tuesday through Friday traffic. 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 July 2000

Day	Day of Week	Inbound
1	Saturday	817
2	Sunday	299
3	Monday	2,466
4	Tuesday	484
5	Wednesday	2,614
6	Thursday	2,712
7	Friday	2,793
8	Saturday	795
9	Sunday	281
10	Monday	2,643
11	Tuesday	2,616
12	Wednesday	2,801
13	Thursday	2,721
14	Friday	2,457
15	Saturday	664
16	Sunday	413

Day	Day of Week	Inbound
17	Monday	2,507
18	Tuesday	2,663
19	Wednesday	2,448
20	Thursday	2,663
21	Friday	2,476
22	Saturday	755
23	Sunday	255
24	Monday	1,837
25	Tuesday	2,833
26	Wednesday	2,748
27	Thursday	2,553
28	Friday	2,704
29	Saturday	767
30	Sunday	265
31	Monday	2,443
Total		57,493

Source: U.S. Customs

Table 5. Averages for Sample Month – Daily Traffic Distribution of Import Commercial Vehicles for July 2000

Day of Week	Week 1	Week 2	Week 3	Week 4	Week 5	Week6	Average
Sunday		299	281	413	255	265	303
Monday		2,466	2,643	2,507	1,837	2,443	2,379
Tuesday		484	2,616	2,663	2,833		2,704*
Wednesday		2,614	2,801	2,448	2,748		2,653
Thursday		2,712	2,721	2,663	2,553		2,662
Friday		2,793	2,457	2,476	2,704		2,608
Saturday	817	795	664	755	767		760

Source: U.S. Customs

*Data from Tuesday, July 4th was omitted from this average because of the unusually low volume during the holiday. The average for all Tuesdays is 2149 in July 2000.

From discussions with U.S. Customs and Caltrans, it was learned that backups typically did not occur on the U.S. side beyond the intersection of La Media and Siempra Vivra and, when they did, they did not grow very long. Occasionally, however, the backups would reach SR-905, several long blocks north and approximately one mile farther upstream, where the San Diego Police Department would divert additional trucks so that there would not be a backup on SR-905. However, on the Mexican side, backups were said to occur on a regular basis and could stretch to the initial inbound data collection location, approximately 1.5 miles from the crossing, and beyond.

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 through 6, the data collection sites were located at:

- An advance station located upstream of the commercial vehicle queue – IB-1 and OB-1.
- The import station (primary inspection booths before detailed, or secondary, inspection) – IB-2 and OB-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. Figure 2 shows the location of the Customs 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 Handspring Visor PDAs (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 PDAs 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 extend a short distance beyond the actual crossing area. However, on occasion the queue would extend onto the local road system. When this occurred, the data collector at the #1 location would have to move further from the crossing 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. During post-processing, the data from all locations nearer to the crossing 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 crossing.

The data collection team used both cell phones and hand-held, two-way radios 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 interference and cell tower locations created some problems with reception, each collector was usually able to use either their radio or cell phone 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.

Data Collection Equipment

As outlined in the "Data Collection Procedures" section above, Handspring Visor PDAs were used as the data entry device and proved adequate to the task. 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. The Handspring Visors use the Palm OS (operating system) and have faster processing speeds (at least in side-by-side comparison with this application) and larger screen sizes than comparable models from Palm Computing.

A custom application was developed for the Palm OS that allowed the data collectors to identify their locations (e.g., IB-1, OB-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.

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 U.S. Customs (inbound direction). Data from Mexican Customs have not yet been made available. Hourly volumes are used in the calculation of delay; those are shown with the delay calculations in Tables 8 through 13.

Table 6. Number of Commercial Vehicle License Plates Collected

Station	7/17/01	7/18/01	7/19/01
IB-1	1931	1972	1267
IB-2	2150	1977	1196
OB-1	1098	1140	1021
OB-2	1161	1120	1078
Total	6340	6209	4562

Table 7. Average Daily Traffic at Otay Mesa

Direction	7/17/01	7/18/01	7/19/01
Inbound	2847	2866	2742
Outbound	not avail.	not avail.	not avail.
Total	2847	2866	2742

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 IB-1 and IB-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.

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 Mexico to the U.S. early in the morning, later returned to Mexico, was missed as it re-entered the U.S. later in the day, and then recorded on its subsequent return to Mexico, 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 13. 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.
- Total Delay – The product of the hourly truck volume and delay per trip.

