BINATIONAL BORDER TRANSPORTATION PLANNING AND PROGRAMMING STUDY

Task 13:
Estimating Border Crossing Utility

Prepared for
The Joint Working Committee

Prepared by
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La Empresa

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Final Report

BINATIONAL BORDER TRANSPORTATION PLANNING AND PROGRAMMING STUDY
TASK 13 REPORT: ESTIMATING BORDER CROSSING UTILITY

This report is the continuation of the Task 9 effort, in which six case studies of commercial border crossings were conducted in order to determine problems in efficiency that affected the commercial roadway transportation crossing the border between the United States and Mexico.

The objective of this report is to indicate the type of information that is required to analyze the border crossings and to supply the techniques by which a transportation specialist or engineer could conduct the required analysis to improve the operational efficiency of transportation at a border crossing between the United States and Mexico. At the same time, this report provides the outline to establish the capacity of a commercial border crossing according to its critical components and a recommended process for designing the required infrastructure for a new commercial border crossing.

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Preface

U.S./Mexico Binational Border Transportation Planning and Programming Study implements a significant binational policy making document entitled “Memorandum of Understanding on the Planning Process for Land Transport on Each Side of the Border” signed by the federal governments of Mexico and the United States at the first “NAFTA Transportation Summit” held in Washington, D.C., April 29, 1994.

The purpose of this study is to provide policymakers with information needed to establish a continuous, joint, binational, transportation planning and programming process. A goal of this study is to improve the efficiency of the existing binational policy making planning procedures and funding criteria affecting our Border Land Transportation Systems (BLTS). The BLTS should be seen as a binational transportation system made of international bridges and border crossings and land connections to major urban and/or economic centers, principal seaports, airports and multimodal/transfer stations, and ultimately, to national transportation facilities.

Disclaimer

The purposes of the Binational Planning and Programming Study and all of its reports were: to investigate current state and national transportation planning processes in both the United States and Mexico, to review available data on border transportation infrastructure and goods movement, and to recommend an ongoing, binational planning and programming process. The information contained in these reports was not developed to serve as the basis for making funding allocation or distribution decisions at either the federal or state level in the United States.

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13.1. Introduction

This report provides information and techniques which will enable an experienced transportation planner or engineer to obtain data and perform analyses needed to assess the transportation operational efficiency of a commercial border crossing system along the U.S.-Mexican border. The material in this report builds upon information developed in prior tasks, especially Task 9, case studies of commercial border crossings at six ports of entry.

13.1.1 Purpose

The purpose of this task was to:

- provide procedures and methods to conduct future case studies of commercial (truck) border crossing transportation operational efficiencies,
- identify critical components of a commercial roadway border crossing,
- demonstrate relationships between operations and physical and policy characteristics,
- develop and demonstrate a procedure for assessing the transportation capacity of a commercial border crossing and its critical components, and
- provide guidelines on the data to be assembled for such analyses.

13.1.2 Factors Affecting Border Crossing Efficiency

Four principal factors affect commercial border crossing efficiency:

- Demand -- the number of commercial vehicles crossing the border (daily or at peak hours). Demand varies by hours of operation of the inspection stations, time of day, season of year, and by local shipping practices, schedules, and sometimes traffic conditions. These variations need to be established based on locally observed or projected conditions.
- (Processing) capacity -- the number of vehicles which can be processed or passed through a component of the border crossing system during a given period of time (usually an hour). Capacity is usually based on the number of units (e.g., lanes, inspection docks) and the processing rate in vehicles per hour.
- Queues -- the number of vehicles waiting to enter the next component of the border crossing process. For the purposes of this report, a queue is the cumulative difference (excess) in the demand and the number of vehicles processed starting from a time of full capacity operation.
- Movement conflicts -- conflicts between vehicles circulating or entering or leaving an inspection dock within a border inspection facility (called a border station or inspection compound). This is more a factor of site layout and traffic patterns and control than a simple result of numbers. It is normally assessed at the time of design or during actual operation.

While there are many elements which make up these four factors, all eventually can be expressed in these terms.

What is presented in this report is a flexible process which will enable an experienced transportation planner or engineer to conduct an analysis of an existing or proposed border crossing by analyzing the critical components which normally most heavily influence border crossing movement efficiency. It should be recognized that some characteristics of individual crossings may not be described in this report. However, the most influential factors of border crossings as of late 1997 are discussed.

Chapter 2 describes the component parts of commercial border crossing systems. It is important to understand that the inspection processes and even the road systems serving the crossings are different in many cases. Chapter 3 summarizes the pertinent findings from the case studies which can be applied to future analyses. Chapter 4 is a discussion of how to estimate the capacity of commercial border crossings. Chapter 5 discusses how the case study approach and techniques can be applied to other existing locations. Chapter 6 describes the analysis model which can be used for future case studies and in sizing future border inspection facilities. Chapter 7 presents a set of general planning guidelines for new border facilities. Finally, Chapter 8 outlines the individual steps required for conducting a case study for either an existing or new facility.

13.2.
Commercial Border Crossing Systems

13.2.1 Commercial Border Crossing Components

Commercial vehicles cross the international border by passing through inspection locations and in some locations, toll booths. While at first glance it appears that the U.S. and Mexican border stations each function as independent units, these stations are really a group of separate inspection and circulation elements which make a system.

The components of a typical border crossing are described below and shown on the diagram in Figure 13.13.1. Not all of these components are present at every commercial crossing. They are listed below in the order in which they are usually encountered during a crossing. In some cases some components may be located "off line" or off to the side where they are not on a direct path from beginning to end. In such cases these components may be bypassed if an inspection of that type is not required. These off line inspections are identified in the following descriptions. Figure 13.13.2 shows a sketch of a typical crossing including all components. The numbered locations correspond to the crossing system component descriptions which follow.

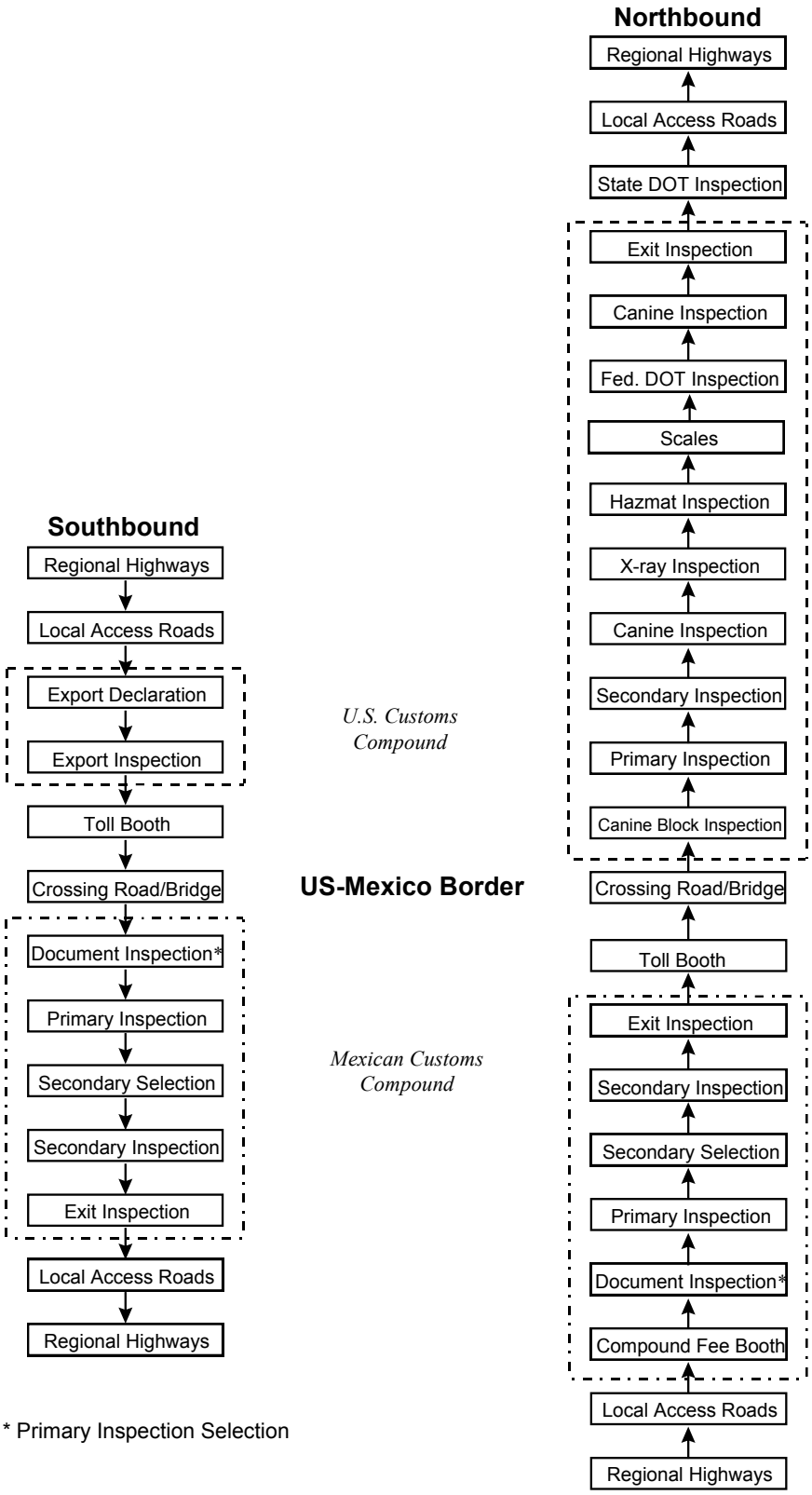
13.2.2 Southbound (United States to Mexico)

All loaded commercial vehicles entering Mexico and all vehicles being imported into Mexico are subject to the commercial vehicle inspection process described below. Empty commercial vehicles are processed with personal vehicles at separate locations.

Regional access highways (U.S.) (designated S1 on Figure 13.13.2). Regional highways bring trucks from a major highway system to the immediate border area. These usually are major roads serving intercity travel as well as major flows in the vicinity of the border. Regional highways serve as border access routes for trucks moving from beyond the immediate vicinity of the border to the crossing. It is generally desirable to serve as much of the non-local truck trips as possible using the regional highways. Stated another way, it is desirable to have the regional highways connect as directly as possible to the border crossings. This is a location issue. The farther from a regional highway a crossing is located, the more truck travel must be made on local streets.

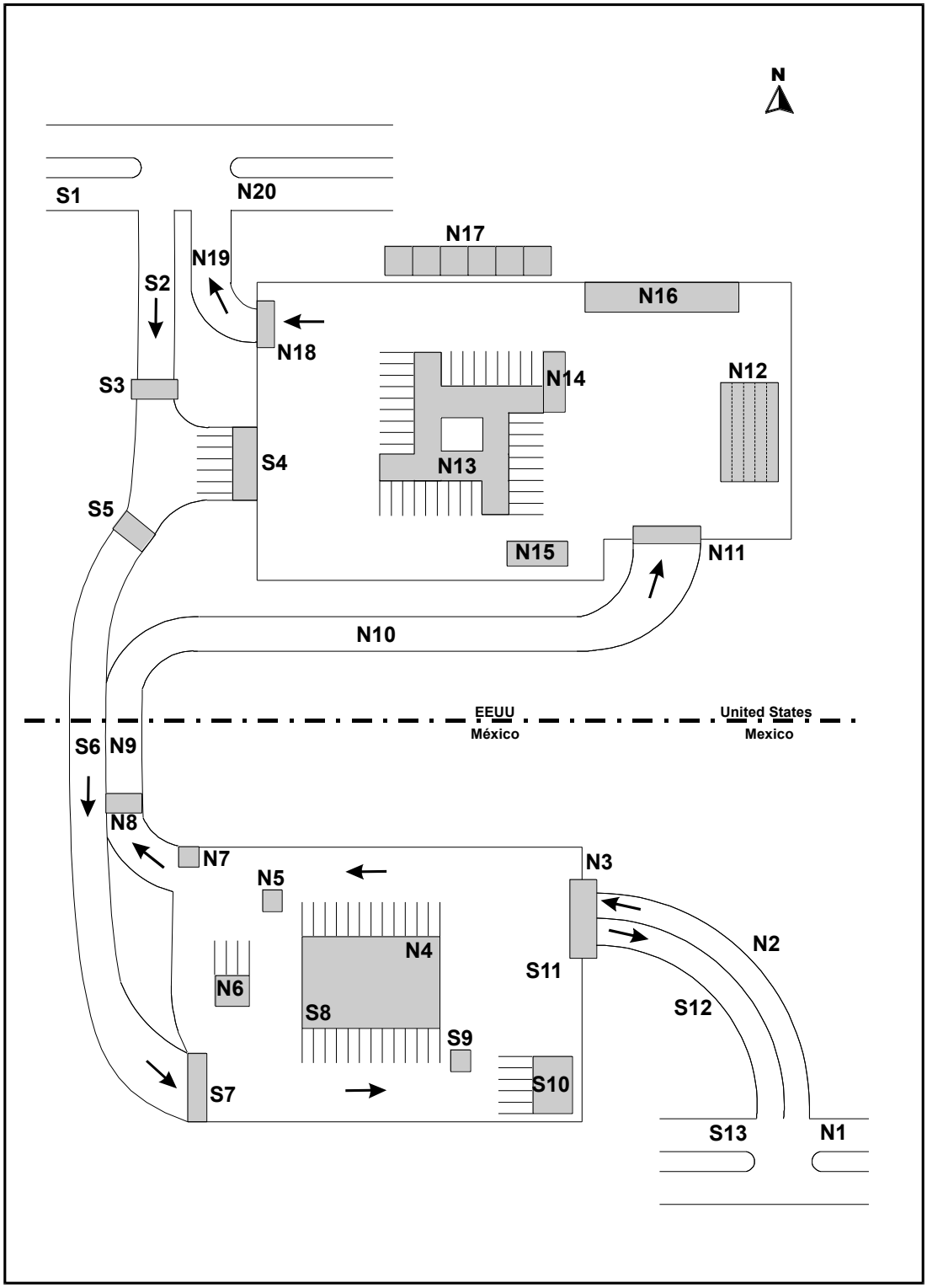
Local access roads (U.S.)(S2). These roads connect regional highways to the border crossings. They may be major streets, but they generally serve relatively local movements. While some are intended to serve border access functions, some are not and do not serve high volumes of trucks very effectively. The capacity of the local access streets can affect the time required to cross the international border if the capacity of the local street is insufficient to handle the total volume. In some cases the streets approaching the border crossing must also serve as a queuing or holding area for trucks waiting to enter to first inspection or toll collection facility. If insufficient queuing space is provided, vehicles back up and block driveways or street intersections and cause delays (such as the case in Laredo, Brownsville, and Eagle Pass).

Figure 13.1 US-Mexico Generic Trade Flow



Source: Barton-Aschman - La Empresa, 1997

Figure 13.2 Commercial Border Crossing Components



Source: Barton-Aschman - La Empresa, 1997

Export declaration collection (U.S.)(S3). All border crossings have a facility where export documentation can be either inspected or submitted. For example, at Ysleta there is a drop box where export documentation is dropped; it is unstaffed. At Otay Mesa there is a booth where the documentation is submitted. Some crossings do not have such provisions. The shipper's export declaration (SED) form is required by the International Trade Administration which is an agency within the U.S. Department of Commerce-Bureau of the Census. The SED provides statistical information on cargo crossing the border and is used for the payment of any export taxes which may be required. Most U.S. Customs brokers participate in the Paperless Export Monthly Reporting Program which eliminates the need for paper to exchange hands at the border crossing. If the SED is submitted at the crossing, this step in the process typically takes just a few seconds and should not in itself be a crossing capacity constraint. Location and design of the drop box or booth can cause movement inefficiency (e.g., turn constraints, ease of maneuvers) just as any other feature can. Where used, this is a step through which all trucks must pass and any constraints would affect the total crossing time.

Export inspection area (U.S.)(S4). Export inspections may also be made by U.S. inspection agencies. However, of the case study locations, only Ysleta and Otay Mesa had formal export inspection facilities where cargo could be unloaded for inspection; however, these facilities are unused at the present time. If used, the important capacity features of these facilities are (1) the number of dock spaces as it relates to the percentage of trucks which are inspected there and the average inspection time and (2) the circulation and maneuvering space in the vicinity of the inspection area. This second factor affects the time spent backing into the docks (for those trucks to be inspected) and can cause delays to passing trucks which might occur due to movement conflicts.

Toll booth (U.S.)(S5). At toll crossings most tolls are collected on the approach end of the bridge. Tolls are collected from all vehicles. Trucks stop to pay with cash or tokens, or show identification for payment by corporate account. In the future it is anticipated that electronic toll collection may be used for trucks, but this is not now in place. Toll booths are usually preceded by queuing areas for waiting vehicles. The number of toll booths and the average processing time are the key factors affecting capacity. However, adequacy of queuing areas also affects total operational efficiency. Queues extending beyond the queuing area can back into the preceding inspection facilities or street. This can block movement and therefore stop upstream traffic and inspections.

Crossing road or bridge and U.S.-Mexican border (S6). The next step is to cross the border on a road or bridge. The constraint is the number of lanes. Rarely is the crossing road a constraint because the crossing road itself does not require stops. Those are introduced by the toll booths or inspections. At many of the border crossings traffic can often be seen stopped on the bridge or crossing road which makes it appear that the road or bridge is the constraint. Usually those vehicles are queued back from an inspection or toll booth which is the actual cause of the delay. Since the crossing road must be used by all vehicles moving through the border crossing, any road or bridge capacity constraint would affect the travel time of all crossing vehicles.

Document inspection and primary inspection selection (Mexican)(S7). After crossing the border vehicles then enter the Mexican inspection compound. The first step in the Mexican inspection process is inspection of documents. This is required for all vehicles using commercial crossings and takes only a few seconds. At the same time the SAAI (the computerized random selection system) randomly selects vehicles for primary inspection. The current policy is to select approximately ten percent for inspection. While this process takes very little time, the number of booths/lanes and the average processing times affect capacity. In some cases too few booths are open during peak demand periods and queues develop. Therefore, queue space is also a

critical design characteristic. When insufficient queue space is available "on site" at the inspection compound, vehicles queue on the crossing road or bridge and can block the bridge, the approach roads or booths. This occurs at several of the case study locations. Bridge damage can result from the vibration of idling trucks, queuing is these locations is not desirable.

Primary inspection (Mexican)(S8). Vehicles selected for primary inspection proceed to the primary inspection platform where they back into a dock. The area consists of the platform and parking and maneuvering area. There is also circulation space required for trucks to pass this area if they are not being inspected. Capacity variables are the number of dock spaces and the average inspection duration as they relate to the number of vehicle to be inspected. Constrained maneuvering space can delay passing trucks and increase time to back into docks. If not enough dock spaces are available, trucks must wait for a space. This either congests the circulation area (if waiting spaces are not available) or causes the inspectors at the document inspection booth to slow down (or stop) processing at that location. Delays due to primary inspection constraints primarily affect only those vehicles being inspected unless they cause document inspection to be slowed down.

Secondary selection (Mexican)(S9). Papers from primary inspection are reviewed and approximately ten percent of the vehicles are selected for secondary inspection. All other vehicles pass this point without stopping. This inspection is a re-inspection for quality control purposes. The selection process takes only a few seconds; it is almost never a constraint since it only involves vehicles which have had a primary inspection.

Secondary inspection (Mexican)(S10). Selected vehicles then proceed to the secondary inspection platform which is either separate or at the end of the platform used for primary inspections. Vehicles not selected for this inspection proceed to the compound exit. The capacity/efficiency factors and impacts for this inspection are the same as for primary inspection. This inspection will become obsolete due to recent changes in Mexican law. Under the new law, the private agency that currently performs secondary inspections will perform 40 percent of the primary inspections. The existing primary inspection areas must be divided into two separate areas to accommodate the changes in operation. Without these modifications there will be serious congestion at some locations due to insufficient inspection space to handle the two inspection groups, such as at Nuevo Laredo, Nogales, and Matamoros.

Exit inspection (Mexican)(S11). All vehicles must pass through the exit booths where the documents are again inspected. Vehicles wait in a queuing area prior to the booths. Document inspections usually are completed in less than a minute, then the trucks leave the inspection compound. The number of booths and the average processing time as related to the number of trucks to be processed are the critical capacity factors. However, the layout of the exit area is also important. Truck turning capability, especially where there are multiple exit lanes, is important as is queuing space. If insufficient queuing space is provided, vehicles can back up into the inspection area and slow down trucks entering and exiting the inspection platforms.