Table 8. Total Delay – 7/17/2001 – 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	6.28	2.33	50	6.67	0.38	158.00	60.57
7:00 – 8:00 AM	6.28	2.35	91	8.63	2.35	254.33	597.68
8:00 – 9:00 AM	6.28	4.36	138	14.72	8.43	231.67	1,953.72
9:00 – 10:00 AM	6.28	4.82	111	27.93	21.65	217.00	4,698.05
10:00 – 11:00 AM	6.28	4.92	104	24.20	17.92	228.00	4,085.00
11:00 – 12:00 PM	6.28	5.00	123	25.65	19.37	214.67	4,157.38
12:00 – 1:00 PM	6.28	5.01	110	30.47	24.18	235.67	5,699.21
1:00 – 2:00 PM	6.28	4.81	123	33.92	27.63	217.00	5,996.43
2:00 – 3:00 PM	6.28	5.88	116	38.93	32.65	228.00	7,444.20
3:00 – 4:00 PM	6.28	5.94	118	36.73	30.45	196.00	5,968.20
4:00 – 5:00 PM	6.28	5.00	129	49.55	43.27	228.00	9,864.80
5:00 – 6:00 PM	6.28	3.60	101	47.88	41.60	223.67	9,304.53
6:00 7:00 PM	6.28	0.93	55	14.68	8.40	135.00	1,134.00
7:00 – 8:00 PM	6.28	1.00	19	6.28	0.00	51.33	0.00

Table 9. Total Delay – 7/18/2001 – 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	6.28	2.27	38	6.38	0.10	158.00	15.80
7:00 – 8:00 AM	6.28	2.99	157	9.17	2.88	254.33	733.33
8:00 – 9:00 AM	6.28	3.00	93	29.87	23.58	231.67	5,463.47
9:00 – 10:00 AM	6.28	3.96	73	64.63	58.35	217.00	12,661.95
10:00 – 11:00 AM	6.28	5.80	57	69.98	63.70	228.00	14,523.60
11:00 – 12:00 PM	6.28	6.00	125	53.78	47.50	214.67	10,196.67
12:00 – 1:00 PM	6.28	6.00	122	61.03	54.75	235.67	12,902.75
1:00 – 2:00 PM	6.28	6.00	135	57.35	51.07	217.00	11,081.47
2:00 – 3:00 PM	6.28	6.00	105	57.02	50.73	228.00	11,567.20
3:00 – 4:00 PM	6.28	6.00	100	41.63	35.35	196.00	6,928.60
4:00 – 5:00 PM	6.28	5.96	46	51.88	45.60	228.00	10,396.80
5:00 – 6:00 PM	6.28	4.34	77	50.85	44.57	223.67	9,968.08
6:00 7:00 PM	6.28	0.87	78	19.42	13.13	135.00	1,773.00
7:00 – 8:00 PM	6.28	1.00	21	6.68	0.40	51.33	20.53

Table 10. Total Delay – 7/19/2001 – 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)
6:00 – 7:00 AM	6.28	2.05	58	6.37	0.08	158	13.17
7:00 – 8:00 AM	6.28	2.88	117	7.45	1.17	254	296.72
8:00 – 9:00 AM	6.28	3.41	119	19.82	13.53	232	3,135.22
9:00 – 10:00 AM	6.28	4.00	104	22.40	16.12	217	3,497.32
10:00 – 11:00 AM	6.28	4.98	108	33.37	27.08	228	6,175.00
11:00 – 12:00 PM	6.28	5.00	78	44.37	38.08	215	8,175.22
12:00 – 1:00 PM	6.28	5.92	87	45.33	39.05	236	9,202.78
1:00 – 2:00 PM	6.28	6.00	61	32.38	26.10	217	5,663.70
2:00 – 3:00 PM	6.28	6.08	6	64.15	57.87	228	13,193.60

Table 11. Total Delay – 7/17/2001 – 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	9.48	4.39	50	14.78	5.30	162	858.60
10:00 – 11:00 AM	9.48	5.00	85	20.48	11.00	200	2,200.00
11:00 – 12:00 PM	9.48	4.95	87	26.17	16.68	272	4,537.87
12:00 – 1:00 PM	9.48	5.00	81	41.03	31.55	261	8,234.55
1:00 – 2:00 PM	9.48	4.22	93	43.95	34.47	204	7,031.20
2:00 – 3:00 PM	9.48	4.00	102	26.80	17.32	234	4,052.10
3:00 – 4:00 PM	9.48	4.00	140	21.92	12.43	258	3,207.80
4:00 – 5:00 PM	9.48	4.64	133	20.42	10.93	344	3,761.07
5:00 – 6:00 PM	9.48	3.09	38	11.77	2.28	186	424.70