NATAP lane. NATAP (North American Trade Automation Prototype) is a program to expedite trucks crossing the border. Trucks which have been cleared in advance are sealed and given documents which let them cross the border without further inspection, other than showing documents. These documents are shown only at the entrance and exit of the inspection compounds. In order for NATAP to work effectively, vehicles cleared under this program must be provided a bypass lane which permits them to bypass queues outside and inside the inspection facilities. The NATAP lanes would be located next to the regular lanes. There would be separate booths at the compound entrance and exit for NATAP trucks.

Local access roads (Mexican)(S12). See local access roads above.

Regional access highways (Mexican)(S13). See regional access highways above.

13.2.3 Northbound (Mexico to the United States)

All northbound commercial vehicles must pass through the following components. There is no exemption for empty vehicles as there is southbound. Personal vehicles are inspected at a separate location or part of the border station.

Regional access highways (Mexican)(N1). See regional access highways above.

Local access roads (Mexican)(N2). See local access roads above.

Compound fee booth (Mexican)(In advance of N3). This booth collects tolls to cover the cost of improvements made at the Mexican border station. The fee booth is also the entrance to the Mexican inspection compound. At present Ysleta/Zaragoza is the only location with such a fee booth. See S5 above for description of capacity/efficiency factors and affects.

Document inspection and primary export inspection selection (Mexican) (N3). This is the entrance to the Mexican inspection compound at all commercial border crossings (other than Zaragoza). Export documents for all vehicles are inspected at this booth to make sure export taxes have been paid. Under the current policy, approximately two percent of the vehicles are selected randomly for a primary inspection. The remainder of the vehicles pass through the compound to the exit. This process typically requires less than a minute. See S7 above for description of capacity factors and effects.

Primary export inspection (Mexican)(N4). Same characteristics and effects as S8 above. This component only effects those trucks selected for inspection.

Secondary export inspection selection (Mexican)(N5). Same characteristics and effects as S9 above. About ten percent of vehicles completing primary inspection are selected for secondary inspection which is about one percent of all northbound trucks.

Secondary export inspection (Mexican)(N6). Same characteristics and effects as N4 above, with only a tenth of the impact.

Exit inspection (Mexican)(N7). Same characteristics and effects as S11 above. At many of the Mexican facilities there are no formal controls at the exit.

Toll Booth (N8). Same characteristics and effects as S5 above.

Crossing road or bridge and U.S.-Mexican border (N9). Same characteristics and effects as the S6 in the southbound crossing described above.

Canine inspection and primary inspection queuing area (U.S.)(N10). This area is used for queuing of commercial vehicles waiting to enter the U.S. inspection compound via the primary inspection booths. These areas are often over capacity resulting in queues that extend over the bridge or crossing road into Mexico. In some cases the Mexican inspections are slowed down because there is no place for the vehicles to go. At some locations canine inspections for contraband are conducted in these queuing areas which introduces another inspection process into the system. The canine inspections may stop or slow the flow of trucks to the U.S. primary booths. The result may be to reduce the net processing rate at primary inspection and increase average travel times. Opportunities to eliminate this constraint are discussed in the Task 9 report. The effect of insufficient queuing space is described under S7 above.

Primary inspection (U.S.)(N11). This is the entry to the U.S inspection compound. All vehicles go through this inspection. Each vehicle driver presents documentation at this point to be reviewed. This inspection typically averages 1 to 2 minutes. Vehicles are selected for

secondary or auxiliary (e.g., agricultural, x-ray, hazardous materials) inspections. Vehicles not selected for another inspection proceed directly to the exit. The U.S. primary inspection is most often the bottleneck in the northbound direction. Like other booth inspections, the number of (open) booths and the average inspection rate, as related to the volume of trucks to be processed, affects the capacity and movement efficiency. Often a sufficient number of U.S. primary inspection booths exist, but not enough are open to meet demand. The number of booths being operated at any given time is an important aspect to observe when making field checks and collecting operational data. All vehicles are affected by any constraints/delays at this inspection point.

Canine block inspection (U.S.)(N12). At some U.S. border stations the canine inspections are conducted in an area just beyond the primary inspection booths. When located out of the way of circulating traffic (as they should be), they have no impact on circulating vehicles and therefore affect only the vehicles being inspected. However, if the blocks constrain circulation, they may reduce primary inspection processing rates or add travel time for circulating vehicles. The later is difficult to quantify except by actual field observation.

Secondary inspection (U.S.)(N13). These inspections are conducted at a platform where vehicles can be unloaded. The characteristics and effects are as described for S10.

Scales (U.S.)(N14). Some trucks are weighed as an auxiliary inspection. Scales are usually "off line" (out of the way of circulating traffic). If this is the case and queues do not block circulating traffic, only the few trucks that are weighed are affected. However, location of scales can introduce conflicts with circulation patterns (scale queues extend into circulation lanes) and result in delays to passing vehicles. This can be quantified with field observations.

X-ray inspection (U.S.)(N15). Vehicles may be run through an x-ray machine in an off-line location. Processing times are long and queues usually develop. Hence, an adequate queuing area is needed. Sometimes queues overflow and block internal circulation, introducing delays to passing vehicles. Otherwise only the vehicles being x-rayed are affected. The average x-ray processing time and the number of machines, as related to the number of vehicles to be x-rayed, are used for capacity and efficiency assessments, respectively.

Hazardous material (Hazmat) inspection (U.S.)(spill containment facilities are usually off-line at a remote edge of the compound). Trucks carrying hazardous materials are typically inspected for safety (U.S. and Local Environmental Protection Agencies and Departments of Transportation) as well as for contraband. Hazmat spill containment areas are usually located away from other active areas of the compound. In most of the newer facilities two containment spaces are provided for trucks leaking potentially hazardous materials.

Federal DOT inspection (U.S.)(may be at any off-line location). A safety inspection may be conducted at these sites, although few inspection facilities currently are equipped. Usually there are one or more bays or berths. The capacity is based on the number of inspection spaces and the average inspection time. Conflicts with circulating vehicles or queue overflows may introduce delays to passing vehicles, but this is rare.

Space for trucks waiting for additional documentation (U.S.)(N16). Some trucks approach the inspection facility with incomplete documentation. They cannot return to Mexico due to the one-way northbound flow. Instead they are held along the perimeter of the compound (or sent to an impoundment lot) until the necessary documentation arrives. Figure 13.2 shows one typical location for these areas, but they may be placed anywhere "out of the way." They have no effect on capacity or travel time unless they obstruct a circulation lane or maneuvering space. There is no way to establish a typical waiting time or number of trucks which may have to wait, but the highest number of waiting trucks observed at any one time during the case studies was less

than one percent of the daily volume. If correctly located out of circulation and maneuvering areas, they should have no effect.

Canine inspection (U.S.)(may be located in the exit queue approaching N18). Canine inspections also may be performed in the exit queue. If done this way, they usually cause delays to exiting vehicles since they stop the flow of trucks to the exit booth. These inspections should be conducted off-line. If not, their impact on exit inspection processing times should be assessed. These inspections may also cause exit queues to extend into the secondary or auxiliary inspection areas. This may impede maneuvers to and from docks or slow internal circulation. Such impacts have to be determined from field observations. Vehicles being inspected and those passing the location may be affected.

Exit inspection (U.S.)(N18). All vehicles must stop at the exit inspection booth to have documents reviewed. This is usually done very quickly (less than a minute). The characteristics and efficiency effects are the same as described for S11. Sufficient exit queue space should be provided.

State DOT inspection (U.S.)(usually on a separate site or may be at an off-line location within the inspection compound). Some or all vehicles may have to pass through this facility where they exist. This depends on state regulations. The average processing time and number of lanes or spaces determine capacity. Capacity related to demand determines efficiency. For off-site locations the precise inspection regimen needs to be analyzed since they vary by state and facility. At on-site locations they can be evaluated the same way as a federal DOT inspection location.

NATAP lane. See description for southbound components.

Local access roads (U.S.)(N19). See S12 above.

Regional highways (U.S.)(N20). See S13 above.

13.2.4 The Components As A System

The border stations are not only composed of several discrete elements or components; the components also interact insofar as vehicle movement is concerned. At most of the existing border crossings, system components are located one after the other — in series. As a result, when one inspection or movement component functions quickly or slowly, it affects the rate at which the adjacent (upstream and downstream) components operate.

The speed of movement through a border crossing generally is controlled by two factors:

- the time required for the actual inspections to be completed
- time spent waiting to start the inspections

Circulation and maneuvering time is usually very short compared to the two above items.

The inspection time is dictated by the type of load being inspected, prior inspection history for the carrier, findings of the inspection, local border station inspection history and priorities, and random chance. The decision to conduct more thorough inspections is made by the various inspection agencies and is not considered part of transportation efficiency. The inspections themselves are also not part of transportation movement or efficiency. Only the time spent (1) approaching the border station, (2) moving from one component to the next, and (3) departing the station are considered in assessing transportation efficiency. Inspection times are taken as a given and used only to help size facilities so the total time in the border station can be minimized by reducing delays caused by poorly designed or inadequate facilities.

13.3.
Applicability of Case Study Findings To Predict Capacity and Efficiency

The Task 9 report summarizes the findings of the case studies of border crossings at six ports of entry. While many of the findings are location specific, several are generally applicable to analyzing capacity and efficiency of U.S.-Mexican commercial border crossings. This chapter summarizes widely applicable findings.

13.3.1 Vehicle Processing Rates and Unit Capacities

Each component of a border crossing system has a rate at which vehicles can be processed or passed through and a number of "processing" units (e.g., inspection booths, dock spaces). The components either accommodate an inspection activity or movement of vehicles between inspections.

Queues result when an inspection component cannot process enough vehicles to keep up with demand. When the deficiency is significant, queues increase (queues of 200 trucks and more were observed at times at two case study locations). This, in turn, leads to the perception that the problem is in the queue area. However, the real constraint is usually the inspection component. If it has sufficient capacity only minimal queues will develop.

The Task 9 case studies included collection of operational performance data for the border crossings studied. Table 13.1 summarizes those findings. While there is some variation between crossings, in most cases the findings are consistent. Where significant differences exist, they are usually explained by local conditions. See the Task 9 report for further details on the performance data.

Table 13.2 shows the average or typical processing rates derived in Task 9. These rates were used to establish unit capacities for those system components for which operational data was collected. (Traditional capacity analysis procedures can be used for determining street and highway capacity for the access roads).

The capacities in Table 13.2 should be used for border crossing analyses unless new data shows significant differences or local conditions warrant other values.

13.3.2 Arrival Rates

Operating hours

Commercial border crossings can be made only when the border stations are open. None of the U.S.-Mexican commercial crossings are open 24 hours per day. The northbound and southbound hours of operation are not necessarily the same since the empties and bobtails (tractors without trailers) are not inspected in the southbound direction. Most commercial crossings are operated between 11 and 16 hours per day in the northbound direction and between 9 and 12 hours in the southbound direction. (These are the hours during which commercial vehicles may cross. The facilities may be open additional hours for document processing). Facility opening is usually between 6am and 8am Monday through Friday. Most of the case study sites were open on Saturdays typically with restricted hours. A few of the facilities were open on Sunday for a limited number of hours or for special types of cargo.

Table 13.1
Summary of Processing Rates and Capacities (US and Mexico)

	Nogales-Nogales	Laredo-Nuevo Laredo	San Diego - Tijuana	El Paso - Ciudad Juarez	Brownsville - Matamoros
Crossing	**Mariposa**	**Bridge II**	**Otay Mesa**	**Ysleta**	**Gateway/B&M**
Northbound Direction					
Vehicle Classification					
Total Trucks (All vehicle types)	1050	2560	2100	980	750
Tractors without Trailers (Bobtails)	60 / 7%	1075 / 42%	420 / 20%	70 / 7%	95 / 12%
Tractor Trailers and Single Units	970 / 93%	1485 / 58%	1680 / 80%	910 / 93%	655 / 88%
Truck Inspections					
Average Primary Inspection Time (min)	1.00	1.00	1.50	3.25	1.50
Primary Lanes (no. used of total)	3 of 4	3 of 4	5 of 6	4 of 6	2 of 4
Estimated Primary Capacity (veh/hr)	180/240[1]	180/240	200/240	70/110	80/160
Secondary Inspection Percentage	na	13%	46%	30%	53%
Average Secondary Inspection (min/veh)	35	28	46	110	24
Average Crossing Times					
Processing within Compound (min)	na	24	26	40	12
Queue/Wait Time (min)	na	31	39	120	18
Total Crossing Process + Queue (min)	51	55	65	160	30
Southbound Direction					
Vehicle Classification					
Total Trucks (Loaded Trucks Only)	400	1590	1300	1150	695
Tractors without Trailers (Bobtails)	na	na	na	na	na
Truck Inspections					
Document Inspection (minutes)	1.0	1.2	1.2	1.0	3.0
Primary Inspection Percentage	10%	10%	10%	10%	7%
Average Primary Inspection (minutes)	180	180	180	180	60
Secondary Inspection Percentage	1%	1%	1%	1%	<1%
Average Secondary Inspection (minutes)	180	180	180	180	30
Average Crossing Times					
Processing within Compound (min)	24	24	24	24	10

[1] ## / ## - capacity based on lane open / maximum capacity

Source: Barton-Aschman & La Empresa, 1997

Table 13.2
Average Processing Rates and Default Capacities

	Southbound		Northbound	
	United States	Mexico	United States	Mexico
Commercial Vehicle Inspections				
Document Inspection (Mexico Only)				
Processing Rate (minutes/vehicle)	na	1.20	na	1.00
Booth/Lane Capacity (vehicles/hour)	na	50	na	60
Primary Inspection (U.S. & Mexico)				
Processing Rate (minutes/vehicle)	0.25	180	1.50	180
Booth/Lane Capacity (vehicles/hour)	240	0.33	40	0.33
Secondary Inspection (U.S. & Mexico)				
Processing Rate (minutes/vehicle)	na	180	60	180*
Booth/Lane Capacity (vehicles/hour)	na	0.33	1.00	0.33*
Toll Booths				
Processing Rate (minutes/vehicle)	0.50	0.50	0.50	0.50
Booth/Lane Capacity (vehicles/hour)	120	120	120	120

***** Less than one percent of the vehicles may be subject to this inspection.
Source: Barton-Aschman & La Empresa, 1997

Commercial vehicle arrival patterns

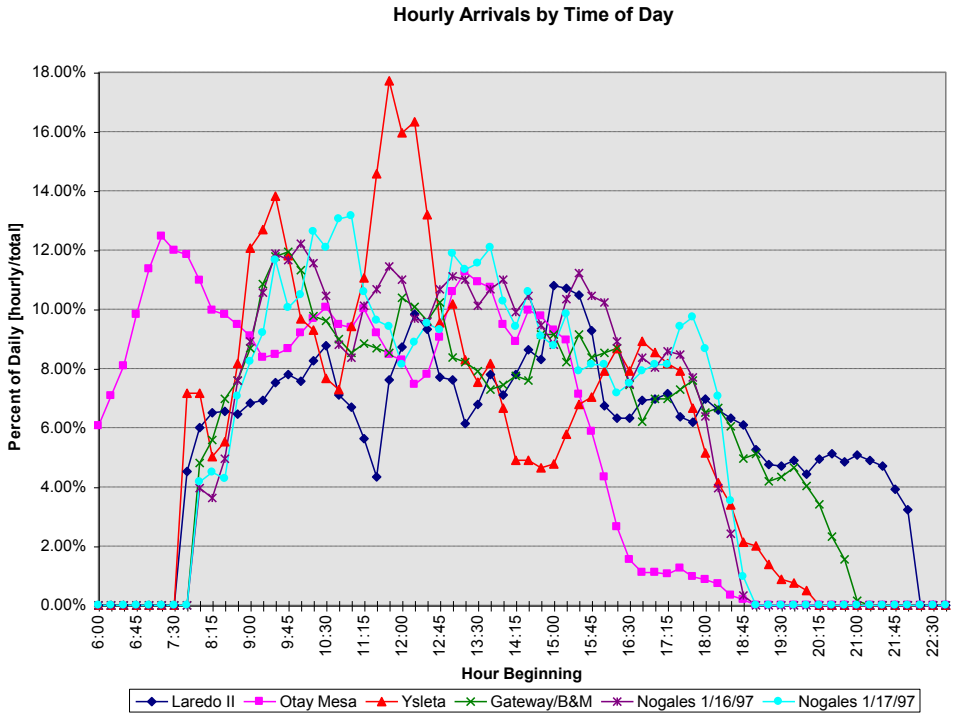
Data collected at the case study sites showed significant variation of vehicle arrivals during the day. While the patterns were not identical, there was a distinguishable pattern observed at the sites studied. Figure 13.3 shows the surveyed arrival rates in the northbound direction. Figure 13.4 shows the surveyed southbound arrival rates. These are all weekday data.

It is suggested that arrival patterns be counted for several consecutive days at selected sites to determine the amount of variation in arrival patterns from day to day.

The arrival patterns were analyzed considering the operating hours and local conditions in place during each of the case study surveys. A fairly consistent pattern emerged. Figures 5 and 6 show what was determined to be the most representative arrival distributions based on the hours of operation. Figure 13.5 shows northbound arrivals for 11, 13, and 15 hours of operation and Figure 13.6 show southbound arrivals for 10, 11, and 13 hours of operation. Minor hourly variations are included to reflect the changes in flows from hour to hour. This is needed to estimate the space needed to accommodate queues.

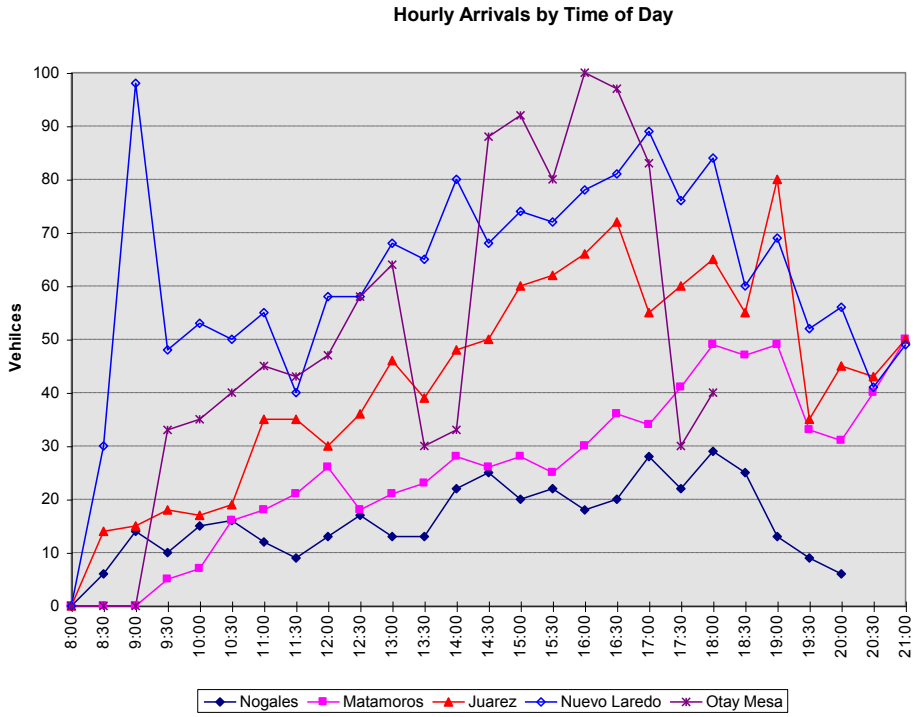
Since arrival rates may vary with local conditions, it is recommended that surveys be conducted of arrivals at existing crossings to be analyzed. However, the values in Figures 5 and 6 and Table 13.3 may be used as a default distribution if local data is not available. The correct distribution should be selected based on the number of hours the border station is to be operated for complete inspections (some stations open early for inspections of empty trucks). See Chapter 8 of this report regarding data collection.

Figure 13.3 Northbound Weekday Arrival Rates



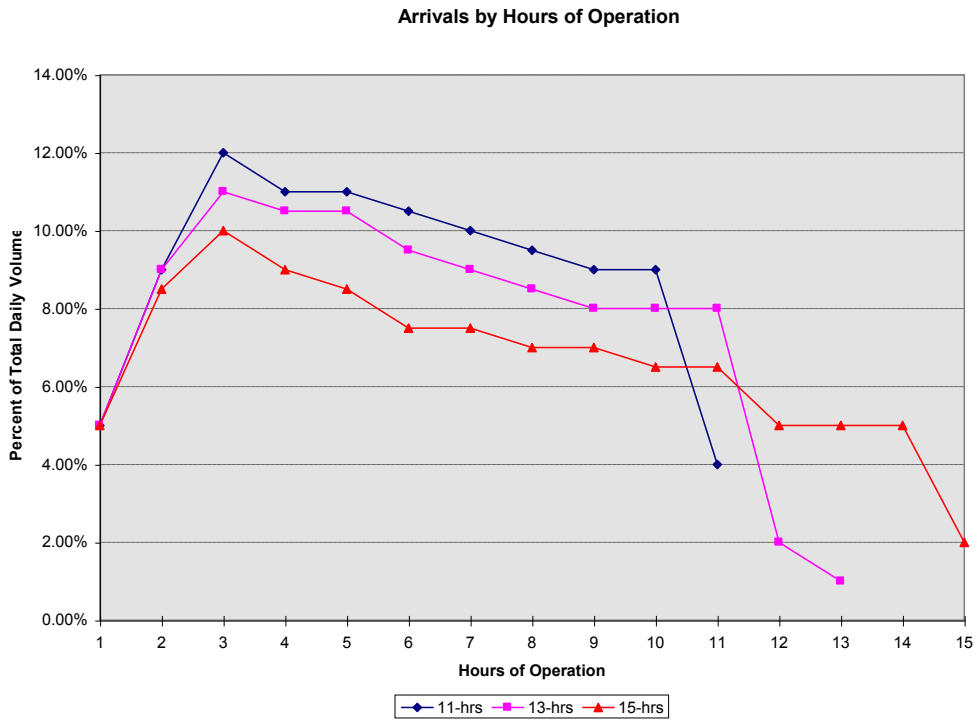
Source: Barton-Aschman & La Empresa, Case study field data, 1997.

Figure 13.4 Southbound Weekday Arrival Rates



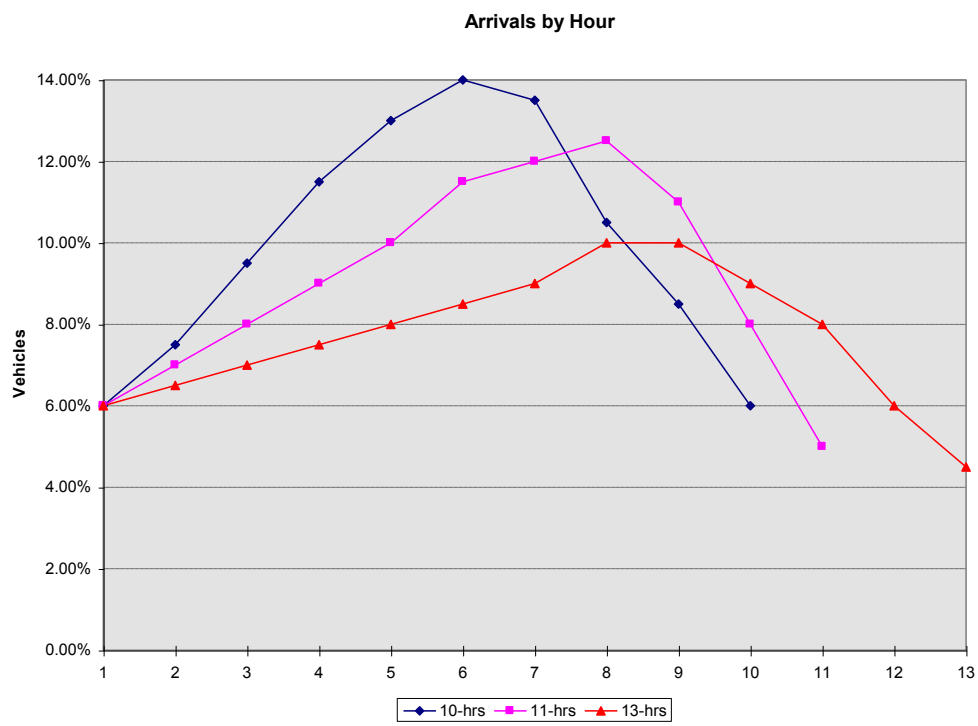
Source: Barton-Aschman & La Empresa, Case study field data, 1997.

Figure 13.5 Typical Commercial Vehicle Arrival Rates - Northbound



Source: Barton-Aschman & La Empresa, Derived from case study field data, 1997.

Figure 13.6 Typical Commercial Vehicle Arrival Rates - Southbound



Source: Barton-Aschman & La Empresa, Derived from case study field data, 1997.

Table 13.3
Typical Percent of Weekday Commercial Vehicle Arrivals by Hour

	Northbound			Southbound		
Hour	**11-hrs**	**13-hrs**	**15-hrs**	**10-hrs**	**11-hrs**	**13-hrs**
1	5.0%	5.0%	5.0%	6.0%	6.0%	6.0%
2	9.0%	9.0%	8.5%	7.5%	7.0%	6.5%
3	12.0%	11.0%	10.0%	9.5%	8.0%	7.0%
4	11.0%	10.5%	9.0%	11.5%	9.0%	7.5%
5	11.0%	10.5%	8.5%	13.0%	10.0%	8.0%
6	10.5%	9.5%	7.5%	14.0%	11.5%	8.5%
7	10.0%	9.0%	7.5%	13.5%	12.0%	9.0%
8	9.5%	8.5%	7.0%	10.5%	12.5%	10.0%
9	9.0%	8.0%	7.0%	8.5%	11.0%	10.0%
10	9.0%	8.0%	6.5%	6.0%	8.0%	9.0%
11	4.0%	8.0%	6.5%		5.0%	8.0%
12		2.0%	5.0%			6.0%
13		1.0%	5.0%			4.5%
14			5.0%			
15			2.0%			
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: Barton-Aschman & La Empresa, Derived from case study field data, 1997.

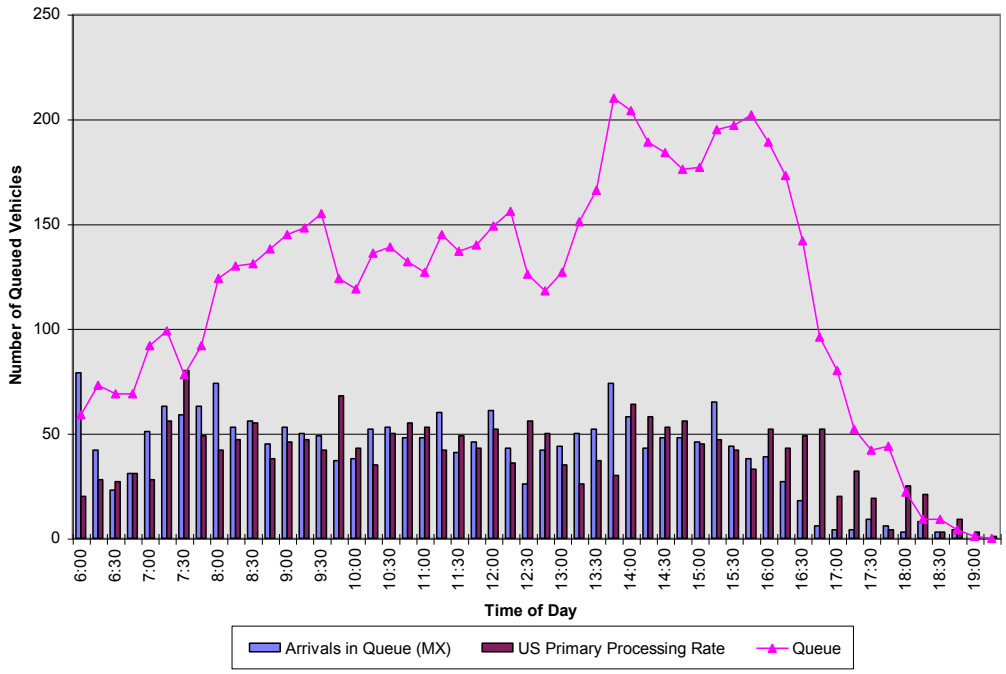
13.3.3 Queuing

The most apparent visible evidence of capacity overload and inefficiency is a queue. The queue results from having more demand at a border crossing system component than there is operating capacity to process it. For example, when more vehicles arrive at the compound entrance than can have their documents inspected, a queue will develop. The queue may be localized or may extend back to or through the next system component. In some case study systems the queue was most visible not where the actual bottleneck was but at a distant location. For example, the northbound queue at Ysleta/Zaragoza was most apparent at the entrance to the Mexican compound in Cd. Juarez. However, the capacity constraint causing the queue was actually the U.S. primary inspection nearly two kilometers away from the Mexican compound entrance, Hence, it is very important to identify the location and actual cause of an existing queue because appearances can be very misleading.

Figures 5 and 6 show examples of the arrival patterns at the case study sites. It also shows the number of primary inspection booths open at various times. Finally, Figures 7 and 8 show the resulting queues which resulted from too few booths being operated early in the day. Notice that after the day's maximum number of booths were opened, the queue began to decrease in length.

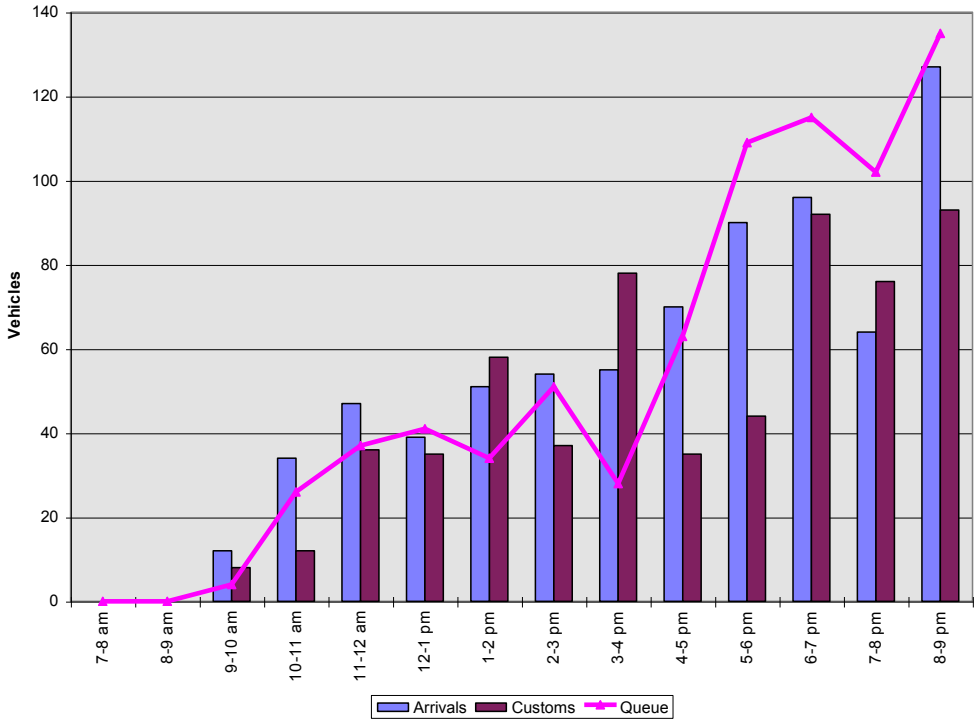
This type of chart can be used to help identify the cause of queue buildup. It can also help the inspection agencies determine staffing schedules to better meet demand.

Figure 13.7 Otay Mesa Northbound Commercial Vehicles Arrival/Queue Data



Source: Barton-Aschman & La Empresa, Case study field data, 1997.

Figure 13.8 Matamoros Southbound Arrival/Queue Data



Source: Barton-Aschman & La Empresa, Case study field data, 1997.

13.4.
Estimation of Capacity at Commercial Border Crossings

Border crossing system capacity should be analyzed separately by direction. Analyses need to be completed for each system component in an existing crossing or each proposed system component for a future crossing.

13.4.1 System Capacity

A border crossing system can be considered like a pipeline. Each section of the pipeline has a certain diameter and a capacity based on that diameter. The capacity of the entire pipeline is equal to the lowest capacity of any one section — the bottleneck. The same is essentially true for a border crossing system. If we consider all on-line components (those which every vehicle must pass through), the system capacity becomes that of the lowest capacity segment. Figure 13.9 illustrates this principle. In that example, the capacities are shown for the critical components of a northbound crossing. The section with the lowest capacity is the U.S. primary inspection booths. This capacity determines the maximum number of vehicles the system can process unless the U.S. primary inspection capacity is increased. If that were to happen, the system capacity would increase only to that of the next lowest component. Hence, the system efficiency is greatest when all of the components are similar in capacity and that capacity is greater than the peak demand.

13.4.2 Analysis Period

While much of the available border crossing data is provided by year, month, or day, even a day is too long a period for analysis of movement efficiency. Transportation analyses of this type are traditionally based one hour or 15 minute periods. Furthermore, these analyses are performed for peak hours or peak 15 minute periods. Case study observations suggest that peak hours are the longest appropriate periods for operational analyses.

The procedures in this report are based on a one-hour analysis period. If daily capacities are needed for reporting periods, they can be derived from hourly capacities using a daily/peak expansion ratio.

13.4.3 Capacity Analysis Procedure

The following procedure is suggested to estimate both component and system capacity. Steps should be carried out in the following order. The output will establish an hourly capacity for the component.

Inspection component capacities

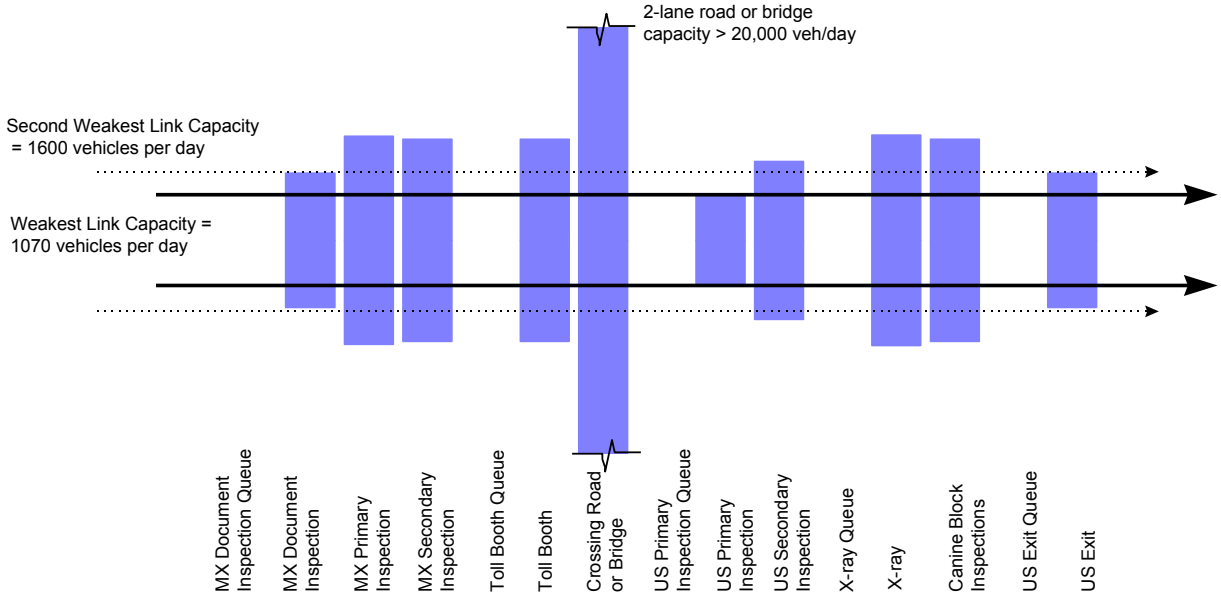
1. *Hourly capacity*. For an inspection component, the formula which estimates hourly capacity is:

   $C_{peak\ hour} = n(60/r)*f = 60n*f/r$, where

   C = peak hour capacity

   n = number of inspection units *being operated* during analysis period (e.g., lanes, berths)

Figure 13.9 Example of Relationship Between Link Capacities (Northbound)



Source: Barton-Aschman & La Empresa, 1997

r = processing rate (vehicles/hour)

$$f = \text{peak hour factor} = \frac{\text{peak hour arrivals}}{4(\text{vehicle arrival rate for peak 15 minutes}^{1})}$$

This formula should be applied to each component separately. The term *n* is from existing operations or proposed facility plans. The term *r* is either the default value given in Table 13.2 or another rate derived from actual surveys of similar inspection units. Data for *f* comes from surveyed data at the site being analyzed or from Table 13.4.

Table 13.4
Typical Border Inspection Station Arrival Peak Hour Factors (Northbound)

Location	Peak 15-Minutes Percentage (%)	Peak Hour Percentage (%)	Peak Hour Factor
Otay Mesa	3.56	12.46	0.88
Nogales (Day 1)	3.19	12.21	0.96
Nogales (Day 2)	4.71	13.16	0.70
Ysleta	5.15	17.71	0.86
Laredo II	4.01	10.80	0.67
Gateway/B&M	3.72	11.94	0.80

Source: Barton-Aschman & La Empresa, 1997

[1] This should be the arrival rate at the entrance to the compound so it will represent demand rather than existing performance.

2. *Daily capacity*. If it is desired to estimate daily capacity, the formula is:

   $C_{daily} = C_{peak\ hour} / H$, where

   H = peak hour percentage of daily commercial vehicle arrivals at the inspection station

   H is derived from Table 13.3 or from local commercial border station vehicle arrival data.

Estimating capacity of queuing areas

The capacity of a queuing area must be estimated using a cumulative computation rather than a "snapshot" computation. That is, because queues build over time, they can only be analyzed by determining excess demand that inspection processing cannot handle. Section 5.2 of this report explains how to estimate queue lengths and needed capacity.

Establishing demand

Demand should be based on arrival rates at the entrance of the inspection compound or, if one exists, at the end of the queue to the entrance.

1. *Existing demand.* It is important to measure demand rather than what is being processed since any capacity constraints will artificially reduce the volume of passing vehicles. The only place crossing demand can be measured is where vehicles flow "unconstrained" to the entrance of the inspection compound. If a queue exists at the entrance, the demand is best represented by a count at the end of the entrance queue (i.e., where vehicles "arrive"). However, if there is an upstream constraint that could be alleviated, the demand should be measured before that constraint if possible. Demand should be measured by 15 minute period. If counting at the end of a queue, the count will have to be made manually since the end of the queue will constantly move. A machine count may be possible if there is certain to be no queue (usually low volume crossings).

   Once the count is summarized, the peak hour of the count day can be determined and the volume identified. The peak hour factor can be similarly computed.

   If it is desired to determine the peak hour of the week and a week of counts have been made, a similar procedure can be used. However, it may be desirable to establish a "design hour." This would need to be determined by policy (none known at this time) related to a designated high operating hour of the year.

   For street and highway planning, it has been traditional to use the 30th highest hour of the year (out of about 8,700 total hours). Many retail commercial facilities are designed for the 50th highest hour (out of about 3,600 total hours open). Many inspection facilities now operate under capacity constraints for one or more hours over a workday of 10 to 16 hours. One hour per day might equate to approximately the 250th highest hour. Hence the traditional road planning criterion (30th highest hour) may be infeasible. It is suggested that perhaps the 99th or 95th percentile hour be used (These percentiles equate to one in 100 and one in 20 hours of capacity constrained operation). An annual hourly count of arrivals would enable this to be established more precisely if it is critical. (At most crossings, United States Customs Service (USCS) already collects hourly totals which could be adapted for this purpose.). Data does not presently exist to establish adjustment factors to estimate such a demand volume based on an average count. However, the daily peak hour on the busiest day of a busy season week (usually Thursday or Friday where maquiladora activity is high) should be at least approaching the 99th percentile (one hour constrained out of 100). That should provide a good approximation of a desirable and counTable 13.design level. Hence

a full day Friday count during the peak season should provide a sufficient approximation of design level demand for planning purposes.

2. *Future demand.* The USCS provides projected daily commercial vehicle volumes for use in designing border stations. In Mexico such estimates are provided by SCT.

   Peak hour design volumes can be estimated by applying peak hour percentages to estimated future daily volumes for the existing facility, for a nearby facility with a similar function, or by using the default values in Table 13.3.

Analyzing Capacity

This analysis should be performed for the peak design hour (not day). The computed hourly capacity can then be compared to the design hour demand. This must be done for each component of the border crossing system. Maximum capacities for an existing crossing should be estimated assuming full staffing of all available inspection stations (booths or lanes). Constrained capacities can be estimated if there are known staffing limitations.

Figure 13.8 shows one way of displaying the results of such an analysis. In this case, the lowest hourly processing capacity is for U.S. primary inspection booths. That limits the inspection compound's capacity. If the primary inspection capacity in this example were increased, the Mexican export document inspection would be the next component to constrain crossing system capacity.

This is how a border crossing system capacity analysis should be performed: (1) compute the capacity of the individual components, (2) compare those to the demand, (3) identify those components which are deficient, (4) determine if improvements to increase capacity are possible, (5) do the same for other deficient components until demand can be met at all components.

13.5.
Analysis Applications

Five applications are likely to be commonly appropriate for analyzing border crossing systems:

- identify and alleviate any existing bottlenecks
- determine queuing capacity needs
- determine reserve capacity
- estimate years before capacity is fully used (saturation)
- sizing of inspection facility components

Each of these analyses is based on a capacity analysis similar to those described in Chapter 4. Other analysis techniques may also be needed depending on the specific location and conditions. Each of the five applications is described below.