Table 12. Total Delay – 7/18/2001 – 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	9.48	4.69	30	10.95	1.47	162	237.60
10:00 – 11:00 AM	9.48	3.53	108	30.78	21.30	200	4,260.00
11:00 – 12:00 PM	9.48	4.55	102	19.43	9.95	272	2,706.40
12:00 – 1:00 PM	9.48	5.00	70	10.27	0.78	261	204.45
1:00 – 2:00 PM	9.48	4.25	114	9.62	0.13	204	27.20
2:00 – 3:00 PM	9.48	4.07	71	9.48	0.00	234	0.00
3:00 – 4:00 PM	9.48	5.00	127	9.75	0.27	258	68.80
4:00 – 5:00 PM	9.48	4.82	135	9.55	0.07	344	22.93
5:00 – 6:00 PM	9.48	ND	ND	-	-	186	-

ND – No data were recorded

Table 13. Total Delay – 7/19/2001 – 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)
9:00 – 10:00 AM	9.48	3.16	72	13.93	4.45	162	720.90
10:00 – 11:00 AM	9.48	3.00	107	12.80	3.32	200	663.33
11:00 – 12:00 PM	9.48	3.00	100	10.78	1.30	272	353.60
12:00 – 1:00 PM	9.48	3.00	84	25.58	16.10	261	4,202.10
1:00 – 2:00 PM	9.48	3.96	145	23.37	13.88	204	2,832.20
2:00 – 3:00 PM	9.48	4.00	24	14.30	4.82	234	1,127.10
3:00 – 4:00 PM	9.48	4.80	84	16.88	7.40	258	1,909.20
4:00 – 5:00 PM	9.48	5.00	90	17.62	8.13	344	2,797.87
5:00 – 6:00 PM	9.48	5.00	65	25.45	15.97	186	2,969.80

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 outbound direction.

Trucks moving inbound to the U.S. would often pull over while traveling along Avenida Internacional. Sometimes this was to meet with a broker who would arrive via passenger car or pickup to meet them. At other times, it appeared that the drivers were simply resting or performing minor maintenance on their vehicles. Since the IB-1 position was near the beginning of the paved one-way portion of the road, these trucks were often stopping beyond where their license plates were recorded. It was easy to identify those vehicles that remained parked for a

long time and remove them from the travel time analysis, but identifying those that stayed for shorter periods were harder to identify.

An attempt was made to identify the empty trucks entering the U.S. as it appeared that they used the two rightmost lanes. However, it was later determined that pre-cleared loaded vehicles also used those lanes so this was not factored into the analysis. However, it should be noted that loaded vehicles appear to have significantly longer processing times at the primary inspection booths.

As mentioned above, once trucks passed through the U.S. primary inspection booths, they were occasionally held by Drug Enforcement officers in several lines that could each contain five or more vehicles. This would occur six or seven times each day and would last for approximately 10 to 25 minutes each time. Also, on 7/18/01, there was considerable congestion from the exit booths in the inbound Customs compound for nearly one-half hour beginning at 11:14 am.

For outbound vehicles, backups would occasionally occur from where trucks exit the Mexican import compound onto the local roads all the way back to the primary inspection booths. While final paperwork is examined as trucks exit the compound, it is unclear whether this process or traffic on the locals contributed to the backups. This occurred on 7/17/01 at around 7:10; on 7/18/01 at around 10:20, 10:45, 10:55, 12:55, and 1:40 pm; and on 7/19/01 at 11:25, 12:45, and 5:00 pm. These backups usually only lasted for three to five minutes, but twice reached 10 to 15 minutes. Also on 7/18/01, the Mexican Customs computer system went down for approximately 20 minutes. When this occurs, all primary inspection booths are closed and the trucks back up on the U.S. side. In this instance, the backup reached and briefly passed the OB-1 data collection location but did not remain long enough to require the data collector to move farther upstream.

There were no weather conditions of note during the three days of data collection. 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 as they accelerated to speeds upwards of 40 miles per hour. The binoculars that all data collectors used to some degree made the glare even more pronounced.

The chosen locations for data collection proved to be well suited to the task. However, during the last day of collection, 7/19/01, the IB-1 collector was visited by Mexican Immigration officials who determined that work permits were required for data collection at that location, which was outside the Mexican Customs export compound. The supervisor and the IB-1 collector were brought to the Mexican Immigration offices adjacent to the San Ysidro crossing and detained for approximately five hours while the situation was reviewed and official documents were drafted. Ultimately, both individuals were officially deported from Mexico and were prohibited from returning to Mexico for one year. This underscores the need to contact all relevant agencies directly and not to rely on the understanding of any one agency.