13.5.1 Identify and Alleviate Existing Bottlenecks

As shown in Chapter 4, each crossing system has a lowest capacity component. It is often desired to identify the existing capacity of that component and then to evaluate how best to remove that capacity constraint.

Sometimes the constrained component can be easily identified from field observations. Sometimes this is not possible due to overlapping queues or upstream constraints. In any case, it is necessary to quantify the capacity and then determine the effects of possible improvements being considered. Selection of the optimum improvement(s) may also be desired.

The analyses below can be made easier by using a model which will provide the outputs if the proper information is provided. Such a model is discussed in Chapter 6.

Bottleneck identification can be done by field observation or can be computed. It is important to understand that the analysis must identify both the *location and cause* of the bottleneck, not just the location. Quite often they are not the same. Whether identification is by observation or computation, it is still necessary to compute the capacities of all components in the direction of interest (northbound into the United States or southbound into Mexico). The following steps can be used:

1. Obtain the capacity factors for each existing component. These may include (as described in Chapter 2):
    - number of inspection booths or lanes *being operated* (NATAP lanes should be considered separately)
    - average processing time per vehicle
    - peak hour factor
    - peak occupancy factor (applicable to dock or other inspection spaces only; otherwise this factor is 1)
2. Estimate the peak hour capacity of each inspection component using the formulas in this chapter or Chapter 4.

3. Estimate the effective capacity of each component using the following formula:

   $C_{effective} = C_{peak\ hour} / POF$, where

   POF = peak occupancy factor = proportion of spaces occupied when considered at capacity (typically 90 percent)

4. Prepare a comparative chart to show the capacities of each component. Figure 13.9 shows one format which can be used.
5. Determine the existing demand (arrivals) in commercial vehicles per peak hour. This should be counted or otherwise determined from operating data.
6. Identify all components with capacity below the demand level. The comparative chart should be used; see Figure 13.9.
7. Identify the components with the two lowest capacities.
8. For the lowest capacity component, identify opportunities for improving capacity. This may include additional booths or lanes, lower percentage of vehicles inspected or shorter inspection times (only if inspection agency practices can be expected to change). Other possibilities are listed in Chapter 8. Evaluate the capacity with the improvement(s).
9. Compare improved capacity levels with demand and next lowest capacity component (which would become the constraint if the lowest was sufficiently improved).
10. Select the improvement based on which one(s) meet or exceed the next lowest capacity level or demand. This may also involve other evaluations such as cost or circulation/maneuvering analysis.
11. Repeat for the next lowest capacity component(s) until the constraint either becomes to expensive or difficult to be practical or all components meet demand level.

If followed through to conclusion, this process will yield a set of improvements which will improve the capacity of the border crossing system to the desired or feasible level.

13.5.2 Determine Needed Capacity for a Queuing Area

The model described in Chapter 6 must be used for this analysis. It works using the following computational technique. The computations are performed by the model.

1. Compare demand (arrivals) and processing capacity for each period (usually hourly but can be by 15 minute period), starting with the opening period.
2. If capacity exceeds demand, there is no queue. For the first period for which demand exceeds supply,

   Queue (number of vehicles) = arrivals - capacity

3. For each subsequent period, repeat the same computation, but accumulate queues unless the queue becomes zero. That is,

   $Queue_1 = Queue_0 + Arrivals_1 - Capacity_1$, where

   $Queue_0$ = the queue at the end of the prior time period

   $Queue_1$ = the queue at the end of the current time period, except that $Queue_1$ cannot be negative. If the computation for $Queue_1$ becomes negative, then $Queue_1$ becomes 0 for the next interval.

4. The actual dimensional length of queue space needed to meet the queue demand is calculated by taking the average length of a truck plus the space between trucks in a queue and multiplying that length by the maximum number of queued vehicles computed in step 3. For example, the length of a tractor-trailer combination (with “interstate” trailer

- 53 feet/16 meters long) averages about 23 meters. Typical spacing between trucks in a queue is about 3 meters. If all or almost all trucks are this type of vehicle, for a maximum queue length of 40 vehicles, the length of queue to be provided would be about 1040 meters. The length of queue can be accommodated in one or more lanes.

5. To determine the design value of queue, it is suggested that an additional "surge" factor be added to account for short fluctuations in demand. It is suggested at least 10 percent or 3 vehicles (whichever is greater) be added. In the example the surge factor would add the highest of either 104 meters (10 percent) or 3 x 26 = 78 meters (3 vehicles). Hence, the queue length for design would be 1144 meters, which could be provided in one or more lanes. It is important that the queue space provided be usable. Any length not usable due to turns or for merging or diverging lanes should not be counted.

13.5.3 Determine Reserve Capacity

Reserve capacity is the excess capacity over the capacity that is needed to meet the maximum demand at a given time. For example, if a particular border station can process up to 230 trucks per hour and the design demand is 170 trucks per hour, there is a reserve capacity of 60 trucks per hour.

To determine reserve capacity,

1. Determine the capacities of each border crossing system component.
2. Determine which component has the lowest (or critical) capacity, $C_{critical}$.
3. Identify the demand, D, in trucks per hour. See Section 4.3.3.
4. Reserve capacity $C_{reserve} = D - C_{critical}$
5. Reserve capacity cannot be a negative number. If the computation yields a negative number, there is a capacity deficiency and the critical components will need to be improved to meet demand (or queuing will result).

13.5.4 Estimate years before capacity fully used

It is sometimes desired to estimate how many years an existing facility can serve before it becomes saturated and needs to be improved or replaced. This estimate can be made using capacity, demand, and growth rate.

$Y = (C_{critical} - D)/(D \times G)$, where

Y = number of years until existing capacity is fully used

$C_{critical}$ = existing capacity of the critical component

D = current demand

G = simple annual demand growth rate in decimal form[2]

For example, if the existing capacity of the critical component is 230 trucks per hour, the current demand is 170, and the annual growth rate is 5 percent, then

$Y = (230 - 170)/(170 \times .05)$

$Y = 7$

At a 5 percent growth rate, the demand will reach existing capacity in about 7 years. At that time the lowest capacity component would need to be improved or, queues would form.

[2] If it is desired to use a compound growth rate, use the formula $Y = (C - D)/\{D \times [(1+G)^Y-1]\}$

13.5.5 Size Inspection Components

When it is desired to determine the size or number of inspection booths, lanes, or dock spaces needed to accommodate a certain level of demand, the following formula can be used:

$N = (D \times P/U)/C_{unit}$, where

N = number of (inspection) units

D = design level demand

P = average proportion of vehicles to be inspected, in decimal form

U = utilization rate (portion in decimal form of total utilized at peak demand level; some flexibility needed for separation of inspections)

C_{unit} = capacity of a single inspection unit

Once the design demand is determined, the inspection facility components can be sized based on their individual capacities. For example, if it is desired to size the U.S. primary inspection, secondary inspection, and x-ray to handle 300 trucks per peak hour, and the following criteria apply, the resulting component sizes are shown in Table 13.5.

The example was sized using the formula manually. The model described in the next chapter will do the sizing estimates automatically with input of the proper information.

It is recommended that the facility be sized for a similar capacity for all components. This should produce optimum results if the actual operations are consistent with the criteria. Sizing should be estimated for the anticipated ultimate commercial vehicle volume, inspection percentages, and inspection duration. Normally this should accommodate:

- projected commercial vehicles crossing at least 20 years into the future
- the vehicular capacity of the border crossing road or bridge, and
- the volume which can be delivered by the immediate access roads

This is necessary to be able to correctly identify the ultimate site layout and land area needs. Normally a border station will be built in increments over time, but the complete site must be acquired or reserved initially so the border station will not become landlocked before meeting its ultimate capacity.

Table 13.5
Sample Inspection Facility Size Estimates (Design Demand = 300 Trucks/Peak Hour)

Component	Percent Inspected	Unit Capacity	Units
Primary	100%	40/hr	7.5 ➔ 8 booths (+ NATAP?)
Secondary	40%	1.5/hr (90% utilization rate)	88.9 ➔ 89 dock spaces
X-Ray (mobile)	10%	25/hr	1.2 ➔2 machines

Source: Barton-Aschman/La Empresa, 1997

13.6.
Border Crossing System Capacity Analysis Model

The capacity analysis procedures described in the previous chapter have been incorporated into a model which will analyze all crossing system components together and produce a system evaluation. This will simplify any commercial border crossing system analysis of the types described in Chapters 5 and 8. This chapter describes the makeup of the model, default values available to the model, and how to use the model to produce the desired results.

13.6.1 Software Routine

A spreadsheet was developed for modeling the efficiency of border crossing systems. The routine, which runs under Microsoft Excel Version 7, provides a means for quickly evaluating the capacity of an existing POE system or sizing a proposed or planned facility. The spreadsheet file contains several worksheets for evaluating both northbound and southbound crossing components. The spreadsheet file is called POE-Flow.xls. It is available from the Binational Transportation Joint Working Committee (JWC) through the Binational Data Bank.

13.6.2 System Components Included

The spreadsheet model provides capacity-related outputs for the following border crossing system components. Unless otherwise stated, the model also provides capacity determinations for queue areas in advance of the listed components.

System Components

Northbound	Southbound
Mexico	United States
Document inspection booths	Document Submission
Export primary inspection	Export inspection
Exit	
Toll booths	Toll booths
Crossing	Crossing
United States	Mexico
Primary inspection booths	Document inspection booths
Secondary inspection	Import primary inspection
X-ray	Secondary selection
Canine blocks (no queue estimate)	Secondary inspection
Exit	Exit

While not included in this model, the capacities of the approach and departure access roads can be analyzed using standard highway capacity analysis software. These include such programs as HCS[3], SIGNAL 94[4] and others that may be accepTable 13.to local jurisdictions for such analyses. It is recommended that the analysts determine which highway capacity techniques and software are accepTable 13.or used by agencies with jurisdiction over access roads for the border stations so the results will be accepted. Use of unapproved software may cause the analyses or conclusions to be rejected. This would necessitate repeating the analyses with the correct tools.

13.6.3 Available Outputs

The following outputs are available from this model:

- Component hourly capacity (for a given number of units)
- Number of component units needed to meet a specified demand (for all components in system)
- Queue length (number of vehicles) resulting in advance of a system component
- Years remaining before capacity constraint

All are computed directly if the necessary input information is provided.

6.4 Input Variables

Tables 6 and 7 show the input variables by component for both the northbound and southbound directions, respectively. If no data is provided, default values can be used.

6.5 Average Values

Data collected during the border crossing case studies was analyzed to derive average or typical values for each variable. These values are for Fridays during peak seasons of the year and are thought to be reasonable for design purposes. However, analysts are encouraged to collect additional data or project their own numbers since local conditions may vary from those of the six commercial border crossings from which this data was collected.

Tables 8 and 9 show the average characteristics found in the case studies. These have been adjusted in a few cases for local operational practices which were considered significantly different from common practice based on field observations by personnel experienced in operational assessments.

[3] Highway Capacity Software, McTRANS, Florida Transportation Technology Center, University of Florida, Gainesville, Florida

[4] SIGNAL 94 is a part of TEAPAC, distributed by Strong Concepts, Northbrook, Illinois.

Table 13.6
Northbound Model Input Variables

		Mexico							United States						
		Document Inspection	Primary Inspection	Exit Queue	Exit Booths	Toll Queue	Toll Booth	Crossing Road	Primary Queue	Primary Inspection	Secondary Inspection	X-Ray	Canine Blocks (non-queue)	Exit Queue	Exit Booths
	Supply														
A	No. of Units Operating (lanes, docks, etc.)	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
B	Utilization Rate (%)	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
C	Processing Rate per Unit (veh/hr)	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
	Demand														
D	Daily Volumes	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
E	Peak Hour (%/daily)	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
F	Peak Hour Volume	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
G	Peak Hour Factor (surge)	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
H	Inspection Percent (%)	✓	✓		✓		✓			✓	✓	✓	✓		✓
I	Annual Growth Rate (%)	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓
Y	Percent Commercial Vehicles							✓							

Source: Barton-Aschman-La Empresa, 1997

Table 13.7
Southbound Model Input Variables

		United States						Mexico					
		Documentation Drop	Inspection Queue	Export Inspection	Toll Queue	Toll Booth	Crossing Road	Document Queue	Document Inspection	Primary Inspection	Secondary Inspection	Exit Queue	Exit Booths
	Supply												
A	No. of Units Operating (lanes, docks, etc.)	✓		✓		✓	✓		✓	✓	✓		✓
B	Utilization Rate (%)	✓		✓		✓	✓		✓	✓	✓		✓
C	Processing Rate per Unit (veh/hr)	✓		✓		✓	✓		✓	✓	✓		✓
	Demand												
D	Daily Volumes	✓		✓		✓	✓		✓	✓	✓		✓
E	Peak Hour (%/daily)	✓		✓		✓	✓		✓	✓	✓		✓
F	Peak Hour Volume	✓		✓		✓	✓		✓	✓	✓		✓
G	Peak Hour Factor (surge)	✓		✓		✓	✓		✓	✓	✓		✓
H	Inspection Percent (%)	✓		✓		✓			✓	✓	✓		✓
I	Annual Growth Rate (%)	✓		✓		✓	✓		✓	✓	✓		✓
Y	Percent Commercial Vehicles						✓						

Source: Barton-Aschman-La Empresa, 1997

Table 13.8
Typical Border Crossing System Component Operating Characteristics - Northbound

		Mexico							United States					
		Document Inspection Queue	Document Inspection	Primary Inspection	Exit Booths	Toll Queue	Toll Booth	Crossing Road	Primary Queue	Primary Inspection	Secondary Inspection	X-Ray	Canine Blocks (non-queue)	Exit Booths
	Supply													
A	No. of Units Operating (lanes, docks, etc.)		Local Input	Local Input	Local Input		Local Input	Local Input		Local Input	Local Input	Local Input	Local Input	Local Input
B	Utilization Rate (%)		100%	90%	100%		100%	80%		100%	90%	100%	90%	100%
C	Processing Rate per Unit (veh/hr)		60	0.67	120		120	2000		40	1	25	2	120
	Demand													
D	Daily Volumes		Local Input	Local Input	Local Input		Local Input	Local Input		Local Input	Local Input	Local Input	Local Input	Local Input
E	Peak Hour (%/daily)		11%	11%	11%		11%	8%		11%	11%	11%	11%	11%
F	Peak Hour Volume		Calculation	Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation	Calculation
G	Peak Hour Factor (surge)		0.85	0.85	0.85		0.85	0.85		0.85	0.85	0.85	0.85	0.85
H	Inspection Percent (%)		100%	2%	100%		100%	na		100%	40%	10%	10%	100%
I	Annual Growth Rate (%)		Local Input	Local Input	Local Input		Local Input	Local Input		Local Input	Local Input	Local Input	Local Input	Local Input
Y	Percent Commercial Vehicles							100%						
	Results													
J	Capacity (veh/hr)		Calculation	Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation	Calculation
K	Capacity (veh/day)		Calculation	Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation	Calculation
L	Peak Hour Volume/Capacity Ratio		Calculation	Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation	Calculation
M	Number of Years to Reach Capacity		Calculation	Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation	Calculation

Source: Barton-Aschman-La Empresa, 1997

Table 13.9
Typical Border Crossing System Component Operating Characteristics - Southbound

		United States						Mexico				
		Documentation Drop Queue	Documentation Drop	Export Inspection	Toll Queue	Toll Booth	Crossing Road	Document Queue	Document Inspection	Primary Inspection	Secondary Inspection	Exit Booths
	Supply											
A	No. of Units Operating (lanes, docks, etc.)		Local Input	Local Input		Local Input	Local Input		Local Input	Local Input	Local Input	Local Input
B	Utilization Rate (%)		100%	100%		100%	80%		100%	90%	90%	100%
C	Processing Rate per Unit (veh/hr)		120	40		240	2000		60	0.67	0.67	120
	Demand											
D	Daily Volumes		Local Input	Local Input		Local Input	Local Input		Local Input	Local Input	Local Input	Local Input
E	Peak Hour (%/daily)		11%	11%		11%	8%		11%	11%	11%	11%
F	Peak Hour Volume		Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation
G	Peak Hour Factor (surge)		0.85	0.85		0.85	0.85		0.85	0.85	0.85	0.85
H	Inspection Percent (%)		10%	0%		100%	na		100%	10%	1%	100%
I	Annual Growth Rate (%)		Local Input	Local Input		Local Input	Local Input		Local Input	Local Input	Local Input	Local Input
Y	Percent Commercial Vehicles						100%					
	Results											
J	Capacity (veh/hr)		Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation
K	Capacity (veh/day)		Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation
L	Peak Hour Volume/Capacity Ratio		Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation
M	Number of Years to Reach Capacity		Calculation	Calculation		Calculation	Calculation		Calculation	Calculation	Calculation	Calculation

Source: Barton-Aschman-La Empresa, 1997

13.6.6 Assumptions

Tables 8 and 9 contain cells for all variables which can be entered into the model. It is desirable to use real data for as many of these cells as possible. Default values (see next section) can be used for some cells. However, it will be necessary to make assumptions or assign desirable values for others. When defining default values they may be based on existing, desired or assumed future conditions.

The following are rows in Tables 8 and 9 which may require assumptions:

For analyzing existing operations	For sizing facilities
• Utilization rate - use desired rate	• Utilization rate - use desired rate
• Annual growth rate - USCS estimate preferred	• Design/peak hour volume if no projections available
	• Number of hours facility is open each day
	• Peak hour factor - default value preferred over assumption
	• Inspection percentage - USCS or other inspection agency estimate preferred
	• Annual growth rate - USCS estimate preferred
	• Percent commercial vehicles - transportation agency traffic projection preferred; total U.S., total and loaded Mexican trucks

13.6.7 Default Values

The average values shown in Tables 8 and 9 can be used as default values if better local information is not available.

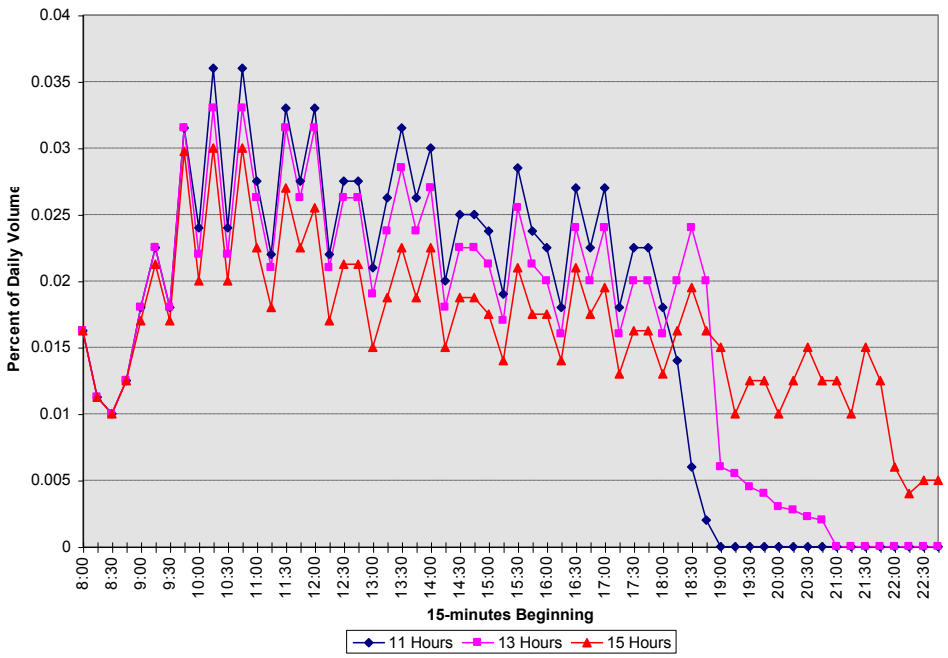
It should be understood that some of these values are based on commercial vehicle arrival patterns for the case study locations which may or may not be representative of other specific locations. The case studies did show definite consistency in patterns of arrivals. However, there was significant variation in some sites based on local shipping practices. It is recommended that local arrival patterns be surveyed if there is an applicable nearby crossing with operations similar to those expected at the study location. For analyses of existing crossings, arrivals should be surveyed on the peak day of the week, desirably during the busy season of the year.

Figures 10 and 11 show the northbound and southbound arrival rates which are incorporated in the default arrival patterns. Patterns are shown for the different operating schedules observed for the case study locations. These ranged from 11 hours to 16 hours, generally started as early as either 6 a.m. (northbound only) or 8 a.m. (both directions)

The arrival rates influence three important factors in the model:

- peak hour percentage of daily arrivals, which affects the number of inspection units needed
- peak hour factor (peaking within the peak hour)
- queuing, if processing capacity is insufficient to meet demand

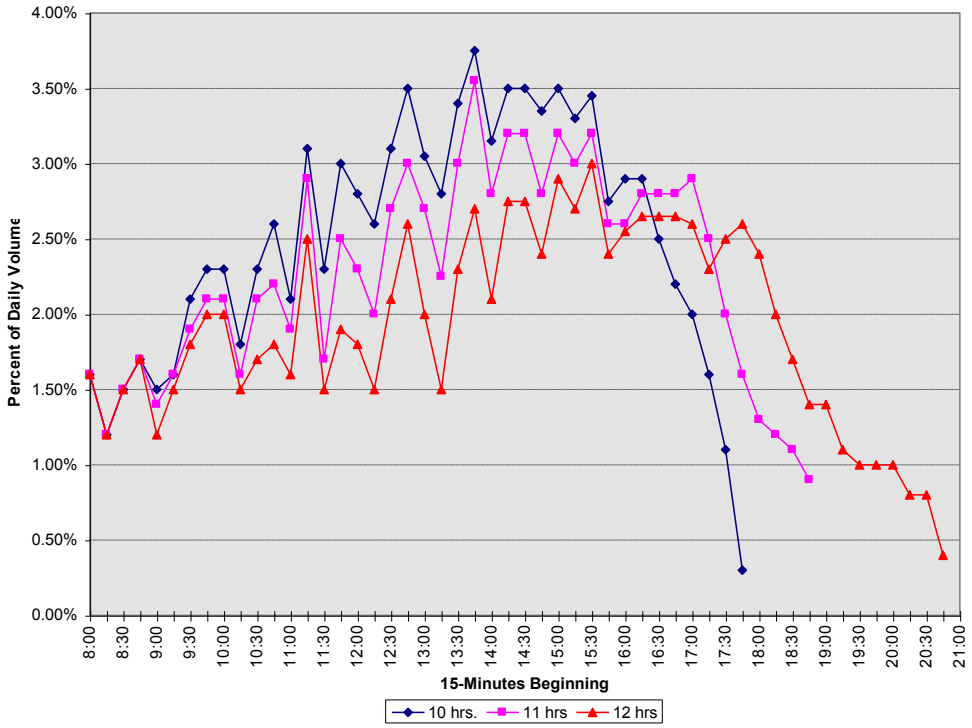
Figure 13.10 Default 15-minute Arrival Patterns - Northbound



Time	11 hrs	13 hrs	15 hrs	Time	11 hrs	13 hrs	15 hrs
8:00	1.62%	1.62%	1.62%	**16:00**	2.25%	2.00%	1.75%
8:15	1.12%	1.12%	1.12%	**16:15**	1.80%	1.60%	1.40%
8:30	1.00%	1.00%	1.00%	**16:30**	2.70%	2.40%	2.10%
8:45	1.25%	1.25%	1.25%	**16:45**	2.25%	2.00%	1.75%
9:00	1.80%	1.80%	1.70%	**17:00**	2.70%	2.40%	1.95%
9:15	2.25%	2.25%	2.12%	**17:15**	1.80%	1.60%	1.30%
9:30	1.80%	1.80%	1.70%	**17:30**	2.25%	2.00%	1.62%
9:45	3.15%	3.15%	2.98%	**17:45**	2.25%	2.00%	1.62%
10:00	2.40%	2.20%	2.00%	**18:00**	1.80%	1.60%	1.30%
10:15	3.60%	3.30%	3.00%	**18:15**	1.40%	2.00%	1.62%
10:30	2.40%	2.20%	2.00%	**18:30**	0.60%	2.40%	1.95%
10:45	3.60%	3.30%	3.00%	**18:45**	0.20%	2.00%	1.62%
11:00	2.75%	2.62%	2.25%	**19:00**	0.00%	0.60%	1.50%
11:15	2.20%	2.10%	1.80%	**19:15**	0.00%	0.55%	1.00%
11:30	3.30%	3.15%	2.70%	**19:30**	0.00%	0.45%	1.25%
11:45	2.75%	2.62%	2.25%	**19:45**	0.00%	0.40%	1.25%
12:00	3.30%	3.15%	2.55%	**20:00**	0.00%	0.30%	1.00%
12:15	2.20%	2.10%	1.70%	**20:15**	0.00%	0.28%	1.25%
12:30	2.75%	2.62%	2.12%	**20:30**	0.00%	0.22%	1.50%
12:45	2.75%	2.62%	2.12%	**20:45**	0.00%	0.20%	1.25%
13:00	2.10%	1.90%	1.50%	**21:00**	0.00%	0.00%	1.25%
13:15	2.62%	2.37%	1.878%	**21:15**	0.00%	0.00%	1.00%
13:30	3.15%	2.85%	2.25%	**21:30**	0.00%	0.00%	1.50%
13:45	2.62%	2.38%	1.88%	**21:45**	0.00%	0.00%	1.25%
14:00	3.00%	2.70%	2.25%	**22:00**	0.00%	0.00%	0.60%
14:15	2.00%	1.80%	1.50%	**22:15**	0.00%	0.00%	0.40%
14:30	2.50%	2.25%	1.88%	**22:30**	0.00%	0.00%	0.50%
14:45	2.50%	2.25%	1.88%	**22:45**	0.00%	0.00%	0.50%
15:00	2.37%	2.12%	1.75%				
15:15	1.90%	1.70%	1.40%	Total	100%	100%	100%
15:30	2.85%	2.55%	2.10%				
15:45	2.38%	2.12%	1.75%				

Source: Barton-Aschman - La Empresa, 1997

Figure 13.11 Default Arrival Patterns - Southbound



Time	10 hrs.	11 hrs	12 hrs	Time	10 hrs.	11 hrs	12 hrs
8:00	1.60%	1.60%	1.60%	15:00	3.50%	3.20%	2.90%
8:15	1.20%	1.20%	1.20%	15:15	3.30%	3.00%	2.70%
8:30	1.50%	1.50%	1.50%	15:30	3.45%	3.20%	3.00%
8:45	1.70%	1.70%	1.70%	15:45	2.75%	2.60%	2.40%
9:00	1.50%	1.40%	1.20%	16:00	2.90%	2.60%	2.55%
9:15	1.60%	1.60%	1.50%	16:15	2.90%	2.80%	2.65%
9:30	2.10%	1.90%	1.80%	16:30	2.50%	2.80%	2.65%
9:45	2.30%	2.10%	2.00%	16:45	2.20%	2.80%	2.65%
10:00	2.30%	2.10%	2.00%	17:00	2.00%	2.90%	2.60%
10:15	1.80%	1.60%	1.50%	17:15	1.60%	2.50%	2.30%
10:30	2.30%	2.10%	1.70%	17:30	1.10%	2.00%	2.50%
10:45	2.60%	2.20%	1.80%	17:45	0.30%	1.60%	2.60%
11:00	2.10%	1.90%	1.60%	18:00		1.30%	2.40%
11:15	3.10%	2.90%	2.50%	18:15		1.20%	2.00%
11:30	2.30%	1.70%	1.50%	18:30		1.10%	1.70%
11:45	3.00%	2.50%	1.90%	18:45		0.90%	1.40%
12:00	2.80%	2.30%	1.80%	19:00			1.40%
12:15	2.60%	2.00%	1.50%	19:15			1.10%
12:30	3.10%	2.70%	2.10%	19:30			1.00%
12:45	3.50%	3.00%	2.60%	19:45			1.00%
13:00	3.05%	2.70%	2.00%	20:00			1.00%
13:15	2.80%	2.25%	1.50%	20:15			0.80%
13:30	3.40%	3.00%	2.30%	20:30			0.80%
13:45	3.75%	3.55%	2.70%	20:45			0.40%
14:00	3.15%	2.80%	2.10%	21:00			
14:15	3.50%	3.20%	2.75%				
14:30	3.50%	3.20%	2.75%	Total	100%	100%	100%
14:45	3.35%	2.80%	2.40%				

Source: Barton-Aschman - La Empresa, 1997

Appendix A contains the case study arrival patterns which are the basis for Figures 10 and 11.

13.6.8 Computations

The spreadsheet model contains thirteen worksheets. Four provide basic information input parameters and formula descriptions. Another four are used to enter the data, perform the calculations and display the results. There are two worksheets which can be used to estimate delay, queuing and inspection booth staffing. The three remaining worksheets contain information on typical hourly and 15-minute vehicle arrival patterns. The following identifies the worksheet naming conventions:

- NB Inputs and SB Inputs - Checklists of data inputs identical to the information presented in Tables 6 and 7 above.
- NB Description and SB Description - These worksheets provide general information on the inputs and formulas used in the model.
- NB POE Evaluation and SB POE Evaluation - Input and calculation worksheets which look similar to Tables 8 and 9 above.
- NB Results and SB Results - These are charts which present the resulting capacity calculations in a graphic format.
- NB Delay & Staffing and SB Delay & Staffing - These worksheets are used to estimate queuing, delay and staffing needs at three critical locations in the POE systems: Mexican documentation inspection (including the random selection system), U.S. primary inspection (or export inspection) and toll booths.
- Arrival Profiles, Hourly Chart, and 15-Min Chart - These worksheets provide data and charts on the typical vehicle arrival profiles suggested for different hours of operation. Seven arrival profiles were developed representing from 10 to 16 hours of daily operation. The hours of operation are defined as the time during which trucks may enter the compounds.

POE Component Evaluation (Inspection Capacities)

The first step in the evaluation process is to develop the basic capacities of the POE. Data is entered into the spreadsheet in the worksheets “NB POE Evaluation” or “SB POE Evaluation” depending on which direction is being analyzed. The inputs should be entered in the following manner:

1. Enter the <u>number of units</u> for each component (Row A).
2. Modify the <u>utilization rates</u> (Row B) if the local conditions are different from the default values provided.
3. Modify the processing rates (Row C) if the local rates are different from the default values provided.
4. Enter the 90th percentile <u>daily volume</u> (Row D) for commercial vehicles using an existing crossing or estimated ultimate average daily volume for a proposed or new facility.
5. Select a <u>peak hour percentage</u> (Row E) to convert daily trips to peak hour trips based on available data or using the default values shown below. The default value will vary based on the number of hours of operation.

Hours of Operation	Peak Hour Percent of Total Daily Volume
10	12.5
11	12.0
12	11.5
13	11.0
14	10.5
15	10.0
16	10.0

6. The peak hour volume (Row F) will be calculated from the total daily volume and the peak hour percentage.
7. To account for surges of vehicles or peaks within the peak hour, a peak hour factor (PHF) (Row G) should be entered for each component. Typical PHFs for the commercial vehicles arriving at the inspection facilities ranged from 0.60 to 0.90 and with an average value of 0.85. This is similar to PHFs for traffic in urban areas.
8. Each component needs an inspection percentage (Row H). This percentage indicates how many of the vehicles are subject to this specific inspection process. Any process that all vehicles are subjected to must be entered as 100 percent. If a process is not being used at a crossing it can be eliminated from consideration by entering an inspection percentage of zero (0). The only exception is the crossing itself which is assumed to carry 100 percent of the traffic.
9. An annual growth rate (Row I) is required if a calculation of the number of years to reach capacity is needed.
10. The commercial vehicles percentage of total traffic (Row Y) using the crossing should be entered. If the crossing is only used by commercial vehicles then a value of 100 percent should be entered. If the crossing is or will be used by both commercial and non-commercial traffic then the percent of commercial versus total traffic should be entered.

Once the inputs are entered, the calculations appear at the bottom of the spreadsheet. There are currently four calculations which are made:

- peak hour capacity (Row J),
- daily capacity (Row K),
- peak hour volume to capacity ratio (Row L), and
- number of years to reach capacity (Row M).

If a value of “na” appears then that component is not used for this crossing (inspection percent = 0). If a zero appears in the years to reach capacity (Row M), the crossing is either at or above capacity. In addition to the numeric values at the bottom of the table, a bar chart is generated which compares the various components. These charts are found on the worksheets called “NB Results” and “SB Results”.

POE Delay & Staffing Evaluation

The second level of analysis which can be performed using the spreadsheet is an estimation of the queuing and delay. The worksheets called NB Delay & Staffing and SB Delay & Staffing are used to perform the analyses. The data inputs available are highlighted in yellow. The steps involved in using these worksheets are:

1. Total Daily Volume - To evaluate an existing POE, this should be the existing 90th percentile daily volume. To size a new or proposed POE, this should be the ultimate design volume. Once the ultimate design is known, then lower volumes can be entered to determine phasing of development.
2. Hours of Operation - The worksheet has arrival profiles for seven different hours of operation that range from 10 to 16 hours of operation (whole hours only). The value entered is used to look up the 15-minute arrival pattern.
3. Is this a toll crossing? - This should be answered by entering either a Y or N. If it is not a toll crossing then the toll booth calculations are ignored and traffic "passes" from the first inspection point to the second inspection point.
4. Mexican (MX) Document Inspection Rate - This is an hourly rate per lane (unit) for the first document inspection when entering or exiting Mexico. This is the location where the SAAI is used to randomly select vehicles for primary inspection.
5. Toll Booth Rate - This is an hourly rate per lane (unit) for the toll booths, if applicable.
6. US Primary or Export Inspection Rates - This is an hourly rate per lane (unit) for either the U.S. primary inspection (northbound) or the export document collection rate (southbound). While the northbound process is relatively consistent and the rates are documented in Task 9, the southbound export inspection process varies greatly from location to location. Generally, little delay is generated by the southbound export inspection.
7. Average Delay - This value is applied to the vehicles queued during each 15-minute interval. For conservative estimates 15 minutes can be used which represents all vehicles arriving at the beginning of the interval. If large queues are observed this would be a reasonable assumption. However, if queues are short and dissipate quickly, then a value of 7.5 minutes might be more appropriate. This would represent random arrivals during the interval.
8. Lane Usage - The three columns labeled "# of Units" allows for adjusting the lane usage based on the arrival patterns of the vehicles. If all lanes are or will be staffed then the number of lanes needed to meet the peak hour flow should be entered. If estimates of staffing are to be optimized, then the lane usage can vary over the hours of operation.

Once the inputs are entered the results are shown at the bottom of the worksheet in an area entitled, "Delay & Staffing Summary". For each of the three components the following summary information is provided:

- Total Number of Vehicles - The total number of vehicles calculated by applying the 15-minute percentages to the total volume entered. This total may vary from the input due to rounding.
- Total Delay - This is a summation of the delay in minutes.
- Average Delay - This is calculated by dividing the total delay by the total number of vehicles to determine an average delay in minutes per vehicle.
- Maximum Queue - This is the largest queue of vehicles formed during the hours of operation.
- Person Hours - This a calculation of the person hours that would be required to keep the lanes open.
- Person Days - This is number of person hours divided by eight.

13.7.
Border Station Planning Criteria

This chapter provides guidance to border station planners and designers based on the findings in the six case studies and generally accepted transportation and traffic engineering principles. This guidance is drawn largely from Chapter 9.8 of the Task 9 report. Additional guidance may be found in the latest edition of the U.S. Border Station Design Guide, published by the Public Building Service of the U.S. General Services Administration, Washington, DC.

The following suggestions are provided for use in improving existing border crossings or planning new crossings. They are aimed at optimizing transportation efficiency through border station site planning and design. This chapter describes the conclusions drawn from all case studies conducted. It includes general observations, identification of common characteristics, and examples of opportunities for improving border crossing systems. Also included is suggested additional research into basic characteristics which may aid future border crossing studies. A suggested work program for prototypical border crossing studies will be included in the final Phase IV report.

The conclusions have been developed by the authors on the basis of study observations and analyses. The JWC asked the consultants to identify the true causes of transportation (movement) inefficiencies and to provide opportunities to reduce or eliminate causes of those inefficiencies and to enhance transportation efficiency. Readers may find the conclusions to be different from common perceptions. However, these are the conclusions of the authors based on an objective, technical study.

13.7.1 Border Crossing Systems

Perhaps the single most important finding is that border crossings need to be considered as binational border crossing systems. By this we mean three things:

1. All crossings in an area function as a “system” serving the same trade or transportation corridors, or economic subregion. In some areas there are separate truck and passenger vehicle crossings. In others, there are multiple crossings serving trucks and/or passenger vehicles in the same corridor.
2. For each crossing, there are many individual components which make up the commercial border crossing “system”. Crossings need to be considered separately in each direction because they differ somewhat in the components included and in how they are operated. Components of commercial crossing systems may include:

   Northbound (Mexico to United States)

   - Ingress route
   - Mexican export inspection
   - Toll collection and queue area
   - Border crossing roadway or bridge
   - Primary inspection queue area and booths
   - Secondary inspection platform(s)
   - Additional inspection areas and facilities (canine, x-ray, etc.)
   - Inspection exit and queue area
   - Egress route

Southbound (United States to Mexico)

- Ingress route
- U.S. export inspection (or document collection) and queue area
- Toll collection and queue area
- Border crossing roadway or bridge
- Mexican booth for document inspection/selection for primary inspection (also queue area)
- Primary inspection platform(s)
- Booth for selection for secondary inspection
- Secondary inspection platform
- Inspection exit and queue area
- Egress route

All of these components affect the efficiency and capacity of border crossings. In many respects, they are like links in a chain: the weakest link will eventually cause the chain to break, or in the case of border crossings, the lowest capacity component will limit the capacity of the entire crossing. While there are variations in specific characteristics of individual crossings, they generally operate quite similarly.

3. For each crossing there is a strong relationship between the problems in one country and the impacts on the other. Mostly it is a case of the operational problems on one side of the border resulting in unwanted conditions on the other side. These tend to cause delays and excess costs (economic, environmental, social).

13.7.2 Efficiency Studies

As mentioned in the first chapter, the task was to identify inefficiencies in the movement through border crossings, excluding the inspections themselves and excluding time expended away from the border with documentation, inspections and other factors discussed in Report 3.1. These studies were not to consider the conduct of inspections. However, access, internal circulation, delays for waiting, and other movement-oriented aspects within an inspection facility were included in these assessments.

All six case studies included examination of the commercial truck mode. Initially some case studies were to include combinations of highway and rail. However, while rail was considered, the detailed studies did not include rail border crossings because of the pending Mexican rail system privatization, the anticipated private sector motivation for more railroad operating efficiency, and joint ownership of rail companies on both sides of the border. These factors should result in greater efficiency at rail crossings and significant change in rail operations. Hence, no detailed rail crossing studies were conducted.

Previous chapters of this report identified opportunities for improvements to each of the six case study crossing systems. This chapter describes general opportunities applicable to all or most existing crossings as well as any new crossings being considered.

13.7.3 Key Findings

The key findings from the six case studies are very important to the understanding of the following discussions. They are stated here to sensitize readers to the systematic nature of the way crossings work.

1. Northbound delays are almost always caused by constraints in the inspection facilities (usually in the U.S. primary inspection booths), not at the border crossing roadway or bridge. In only one case was the actual border crossing roadway operating at capacity.
2. Northbound almost no existing crossing (i.e., bridge or crossing road) will ever reach its transportation (vehicular) capacity because the U.S. inspection facilities will run out of capacity first. U.S. inspection facility sites are too small to accommodate enough inspection capacity (primary booths, secondary spaces, and other inspection areas) for trucks (and/or passenger vehicles) to reach saturation flow on the crossing road or bridge.
3. Southbound several Mexican customs inspection facilities have significant constraints due to site size or lack of exit capacity (document inspection and verification).
4. In Mexico the ingress and egress routes are overloaded or carry high truck volumes for which the streets or adjacent development were not intended. Typical access roads are urban streets with no special provisions for high volume, heavy truck traffic and with many conflicts between passenger and commercial vehicles.
5. Demand management and institutional practice changes could reduce some delays in each direction. Practices such as scheduling shipments during off-peak periods, pre-clearing more loads, and encouraging inspection agencies to reduce avoidable time delays would reduce overall delay.
6. Inspection facilities need to be examined in a systematic way covering all components in order to determine “bottlenecks”. Several existing facilities are “out of balance” (have components with significant capacity constraints which limit the effectiveness of the rest of the components which have excess capacity).
7. High volume, commercial truck traffic should be separated from other traffic because the requirements and characteristics for their efficient operation at border crossings are not compatible with passenger vehicles.
8. Minimizing travel delays does not appear to be a priority for either U.S. inspection agencies or toll collectors.
9. In most cases, there appears to be good coordination and cooperation between the U.S. and Mexican inspection agencies.
10. The only reasons for new border crossings (additional locations) should be (1) to serve new trade or transportation corridors, (2) to eliminate freight movement from urban traffic, and (3) to avoid or eliminate land use incompatibility. Many new locations are now being justified on the basis of perceived bridge congestion which is actually due to queues backing up from undersized or inefficient inspection facilities.