Statistics

Table 14 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 95th 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 95th 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 14. Crossing Times

	Baseline Time	Average Crossing Time	95th Percentile Time	Buffer Time	Buffer Index
Outbound	9.5	19.1	36.9	17.8	93.2
Inbound	6.4	35.0	64.3	29.3	83.7

From the table, it is apparent that the average travel time is more favorable for outbound traffic than for inbound traffic. The buffer time, while larger for inbound traffic, is a smaller percentage of the average travel time, resulting in a lower buffer index.

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

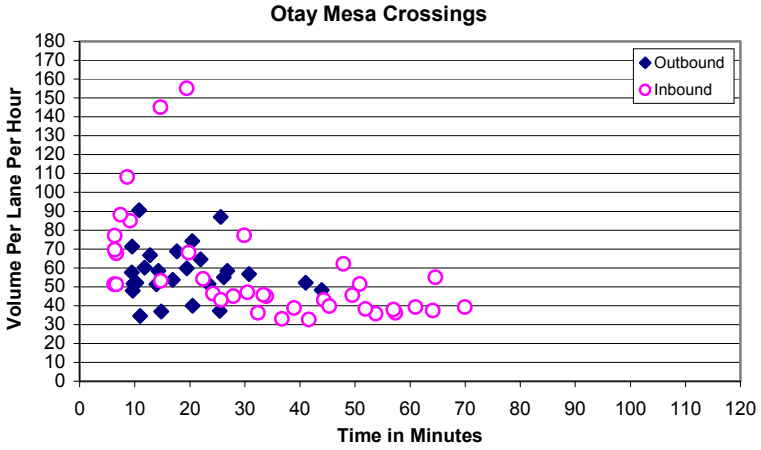

Figure 8. Average Travel Time for Different Hourly Volumes

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.

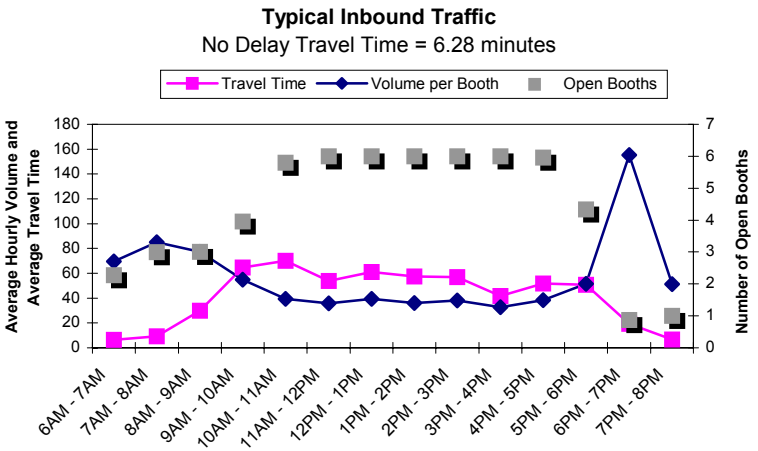

Figure 9. Typical Inbound Traffic

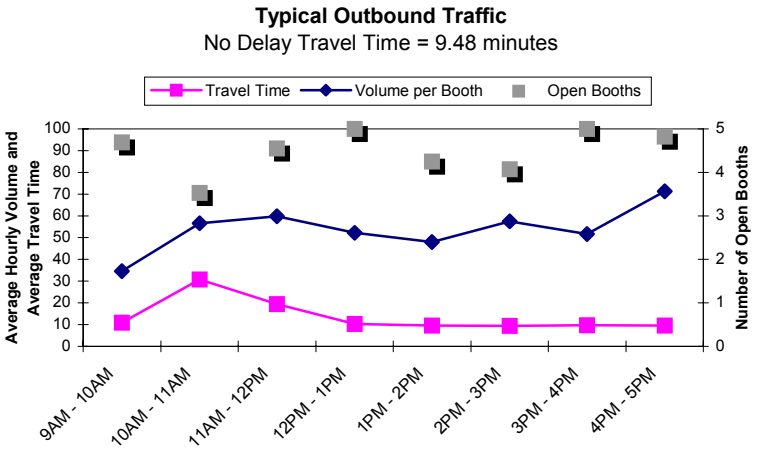

Figure 10. Typical Outbound Traffic

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.

Data Collection Activities

- 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