13.7.4 General Characteristics of Border Crossing Systems

This section describes typical characteristics of border crossing systems. Some of the operating characteristics of the case study crossings are shown in Table 13.1 in Chapter 3. These are used to provide typical criteria for analyzing or planning crossing system components.

Northbound

Ingress routes in Mexico. These are generally major streets or at-grade highways with frequent cross-street and/or driveway access. In urban areas, most are heavily traveled by mixed traffic. In some locations, truck border crossings have been relocated to exclusive

crossing points away from other traffic (e.g., Otay Mesa-Mesa de Otay). However, even these crossings are accessed from local major streets. In some cases the heavy traffic on the approach routes results in congestion and delays to trucks, other traffic, or both. For example, the heavy traffic in Cd. Juarez often delays trucks approaching the Mexican export inspection facility. In Matamoros, northbound trucks delay some of the passenger vehicle traffic approaching the Gateway Bridge.

Existing border crossing access routes do not always link directly to major maquiladora or other industrial areas in Mexico. Trucks often must travel on narrow city streets through major parts of urban areas to reach border crossings (e.g., Matamoros, Nogales, Piedras Negras, Cd. Juarez). Often these streets are not designed for high volumes of trucks. Turns are often difficult. Streets deteriorate under heavy loads. Travel is slow. Only the separate truck routes in outlying areas seem to operate efficiently.

Access to Crossings. No special provisions have been made for entrance to border crossings at the case study sites to accommodate high volumes of trucks except at Laredo-Nuevo Laredo. Most truck entrances to the crossings are simple driveways without traffic signals or any other provisions. This was a problem at Mesa de Otay and Nogales. Generally the lack of dedicated access routes did not result in significant delays except in Nogales.

Queue to First Control Point. The first control point is normally either the Mexican export inspection booth or a toll booth. However, the queues outside the first control point are usually directly or indirectly caused by insufficient capacity at the U.S. primary inspection booths. Queues developed outside the first control points at all crossings, either because (1) the flow of arriving trucks exceeded the capacity of the booths being operated (2) because the personnel were applying informal flow management to keep subsequent system components from becoming congested, or (3) personnel wanted to keep idling trucks off a bridge (the vibration causes structural deterioration over time). Where such informal management was applied, it was not clear where the authority came from.

In many locations, the available queue space appears to be incidental rather than planned (e.g., Nuevo Laredo and Zaragoza). Sometimes it uses the area between a street and the export facility (Mesa de Otay). At other locations the queues are on the streets as was the case in Nogales, Sonora and Cd. Juarez. The needed queue capacity depends on both the truck arrival rate and the processing rate at the most limiting control point.

Mexican Export Inspection. Inspection of northbound loads destined for the United States is made at this point. There are booths where the documents for all trucks are inspected. Generally about two percent of the trucks are sent to a platform to have loads inspected. In some cases no platform or dock space is provided and trucks are inspected on the street. Typically, where there is a platform, it is off-line (out of the flow of traffic), but is not always easy to access when demand is high. Processing times for Mexican export booth document inspection ranged between 0.5 and 1.5 minutes at the border crossings studied. The average was one minute. Export inspections at the platform ranged between 60 and 180 minutes, and averaged about 90 minutes. There were North American Trade Automation Prototype (NATAP) lanes through parts of the Otay Mesa-Mesa de Otay and Ysleta-Zaragoza crossing systems, but they were not in operation at either crossing when the case studies were performed. These lanes are intended to enable pre-cleared trucks to pass through the facility without stopping by using fully electronic processing of the NATAP trucks.

Toll Booth. All toll booths at the case study crossings were manually operated. There were no coin baskets or electronic toll collection. There is prepayment of tolls via corporate accounts at some locations. However, toll collectors must find these accounts and record the transactions on their computers. This takes as long or longer than collecting a cash toll. In Matamoros, the

measured average toll collection rate was 16 seconds per vehicle (mixed traffic). In few cases were enough toll booths supplied to reach the capacity of the bridge crossing the border (assuming the inspection facilities were not the constraint).

Another observed inefficiency at Matamoros was that all northbound toll booths were closed for 10 to 15 minutes for shift changes while the toll collectors tallied their receipts and counted their money. Much of this delay could have been avoided by staggering shift changes or by handling the checkout procedure in the office. Similar closures resulted at Ysleta-Zaragoza when toll collectors at the truck bridge took breaks.

Crossing. The crossings consist of bridges (over the Rio Grande/Rio Bravo) or connecting roadways between Mexican and U.S. inspection facilities. Some bridges carry mixed traffic (e.g., Laredo II, Eagle Pass, Gateway) while others carry trucks on separate bridges or lanes (e.g., B&M, Ysleta-Zaragoza). The same is true with at-grade roads such as the crossings at Otay Mesa-Mesa de Otay where trucks cross on dedicated truck roads and Nogales-Nogales where trucks cross in mixed traffic. All of the two-way crossings studied were either two or four lanes except Laredo II and Colombia.

Generally, the crossing bridges or roads themselves do not generate any delays unless incidents occur. (The only exception is the two-lane bridge at Eagle Pass-Piedras Negras). However, there is frequently congestion backing up from the U.S. primary truck or passenger vehicle inspection booths onto the crossings, which gives the appearance that the crossing is congested.

Primary Inspection Booths and Queue. All trucks entering the United States must go through the truck inspection facility. This contrasts with the southbound entry to Mexico where empty trucks typically do not go through the truck inspection facility (except Nuevo Laredo).

The first U.S. inspection point is the primary inspection where documents are inspected. No physical inspection is performed at this location at most of the crossings although at some crossings there were occasional canine or vehicle inspections. These additional inspections only occur at primary inspection area when no other space was available to conduct the inspections. In all case studies, at some time in the survey period truck arrivals exceeded the primary inspection processing rate. Hence, there was almost always a queue in advance of primary booths during the busy periods of the day. There were two reasons for this:

1. Booths were not opened in sufficient number to meet the truck arrival rates. They appeared to be operated according to pre-defined schedules, in many cases additional booths opened at about 3:00 p.m. when the second shift started.
2. There were not always enough primary inspection booths at some locations (e.g., Brownsville-Matamoros B&M Bridge) even if staffing was available.

The northbound queues approaching the U.S. primary booths ranged from 0 to over 200 trucks at the six case study crossings. At four of these six crossings the queues extended back onto the bridge or crossing road, making the crossing appear to cause congestion.

Primary inspection processing rates at the study locations ranged between 0.5 and 10.0 minutes per truck. However, the sites where only documents were checked (excludes Brownsville and Ysleta) ranged between 0.5 and 2.5 minutes and averaged approximately 1.5 minutes. It appeared that a processing time of about 1.5 minutes per truck should be used for planning purposes.

Secondary Inspection. Some trucks are directed to the secondary inspection area. The secondary inspections may cover the vehicle, the load, or documents and may take a few minutes to several hours. The extent of inspection was not a part of this study. It should be noted

that the surveys counted all forms of “secondary” inspection, not just Customs inspections. Therefore, the percentages listed below include: USDA, FDA, Customs Compliance, and Customs Enforcement inspections. Also, these secondary counts typically include informal entries which require filing of their import documents.

Between 13 and 53 percent of the trucks were selected for secondary inspections at the crossings studied. The secondary inspections at Brownsville (both bridges), the highest rate surveyed, included some trucks (for which it appeared) that the primary inspection of papers occurred at the secondary platform. The average percentage of trucks selected for secondary inspection was about 31 percent, or about 28 percent omitting Brownsville. It is suggested that planning be based on 40 percent secondary inspections (based on current practice by inspection agencies).

Supplemental Inspections. Several additional inspections are conducted in the U.S. inspection facility. These include canine (for drugs) in the yard, weight, x-ray, agricultural, hazardous materials, and safety. The safety inspection is a state inspection and may be conducted within the U.S. facility, as in Texas, or outside the U.S. facility elsewhere. In all cases, supplemental inspections were conducted on only a portion of the total trucks.

Supplemental inspections are performed at various locations within the U.S. compounds. Most of the equipment or structures used by these inspections are located where space has been judged available. In newer facilities, these locations tend to be on the periphery. There did not appear to be a consistent pattern to the planning and design. A later section of this chapter addresses supplemental inspection locations.

The only one of these inspections which involved many trucks and created any inefficiencies was the x-ray inspection. Trucks were typically queued waiting to be x-rayed. At the two facilities having vehicle x-ray machines, the x-ray queue blocked circulation within the compound, primarily due to improper location of the x-ray unit and truck queuing. X-rays averaged approximately 2.5 minutes per truck at the Ysleta facility. This facility was equipped with a porTable 13.unit where the driver would park his vehicle in a designated area and then the x-ray unit scanned the load. Permanent x-ray units take longer to scan vehicle, because the driver must exit the vehicle and the tractor and trailer are dragged through the unit on a conveyor system. X-ray inspections at the permanent unit at Otay Mesa were taking an average of almost 10 minutes per vehicle. Additional data needs to be collected on the average processing times for x-ray units.

Exit Queue and Inspection. After the inspections, trucks proceed to the exit for a final document inspection. This is merely verification that all required inspections have been completed. This typically took less than 0.5 minute per truck at all locations.

At most facilities there are two exit booths. However, only one booth was used most of the time. Because there were surges of exit traffic, queues developed at some facilities. At Ysleta and Laredo the queues were occasionally created purposely, then used to conduct canine inspections.

At Brownsville, trucks were released from secondary inspection platforms in “waves” of six to eight trucks at a time. This resulted in the trucks all approaching the exit at about the same time. Maximum observed exit queues totaled about eight trucks. At Otay Mesa, canine block inspections of 15 to 20 vehicles were released all at once. These releases created temporary exit queues in excess of 20 vehicles since other vehicles were being released from both the primary and secondary inspection areas.

It should be noted that employee parking is provided inside some of the inspection compounds. Entry to this parking and to the main cargo compound is made by driving the wrong way into

one of the exit lanes. At some of the newer facilities, parking is located outside the actual inspection area. This removes most of the need to use an exit lane for inbound traffic.

Egress Routes. Virtually all egress routes to the United States take trucks to a main road by way of a secondary road. Some of these roads are very short and trucks reach the main road within a few hundred meters. Most provide direct routes to regional highways. However, some of the older crossings require driving through a downtown area or other urban area (e.g., Brownsville-Matamoros B&M Bridge). As mentioned above, several truck crossings have been moved to outlying locations (e.g., Otay Mesa-Mesa de Otay) to facilitate access to major highways and avoid delays.

Southbound

Ingress Routes in United States. See northbound egress routes.

U.S. Export Inspection. Some crossings have been provided with export inspection booths or platform facilities. Otay Mesa and Ysleta are two of these. However, these facilities are not currently being used. Southbound trucks currently bypass these facilities or drop documents into an unstaffed collection box.

Toll Booths. As with the toll booths in Mexico, all tolls are collected manually or through computer-accessed corporate accounts. Toll booths can be a capacity constraint southbound because the Mexican inspection routine is far less time consuming on the average.

For bridges accommodating both trucks and passenger vehicles (with mixed or separated flow), toll collection is done by the same entity. However, sometimes the truck toll booths are separated from those serving passenger vehicles (because the inspection facilities are separated). Staffing at these locations are managed as if it was separate operation. At one bridge no relief collector was available to replace a collector taking a rest or lunch break and the bridge was effectively closed as a result. This was reported to be normal practice. This operational delay could be avoided by providing one of the relief collectors during the break period.

At Brownsville, average toll collection was approximately 16 seconds per vehicle (mixed traffic). Payment by corporate account at other locations took 0.5 to 1 minute to process.

Crossing. See northbound crossings. Only loaded trucks and vehicles being imported into Mexico are subjected to the Mexican truck inspection process. Empty trucks and tractors without trailers pass through inspection with passenger vehicles at all crossings except Laredo-Nuevo Laredo where empty southbound trucks enter the truck inspection facility and immediately exit with a pass.

Document Inspection and Queue Area. The first step in the Mexican inspection process is document inspection by a central computer (SAAI) that recognizes the document bar code and selects about ten percent of the trucks for primary inspection. All loaded trucks and cars being imported to Mexico must pass through this step. Usually there is one booth per lane and there are at least two lanes. Processing time ranged from 0.8 to 2 minutes per truck, although the average for four of the five crossings surveyed was about 1.2 minutes per truck.

A queuing area is usually provided in advance of the document inspection booths. Except at Mesa de Otay and Matamoros, there are only a few spaces provided off the bridge or crossing road. Significant queues did occur at most crossings. These queues appeared during the peak hours of operation and ranged from about 50 to 250 trucks. At only one of the five crossings surveyed did the queue back onto the crossing road or bridge (Laredo).

By policy, ten percent of the entering vehicles are sent for primary inspection. This includes both trucks and import cars (primary inspections are a total of ten percent of trucks and import cars combined). Trucks not selected for primary inspection proceed directly to the exit.

Generally the number of booths is sufficient to accommodate truck arrival rates. However, they are not always open according to demand. Often the queue has already formed before sufficient numbers of booths are opened and it is impossible to process enough trucks to eliminate the sizable queue. In most cases there is insufficient queuing space in advance of the booths. Sometimes the selection of booths being operated causes conflicting truck movements leading to extra delays or processing rate inefficiencies as was the case in Matamoros. These inefficiencies result in decreased processing rates per booth as the number of booths increase.

Primary Inspection. Trucks selected for this inspection proceed to the platform. Inspections are similar for each truck and include inspection of only the freight. Mexican policy is for these inspections to take a maximum of three hours. Inspections were observed to range from one to four hours at the surveyed facilities, averaging approximately 2.5 hours. Based on inspection policy, an inspection time of three hours should be assumed for planning purposes. Once the inspection is complete, trucks approach a second booth where selections for the secondary inspection are made. Only trucks having completed primary inspection are subject to secondary inspection.

Primary inspection capacity is a constraint at Nogales, Sonora and Nuevo Laredo. The speed of inspection cannot compensate for the lack of room. The inspection yard therefore becomes saturated during busy periods. There does not appear to be a standard number of primary inspection dock positions. Only two of the facilities appeared to have substantial excess capacity.

Secondary Inspection. By policy, ten percent of the vehicles completing primary inspection are selected for secondary inspection. This is one percent of all vehicles passing through the inspection facility. The secondary inspection is a repetition of the primary inspection (for quality control purposes), but is performed by another entity (private contractor; usually more efficient than primary inspection). By policy this inspection is also to be a maximum duration of three hours. These inspections averaged between one and three hours per truck at the surveyed facilities, averaging approximately one hour per truck carrying maquiladora cargo and two hours per truck carrying other cargo.

While the primary inspection platforms had no standard number of positions, the secondary platforms generally had two positions. Secondary inspection is not currently a constraint at any facility.

Exit Inspection and Queue Area. As with the U.S. inspection, the Mexican exit inspection is a review of the documents to make sure the necessary inspections were completed. It normally takes less than one-half minute. There is little queuing at most facilities, but there is also little queue area provided. Maximum queues typically were about seven trucks. Occasionally these queues blocked the secondary inspection area. However, only at the Matamoros inspection facility was the exit inspection the critical constraint.

Egress Routes. See northbound ingress routes.

13.7.5 Opportunities for Improvement

Based on observations and analyses conducted during the case studies, several opportunities have been identified for improving operational efficiency and facility layouts. These opportunities fall into several categories:

- general planning considerations,
- facility layout and operational changes, and
- institutional actions.

General Planning Considerations

Crossings should be considered part of the regional transportation system. The border areas have typically one or more major highways on each side of the border. Most U.S. inspection facilities are on roads with direct connections to highways extending to the major industrial concentrations and/or ports in each country. This is not the case for the Mexican access where some crossings have distant, circuitous, or inefficient access to the regional highways. It is important that regional access highways be considered in locating future border crossings. Crossings located away from the existing or planned major highway system require one of two things:

- state and federal transportation agencies must fund new major highways to connect to the border crossings; if not; then
- crossings will get connected to local roads and trucks will be forced to traverse the local street system to reach the major highways.

Either of these situations should be avoided unless there is close proximity between the U.S. and Mexican primary generators of the binational truck trips.

Where high volumes of large trucks are expected, dedicated corridors serving separate truck crossings would be beneficial. This would enable the trucks to be separated from passenger vehicle traffic and therefore reduce conflicts in operations (for the crossing access routes, the border crossings, and inspection facilities). Otay Mesa-Mesa de Otay and the Colombia Bridge are such examples. This will also enable trucks to be placed away from land uses with which trucks are not compatible. The truck corridors to the border should serve industrial land use concentrations, especially those which will have major maquiladora concentrations. These roads can be designed to handle the high truck volumes.

Land use management (plannning and zoning) should direct binational industry to locations accessible to existing and planned access routes to truck border crossings. Maquiladoras, warehousing, distribution centers, intermodal terminals, and other Binationally oriented industry should be located where convenient to:

- efficient access to existing and planned border crossings
- regional highways (and rail as applicable)
- uncongested roadways

This will keep heavy truck volumes off local streets and minimize truck travel times.

All components of the crossing system should be sized for the ultimate volume of trucks to be served. When new crossings are built, they are often in undeveloped areas with open land around them. It is possible at such times to obtain sites which can accommodate the ultimate size system—access roads, crossing lanes, inspection facility of adequate size, sufficient logistics services etc. Land is more available and less costly when a new facility is being planned. Facilities should be planned and land acquired for their ultimate anticipated volume. They can be implemented incrementally as many inspection facilities now are.

Crossing Configurations

Separate commercial and passenger vehicle flows. These two types of flow should be separated so they do not conflict with or delay each other. The inspection facilities are already separated. Each can generate queues which extend well back from the inspection booths, especially northbound where inspections are more time consuming. By separating the two flows, the delays to one flow will not affect the other. Usually passenger vehicles back up during peak periods and will delay trucks in mixed flow traffic. This is the case in Laredo and on the Brownsville-Matamoros Gateway Bridge.

Separate vehicle and pedestrian flows. At traditional crossings, vehicles use roadway lanes and pedestrians use sidewalks on the edges of the bridges and crossing roadways. This results in trucks having to cross pedestrian paths in advance of the inspection points. This crossing of pedestrians and trucks is typically accomplished without any special traffic control.

At the Ysleta-Zaragoza bridge, a pedestrian bridge carries pedestrians to the second level of the inspection building out of the path of trucks and other vehicles. Pedestrians then descend to the first level within the building. This is safer and more efficient for all. It can be accomplished more easily where crossings involve bridges but should be pursued in all locations with significant pedestrian traffic.

Toll Collection

Maintain sufficient lanes open to meet demand. Sufficient lanes should be provided to meet peak hour demand. When bridges or other toll facilities are built including toll collection lanes, they should be sized for ultimate volumes. Staffing the lanes to meet demand will avoid queues from accumulating.

Electronic toll collection should be utilized to speed toll collection. This would also enable prepaid corporate tolls to be collected without manually accessing accounts by computer. Manual collection will still be needed in some lanes for those who are infrequent travelers across the border or those who prefer not to have toll transponders in their vehicles. Electronic toll collection capacity is limited only by permissible travel speed and vehicle spacing, but should be able to process ten passenger vehicles per minute if demand exists. The Dallas (Texas) North Tollway Toll Tag lanes currently process over 25 vehicles per minute, based on recent consultant observations.

Collect tolls more efficiently. Observed toll collection rates appear to be less than four vehicles per minute. However, elsewhere tolls are collected much faster. Speeding the process are large signs showing the amount of the tolls, both in advance of the toll booths as well as at the booths, no receipts handed out except on request, and tolls of less than a dollar. The Tri-State Tollway in Chicago collects cash tolls at approximately 10 cars per minute and 3 large trucks per minute (consultant observation).

Use current technology. Self-serve or electronic equipment collection are much higher than collection rates observed at the case study border crossings, but vary depending on equipment used. Self-serve lanes can process up to ten personal vehicles per minute under a steady queue (tolls less than a dollar), although perhaps 6 to 8 per minute would be more realistic with the current tolls charged at border crossings (ranges from $US 1.25 to $US 1.45 at adjacent crossing in downtown Brownsville).

Collect tolls in one direction only. Delays could be avoided in one direction if round trip tolls were collected in one direction only. Tolls could be doubled in one direction and free in the other. In order for this to work, this change would need to occur on all bridges along a significant section

of the border, with tolls being collected in the same direction on all of them. This would eliminate the toll collection cost and time delays in one direction. Toll collection effort and time consumed in the other direction would be the same as existing. One-way toll collection is used on California toll bridges. If tolls are rounded off to even dollar or peso denominations (e.g., 3 dollars or 20 pesos), toll collection could even be faster.

Inspection Facilities

Ingress routes should be major streets or highways. They need to be able to efficiently accommodate large trucks and have direct connections to the regional highway system.

Inspection facility access should efficiently accommodate truck turns into the site. This requires adequate geometric design for truck turning paths from the proper lanes of the adjacent street. It also requires sufficient sight distance to enable drivers to safely and quickly drive to the open booths. This means that booths should be set back from adjacent streets by at least three full truck lengths (about 250 feet or 75 meters including spacing between trucks). In some cases a traffic signal or other appropriate control device may be needed to enable trucks to cross opposing traffic.

Sufficient queue capacity should be provided on site in advance of the initial inspection or toll booth. This should be based on the anticipated normal peak daily truck volume and the processing rate of the booths (or other capacity constraint). It is suggested that in the northbound direction one full truck length (including space to the next truck) should be provided for every two peak hour trucks based on the 10th to 15th highest volume day of the year. In the southbound direction it is suggested that one full truck length be provided for every 30 daily trucks based on the 10th to 15th highest volume day. Trucks should be assumed to be pulling 53 foot trailers and be up to 75 feet (23 meters) long. With ten feet (3 meters) between trucks, 85 feet (26 meters) should be used for each truck length.

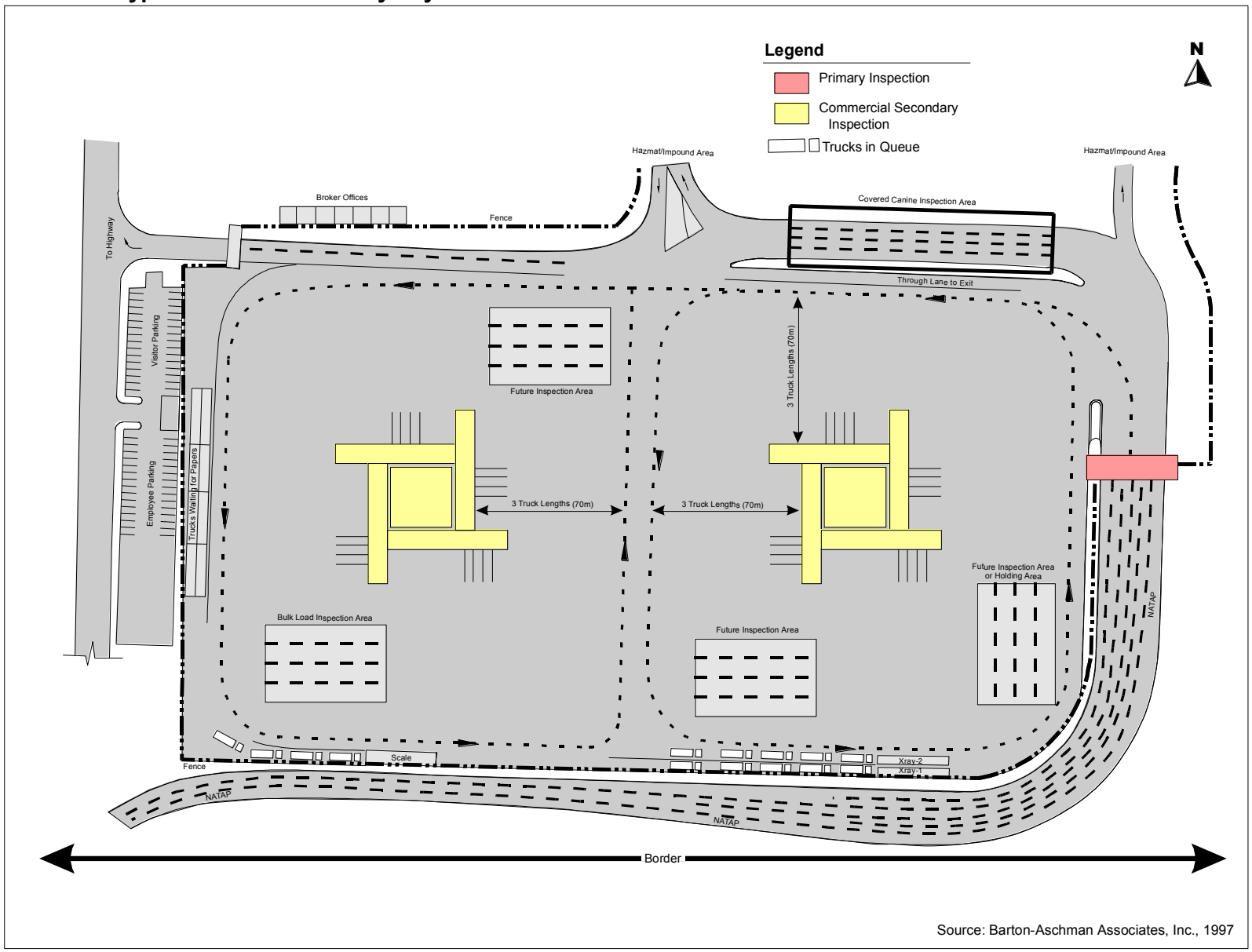
It is suggested that none of the truck queue spaces be provided on the bridge structure. The vibration caused by idling truck engines will accelerate bridge deterioration. In addition, the cost of providing queue space on a bridge is more expensive than providing it at-grade.

The queue road should have at least two lanes throughout its entire length. This will ensure that immobile trucks can be passed. Each inspection lane should extend at least 425 feet (130 meters) (about 5 truck lengths) in advance of the inspection booths.

Figure 13.12 shows a suggested layout which may provide sufficient queue length. Notice that the queue road extends along two sides of the site. In addition, a NATAP lane should also be provided. This will enable pre-cleared trucks to pass through the facility with minimal delay.

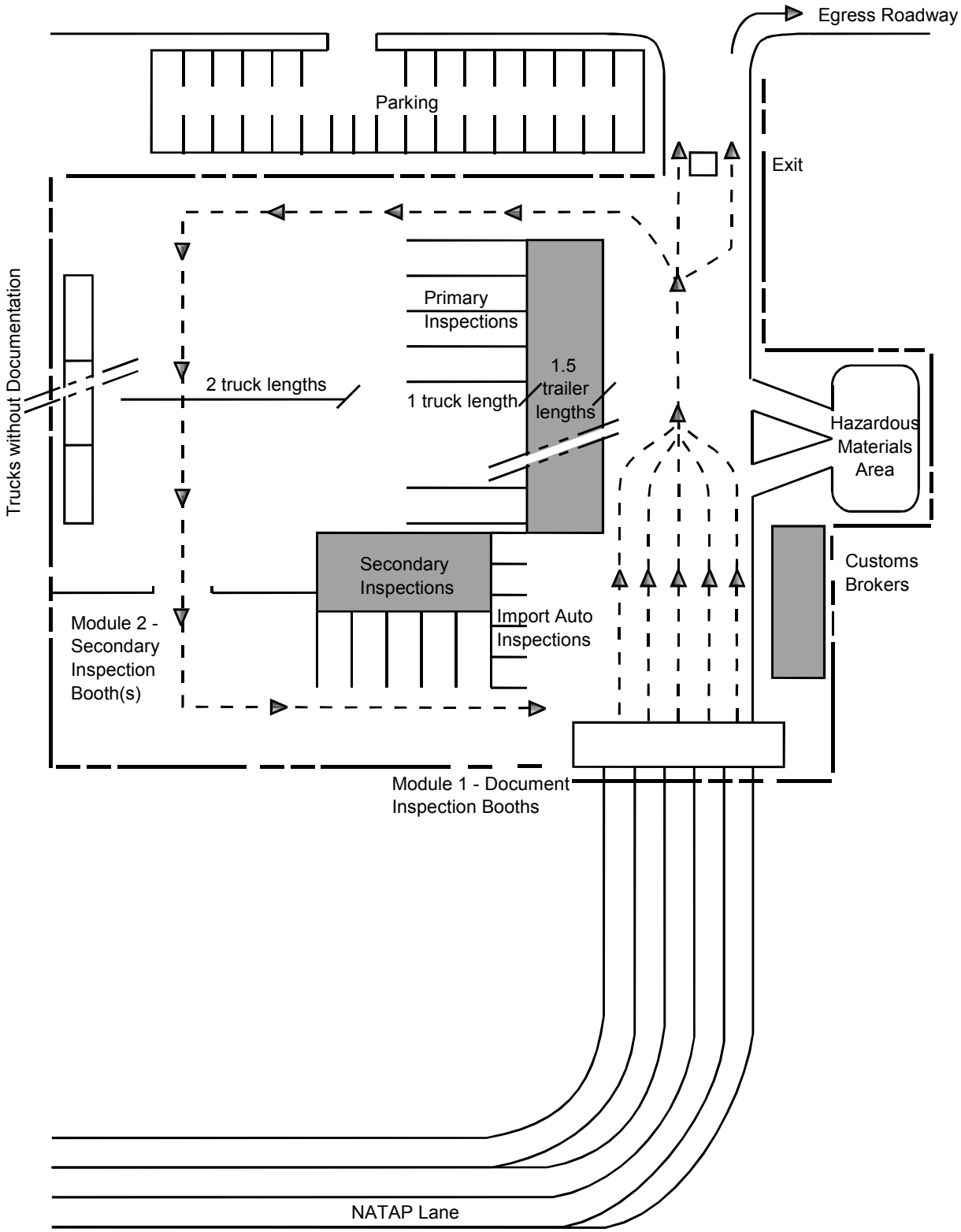
Adequate counts of truck volumes must be recorded in both the northbound and southbound directions for the planning, design and monitoring of inspection facilities. These counts need to differentiate between loaded tractor trailers, loaded single units, empties and bobtails.

Figure 13.12 Prototypical U.S. Port of Entry Layout



Source: Barton-Aschman - La Empresa, 1997

Figure 13.13 Prototypical Mexican Port of Entry Layout



Source: Barton-Aschman - La Empresa, 1997

U.S. primary inspection lanes are usually the bottleneck**; provide and staff sufficient lanes to meet ultimate demand.** Primary lanes should be opened on time and be staffed to meet demand. It was observed that queues were allowed to build early in the day at several facilities and due to short staffing, processing did not catch up to demand until the afternoon. In some cases (e.g., Brownsville B&M Bridge, Laredo II) there were not enough booths to meet arrival rates, even when fully staffed. The primary inspection processing rate is typically one truck per 1.5 minutes. A minimum of one lane should be provided for each 250 daily trucks forecast for design purposes.

Internal circulation should be counter clockwise. This facilitates circulation by having the inside turns on the driver's side of the truck where visibility is best.

All secondary and supplementary inspection sites should be off-line. All of these inspections are optional. Trucks should not need to pass through inspection sites unless they are to be inspected there. Hence, the circulation pattern should be to enter through primary booths and pass through the compound without stopping until reaching the exit where all trucks must be inspected. Supplemental inspection sites may be arranged in different orders, although scales should precede the x-ray (because tankers are often weighed before being x-rayed) and the canine inspection block should be close to the primary booths but out of the circulation path.

Mexican secondary inspection facilities should be reorganized to respond to changes in Mexican regulations. Beginning in September 1997, secondary inspections will no longer serve as the quality control of primary inspections. Instead, primary inspections will be conducted by both Customs and the private companies which have had the secondary inspection concessions. The distribution of primary inspections between Customs and the private firms will be 60 percent and 40 percent, respectively. Quality control will be accomplished by comparing the results of these two independent inspection groups.

With the consolidation of primary and secondary inspections, the existing inspection areas will need to be restructured in a proportional manner between the Customs and the private companies. The space provided in the existing secondary inspection areas will no longer be sufficient to handle 40 percent of the inspections. In theory, these areas should be separated, however, in practice this may be difficult at the ports of Nogales, Piedras Negras, and Matamoros.

Given the similarity in the primary inspections in the Mexican ports and the proposed regulatory changes, the design of the area of primary inspection should be considered as two separate zones with the capacity to serve the proportional peak demand of the estimated flow. It is also important to consider that the average inspection is three hours in length. Finally, a special area for parking vehicles destined for primary inspection should be considered in new projects. This space would provide reserve capacity in the event that the primary inspection docks reach saturation (capacity).

More exit lanes should be provided from the Mexican inspection facilities. This will eliminate the queues which develop during heavy inspection periods in several Mexican compounds. The number of exit lanes should be estimated based on the projected peak hour truck volume and the inspection rates. It is suggested that a minimum of one exit lane be provided for each 90 peak-hour trucks passing through the compound. The inspection rate could be doubled if a better method of inspection were devised.

Sufficient maneuvering space should be provided in front of all docks. At least three full truck lengths (225 feet or 70 meters) should be provided in front of all docks to ensure efficient maneuvering. It should be understood that many of the drivers using the inspection facilities are not skilled in backing trucks in confined spaces and need extra space to line their trucks up.

NATAP lanes should be extended through the inspection facilities. They should allow NATAP trucks to bypass all inspection areas and queues, thereby deriving maximum benefit from the NATAP process. The NATAP lanes need not be exclusive throughout the inspection compound, but should only share space with active circulation lanes not available for queuing or inspections.

Institutional Changes

Federal and state transportation agencies should provide lead agency guidance in locating new border crossings. Border crossings are major components of the federal and state transportation systems. They should be effective parts of the regional systems. As part of the state (U.S.) and federal (Mexico) plans, these agencies should sponsor proposals for new crossings where they fit into the regional transportation system plans, especially in strategic corridors. The agencies' current reactive role to local sponsorship results in some crossings being located away from the regional highway system. This requires extensive and expensive new road and highway connections.

Encourage shippers to move loads at off-peak times. Present truck arrival patterns indicate that truck volumes during peaks hours are approximately 40 to 120 percent above the daily average. Peaks occur at various times throughout the day. However, the majority of crossings, experienced at least one peak between 12:00 p.m. and 4:00 p.m. Other peaks occur at some crossings, such as an early morning peak at Otay Mesa when empties and bobtails are allowed to cross. Ysleta had one peak at 9:30 a.m. followed by a large peak at 12:00 p.m. Delays can be reduced by shippers if they dispatch trucks to arrive at the border during low demand periods.

U.S. Customs, trucking associations, trade associations, transportation agencies, and/or the JWC could also publicize periods of low demand to encourage truckers and shippers to more frequently arrive at off-peak periods. Should these users elect to cross the border during times of peak delay, they should bear the cost of time delays rather than public entities building additional facilities.

Pre-clear more loads. Some shipments are now pre-cleared before reaching the border. Inspections at remote locations or advance documentation checks could reduce border crossing time. By pre-clearing trucks, time consumed at the border can be reduced to primary/document inspection only. Agricultural loads are currently pre-cleared at Nogales and inspected by both countries' agricultural inspection teams at locations away from the border crossing.

Pre-inspection can be further encouraged by sealing pre-inspected trucks and allowing them to use NATAP lanes which would effectively eliminate time delays at the border.

Encourage truckers to use fastest routes, demonstrating the benefits. It was reported by several sources that truckers tend to use the lowest cost routes rather than the fastest ones. This is particularly true where tolls are charged. Drayage companies are paid by the trip and have no incentive to make the trip faster unless they can make an additional trip. Drivers being paid by the hour have no incentive to use quicker routes. Drivers paid by the trip have no incentive unless they can make an additional trip. They also can keep the cost of the toll. Where toll and free crossings exist in nearby proximity (e.g., El Paso-Cd. Juarez tolled Ysleta-Zaragoza Bridge and free Bridge of the Americas), drivers tend to use the free bridge, especially if not pulling a load. This results in greater use of the free facility when travel time would be less using the toll crossing. Where time can be saved using a crossing, it should be publicized by either the inspection agencies, the DOTs or SCT, or the JWC; or mandated.

Encourage additional inspection agency coordination of inspections. Inspection scheduling should be coordinated better to have one agency's inspectors immediately follow

another agency's inspectors once an inspection is complete. Communication and coordination is also important once a process is established.

Use electronic (computer) capabilities more to reduce time and effort to process paperwork manually. Computer technology should be available to identify trucks by a transponder card, bar codes, or other similar technology. This should allow up-to-the-minute processing of both accounts and status. NATAP is a good first step.

Encourage enforcement agencies to consider reduction of unnecessary delays to be part of their mission. Enforcement agencies have a difficult and time consuming challenge to successfully inspect vehicles crossing the border. Many inspections require hours to complete. This should be considered accepTable 13.under the laws, regulations, and policies of the two countries. However, there are unnecessary delays occurring regularly at several of the U.S. inspection facilities at case study sites. Most of these delays consist of long waits approaching primary inspection (not enough booths open). Other delays occur at several Mexican facilities due to poor utilization of or ineffective traffic management at document inspection booths. This inefficiency is due to poor layout and maneuvering space along with the lack of traffic control. In both cases, increased staffing and/or improved traffic management practices could resolve most of these delays. The U.S. Customs could staff the primary inspection booths to meet demand patterns and the Mexican customs could post one or more traffic control officers to direct trucks to open booths which cannot be readily seen by the drivers.

On a typical Friday at the four locations surveyed using the controlled count methodology (Brownsville, Otay Mesa, Laredo and El Paso), the above measures could save at least 3,500 hours of northbound truck travel time.

Bridge and road border crossings should be viewed as parts of the transportation system rather than an economic enterprise. Toll facilities are looked upon by many local municipalities as a way to make a return on investment, directly or indirectly. Some cities view crossings as a revenue generator (excess toll revenues). Others view them as a way to encourage new business to locate in their area. This has led to the construction of new crossings which are not optimally located and/or require substantial additional investment in roads to make them viable. They should be viewed as functional parts of a transportation system consistent with area transportation objectives.

13.7.6 Additional Research

Three additional research topics are suggested to provide needed information for proper planning to accommodate binational transportation needs. These are described below.

Additional data on processing rates. Sizing of facility components could be improved if primary and secondary processing rates are measured by truck type (bobtails, empty tractor trailer combinations, and loaded trucks); percent of trucks inspected for all secondary inspections (enforcement, compliance, agricultural); percent x-rayed; percent inspected in canine blocks and duration of inspections.

Estimate mode split for freight among truck and rail, and if practical, air and sea. Part of the above need can be met by providing methods for forecasting the transport mode to be used for binational shipping. Most important for the types of studies made under this contract are truck and rail. However, estimates of air and sea shipping would also be useful for planning airport and seaport facilities.

13.8.
Prototypical POE/Border Crossing Case Study Description

This chapter outlines a typical case study for either a Port of Entry (POE) or individual commercial vehicle border crossing. The study emphasizes an assessment of operational efficiency, of trade movement by truck across the U.S.-Mexican border. This description covers only commercial activity; it does not cover passenger vehicle or pedestrian crossings (although many of the same principles and activities would be the same).

13.8.1 Ports of Entry and Study Definition

A port of entry, as defined by the U.S. Customs Service (USCS), may include one or more adjacent border crossings along a section of the international border. In the United States, normally the crossings within a port of entry are operated by staff of the USCS under a single director. However, commercial vehicle travel patterns alone may or may not define the crossings within a port of entry system to be in the same commercial travel corridor. Typically, shippers do not choose the corridor based on the efficiency of movement but rather by habit and familiarity ignoring good logistical practices.

In the United States, some existing trade data is available only by port of entry; it is not disaggregated to the individual crossing level. In Mexico, the data are classified by city which, in some locations, may include several crossings. Some of this data is discussed in reports on Tasks 2 and 3 of this study.

When considering a case study, it makes more sense to determine what the objective of the study will be rather than to start by designating a port of entry to evaluate and then decide what to study. Typical case studies could include one or more of the following:

- study trade flows across the border
- study border crossing efficiency
- identify major trade corridors served by a port of entry
- study economic impact of trade across a segment of the border
- study costs or benefits of trade across a segment of the border

This report addresses the first three types of study. The Task 14 report provides methods for conducting the last two.

It is best to define the needs before selecting the type of study to perform. The needs may be based on:

- questions raised locally or elsewhere
- observations of operational problems
- need to prepare long range plans or improvement programs to meet new or increasing demand
- other events or issues affecting trade or transportation

Once the need for a case study has been initially identified, an initial study scope of work should be developed. It should define the study purpose, the desired output(s), and a general approach. This should be reviewed with the study sponsors/requesters. It is best if the next

step, interviews of key people, can be completed before the scope of work is finalized. That way issues or needs can be better defined and appropriate procedures defined.

A list of questions and people to interview should be developed. The intent is to obtain a more complete definition of the problems or needs to be addressed by the study.

13.8.2 Key Person Interviews

The next step should be to talk with key people who are or will be involved in border trade or the port of entry or border crossing operation being studied. These may include:

- Customs services
- Immigration services
- Other federal inspection agencies operating at the study location
- Federal transportation departments
- Department of State's border coordinator
- State border inspection agencies (agriculture, transportation, safety)
- U.S. General Services Administration (GSA) and in Mexican the Commission of Appraisals of the Secretariat of the Comptroller and Administrative Planning (La Comision de Avaluos de la Secretaria de Contraloria y Desarollo Administrativo SECODAM)
- State transportation department
- Adjacent city and county officials
- Local transportation planning organization (i.e., MPO)
- Chambers of commerce
- Broker's association
- Trucker's association
- Major shippers
- Border bridge operator
- Other entities involved in generating or serving shipping across the border
- Other entities involved in transportation operation or enforcement at the border

It is preferable to interview the most senior or most knowledgeable person in each selected organization so the most appropriate and correct information can be obtained. This is especially important in defining the actual need. Other staff may be more helpful in obtaining data or other details.

The key persons should be asked to describe existing border trade, crossing operations, impacts, problems or issues, desires, etc. based on the initially identified need. The objective is to better define the need so the study area or crossings can be determined and the scope of work more fully defined. These will feed into the next step.

13.8.3 Identify Basic Concerns and Complete Work Scope

The interviews should provide the basis for completing the definition of concerns or objectives to be addressed. These should be objectively stated and reviewed with the study sponsor.

Once the needs are agreed on, the scope of work should be completed. In addition to the description of concerns and objectives, it should include the outputs, steps to be taken, the information needed, and the methods to be used. Given the large number of entities which may

have interest or jurisdiction, it may be appropriate to designate reviews or work sessions to discuss important findings.

13.8.4 Background Data

Three types of data may be needed:

- trade data describing the magnitude and types of trade served
- facility inventory data to describe the characteristics of the facilities of interest; these could include border or bridge crossings, access system, support facilities (e.g., warehouses, truck terminals), major shipper locations, truck routes, toll charges, etc.
- operational data (e.g., traffic volumes, truck counts, operating and inspection procedures)

Typical sources for operational and transportation facility characteristics are indicated in the in the Tasks 2 and 3 reports. More specific data can be obtained from the USCS POE from the Port Directors and through collection of new data. Local transportation departments and the Customs Management Center Directors for the USCS are also good sources. In Mexico, the local offices of CAPUFE are the best source for statistics on truck movements across the international toll bridges. Some local Mexican Customs offices maintain the accurate counts of trucks in both directions.

13.8.5 Border Crossing Capacity/Delay/Efficiency Study

Generally a capacity/delay/efficiency study will be used to either:

- assess the operational efficiency of an existing border crossing
- develop information as input to improving an existing border station's operation or facilities
- size or support the planning and design of a new border station or expansion

The following steps are suggested. Depending on the specific study need, some or all of these steps may be applicable.

1. Identify existing crossings which serve the trade corridor being studied. It is important to distinguish between the crossings within the port of entry system and those serving the trade corridor; they are not always the same.
2. Collect and review truck volume data to determine the utilization of each route and crossing. Potential sources include:

United States	Mexico
U.S. Customs Service (USCS)	Department of Treasury & Public Credit (SHCP)
Bureau of Transportation Statistics (BTS)	Secretariat of Industry, Trade & Tourism (SEDICOT)
Cities	Secretariat of Commerce & Transportation (SCT)
Counties	Municipalities
State DOT	States (including state SCT offices)
Border bridge operators	Federal Toll Highways & Bridges (CAPUFE)
Metropolitan Planning Organizations (MPOs)	Border bridge operators (FIDENOR, etc.)

3. Conduct a reconnaissance of the border access routes and the border stations serving the corridor. Identify any observed inefficiencies, queues, congestion, conflicts,

circulation difficulties, etc. Record important access route physical characteristics which may be needed for capacity analyses, including conflict points and likely capacity constraints. List all border station inspections and crossing system components. Also record the number of critical inspection units in the border stations (for U.S. stations, the number of primary inspection booths, secondary dock spaces; in Mexican stations, the number of both import and export document inspection booths, primary inspection dock spaces).

4. To the extent not already done during the key person interviews, meet with persons responsible for aspects of operations. Discuss border station schedules, level of activity (e.g., number of crossings; obtain data), operations, problems, needs, pending improvements, and other topics relevant to the study purpose.
5. Determine which crossing(s) need to be studied further to complete the desired analysis. This will depend on the problem/need/objective of the study.
6. For each crossing to be studied further, collect the following data unless confirmed not to be needed; operating data should be for a peak weekday during a peak season.
    - select "peak" day
    - inventory number and type of units for each crossing system component, such as:
        - booths
        - lanes
        - dock spaces
        - x-ray machines
        - scales
    - border station site plan or aerial photograph (or sketch if better information not available)
    - surveyed arrival counts by five minute interval[5] (at the first entry point to a border crossing system inspection facility or at the back of the queue approaching that point); survey from opening to closing times
    - surveyed processing times at critical points by five minute interval[5] from opening to closing times:
        - toll collection
        - export document inspection and inspection selection
        - export primary inspection (Mexico only)
        - export secondary inspection
        - export document inspection (Mexico only)
        - import document inspection and primary inspection selection (Mexico only)
        - import primary inspection
        - import secondary inspection selection (Mexico only)
        - import secondary inspection
        - canine block inspection -- all locations (U.S. only)
        - x-ray inspection (U.S. only)
        - other auxiliary inspection (U.S. only)

[5] Five minute interval needed so queues and processing times can be estimated; direct timing is very labor intensive.

- exit document inspection
- any other location where significant numbers of vehicles are stopped for 2 minutes or more, except queue areas

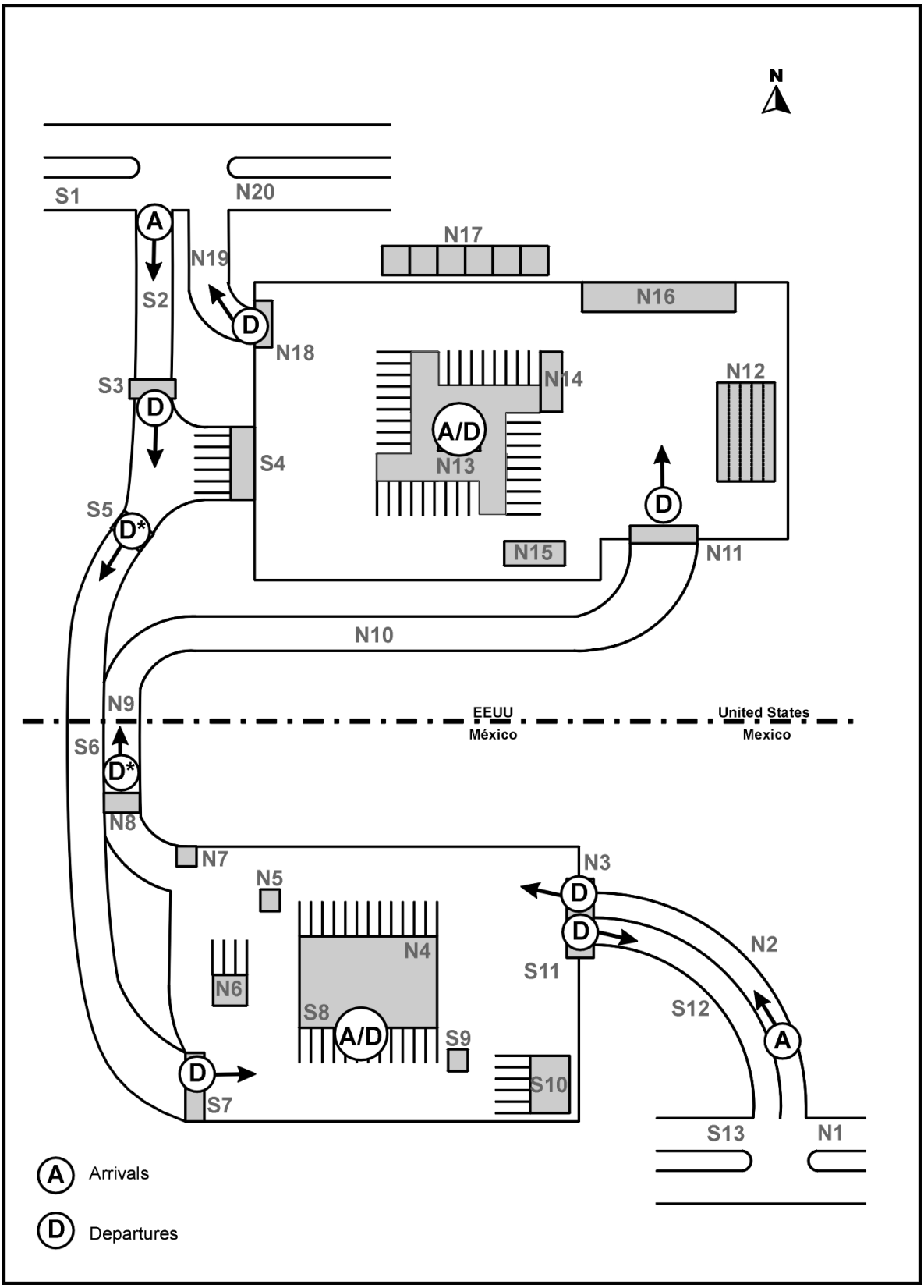
Also record the number of inspection or toll collection units operating at any time; these may change during the day.

Note: For components where vehicles must stop (i.e., toll booth) the volume and processing times can be collected together by noting the number of vehicles arriving and leaving by five-minute period, then computing the average processing time.

Figure 13.14 shows where survey personnel should be located for a complete survey of a typical border crossing system. Personnel should be located so they can count arrivals and departures of one or more components. The arrows on Figure 13.14 show the counts that could reasonably expected to be made at a busy crossing. Local site considerations (sight lines, volume of trucks, personal safety, station director's orders, etc.) may require different locations and number of personnel. No surveys should interrupt border station operation or truck flow.

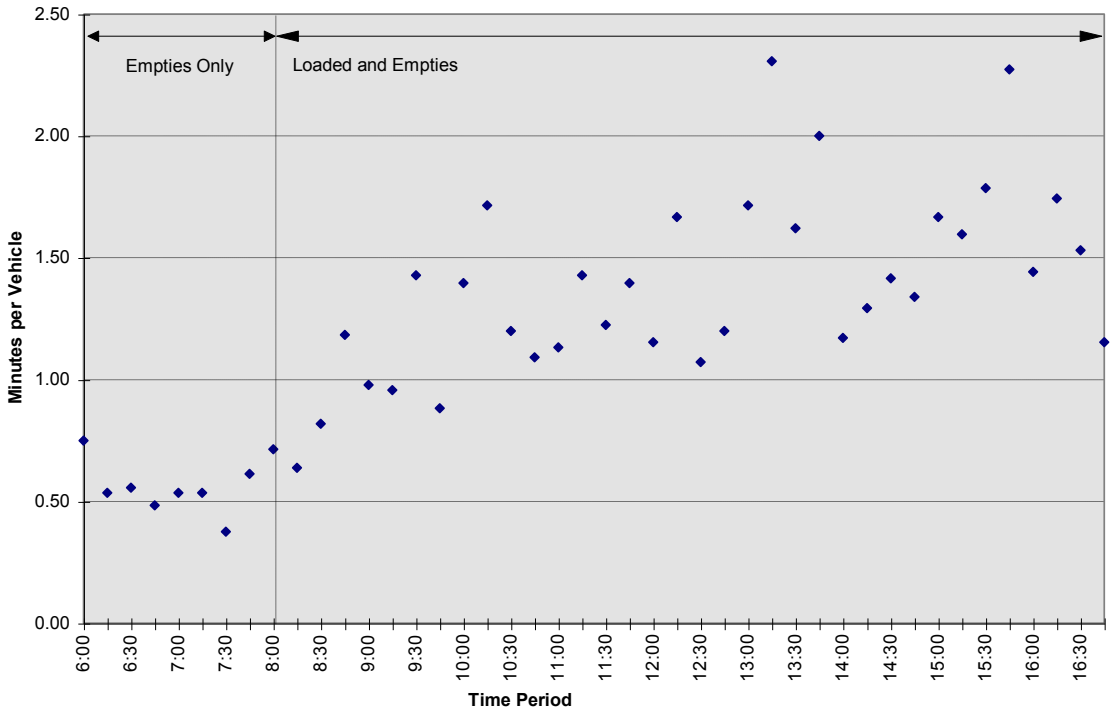
7. Observe operations. At least one person experienced with evaluating operations in the field by observation should participate. Look for *causes* of any inefficiencies; be sure to distinguish causes from symptoms. Discuss any uncertainties with border station personnel. There should be a cause for any of the following:
   - delays (access routes, inspections, circulation, maneuvering to/from docks)
   - queues
   - conflicts
   - gaps in moving traffic other than low demand
   - inefficient maneuvering or circulation
8. Obtain the USCS daily count of vehicles processed for the survey day(s)
9. Identify apparent bottlenecks from field observations.
10. Summarize and analyze the data collected. Graph the processing times at inspection locations where problems appear to be generated (see Figure 13.15 for example). Compute queue lengths where observed to be significant; this can be done by subtracting the arrivals at the crossing component following the queue from the departures from the preceding component using the times recorded in the survey. Use model to analyze capacities and identify location and extend of capacity deficiencies and imbalances among the system components.
11. Compare computed results to observations and resolves any differences.
12. Identify possible improvements which can eliminate or reduce existing problems. These should be aimed at eliminating the *cause* of the inefficiency or constraint. At several of the case study border stations changes to personnel schedules could alleviate much or all of the observed queues and delays, so physical improvements may not always be needed. Possible types of improvements include:
    - management, institutional, or other operational changes
    - physical improvements (cost-effective or "high cost")
    - include additional crossing capacity
    - a new crossing

Figure 13.14 Typical Survey Personnel Deployment



Source: Barton-Aschman - La Empresa, 1997

Figure 13.15 Sample Primary Inspection Processing Times - Otay Mesa, 1997



Source: Barton-Aschman/La Empresa, 1997

Among the opportunities which could be considered are:

Institutional and management

- changes in staffing schedules to open inspection capacity more in accordance with demand/arrival patterns
- change in number of stations or operating hours
- use of different inspection lanes/booths to facilitate circulation/maneuvering, especially when some of the booths/lanes will not be in use
- reallocation of inspection dock spaces
- encourage/manage arrival times to spread peak demand over more of day
- release trucks as inspections are completed rather than in “waves”
- designate (different) approach routes to separate commercial vehicles and/or to route them on roads with sufficient capacity

Site layout improvements

- modify the circulation pattern
- increase maneuvering space
- relocate truck holding areas to more remote locations
- relocate certain inspections to locations out of the circulation paths (e.g., canine blocks, porTable 13.x-ray)

- in constrained sites, relocate safety inspections off site
- modify border station access, either the facility access or access roads to alleviate bottlenecks

Additional capacity

- increase the number of (primary or document) inspection booths
- increase the number of inspection dock spaces
- modify toll collection procedures/technology to reduce processing time
- provide more queue capacity
- expand border station site(s)
- reconstruct some border station buildings or other facilities for greater inspection or circulation efficiency

New border station

- relocate border station to larger or more efficient site or construct supplemental station to function as annex for certain inspections (e.g., separate Caltrans safety inspection site at Otay Mesa to be connected by dedicated road between sites)

New border crossing

- The case studies showed that there is little likelihood that a crossing bridge or road will run out of capacity before the inspection stations do. Hence, efforts should be initially focused on improving the capacity and operation of the inspection facilities before examining a new crossing unless travel patterns or other considerations dictate a new corridor. Until other opportunities are explored, it is usually not cost-effective to consider a new crossing location, especially if a bridge is required. This is because new access and crossing roads are usually required in addition to the border stations themselves.

13. Discuss the possible institutional and management solutions with the study sponsor for reasonableness, then analyze their potential effectiveness.
14. Evaluate potentially workable physical and operational solutions using the capacity analysis software described in Chapter 6, manual analysis techniques, or (for internal circulation in high volume areas), traffic microsimulation models (e.g., NETSIM, CORSIM, GPSS).[6] Some may require geometric layouts and some conceptual design work to complete the evaluations.
15. If appropriate, explore changes to the site layout, considering cost-effectiveness. Utilize the principles contained in the last chapters of the Task 9 report to obtain operational efficiency and flexibility.
16. Compare the results of the options which appear to produce desired improvements. Identify how well they meet objectives/criteria established for improving the border crossing. It may be desirable to perform a cost/benefit analysis using:
    - value of time/reduction in delays
    - cost of improvements or new facility
    - incremental cost of operations (positive or negative)

[6] NETSIM and CORSIM are traffic simulation software distributed by McTrans (see footnote 3). GPSS is a more general purpose simulation package which can be adapted to internal circulation analysis.

17. Identify the most desirable improvements (if any) and discuss with study sponsors. Discussions should also occur with the affected inspection agencies and agency owning the facilities needing improvement. Very often this may require a joint effort among the local city or county, the transportation agencies, the inspection agencies, and the facility owner.

13.8.6 Serving New Routes and Generators

From time to time there may be need to serve new commercial trip generators and/or travel corridors (usually highways) developed by transportation agencies. Rarely will the new corridor attract all of the existing commercial vehicles to the new location unless they can no longer cross at the former locations. In some cases it may have been decided that a new crossing is needed to meet various local objectives or because a satisfactory improvement of the existing crossing is not feasible or cost-effective. In such cases, it will be necessary to locate a new border crossing then create a new crossing and border stations.

In recent years commercial vehicles have been frequently separated from passenger vehicles and provided with a separate crossing or inspection facility. This is perhaps the first decision which has to be made. Most crossings remain open after the new facility is completed, so the questions are:

- will the existing crossing remain open?
- will commercial vehicles be accommodated on the existing crossing?
- will the new crossing accommodate commercial vehicles only, passenger vehicles only, or both?

If the answer to the second question is “no,” the new crossing question is not commercial and is subject to a different analysis than is described here. The analysis should then address what can be done with the existing crossing when it has fewer passenger vehicles to serve (after some go to the new crossing). This might involve redesigning the entire border station (both personal and commercial vehicle parts) to better accommodate the commercial vehicles (if that is needed). In any case, the analysis would be similar to the analysis of existing conditions described in the previous section.

If commercial vehicles will use the new crossing, then an appropriate location should be determined. This requires establishing criteria for that location. It will also depend on whether personal vehicles are to be accommodated.

In general, the following steps should serve as a guide for such analyses. Specific issues, needs, or conditions may require other analyses. This is also not intended to be a complete primer on the steps necessary to achieve either local or binational approval of a new crossing or permits to proceed with construction. Those requirements and guidelines can be obtained from the U.S. Department of State and Mexican Secretariat of Foreign Relations. A generalized list is contained in Section 4.4.1 of the Task 4 report. The following discussion relates only to the transportation aspects of a border crossing case study.

1. Determine the current and future (20 years) distribution of demand in the corridor being examined. This should include the location of maquiladoras in Mexico and truck terminals and major distribution centers and customs brokers warehouses on the U.S. side.

   In the United States, this may be aided by data available from USCS or the U.S. Bureau of Transportation Statistics by individual crossing or port of entry. Generalized regional travel patterns can be obtained for use in analyzing broad corridors covering large areas. This may be satisfactory for looking at corridors traversing largely rural areas of the

border. Traffic volume data from state or federal DOTs may also help. In urbanized areas, MPOs should have recent traffic volume information and also projections of future demand and travel patterns. They may also have estimates of future truck traffic within their urbanized areas. In some cases these data may extend beyond the urbanized areas. In Mexico, the information about traffic is provided by SCT via automatic counters located in federal roadway corridors at the outskirts of the major border cities, while CAPUFE maintains daily vehicular flows on the highways and toll bridges. Some states, such as Tamaulipas, have just created an institute of transportation to address these issues. At the municipal level, as in Cd. Juarez, there is a municipal planning organization that works in coordination with the El Paso Metropolitan Planning Organization. Nonetheless, this is a relatively isolated example. (There are few existing coordination efforts like this)

The Task 12 report discusses techniques for forecasting trade flows. These techniques may be applicable for the particular study.

This information should enable the analyst to assess the location and general magnitude of current and future demand across the corridor.

2. Review the existing and planned highway and major road system in the corridor. Depending on location, this may be available from the Mexican Secretariat of Communications and Transport (SCT), or state, county, MPO, city transportation agencies or departments. Identify logical border crossing locations which could both serve demand patterns and connect into the regional highway system in a logical way (connection fairly direct to major regional roads and provides reasonably cost-effective crossing route).
3. For logical options which would connect to regional routes, estimate volumes of trucks or traffic which will use the possible connections/crossings. This can be done using the travel forecasting techniques available in urban areas from the U.S. Metropolitan Planning Organizations (MPOs) and in Mexico by SCT and the secretariats of public works in the border states. At present, there is not a unified binational travel forecasting procedure, so U.S. and Mexican forecasts will have to be patched together. USCS may also be able to provide estimates, at least for existing and short term estimates.
4. For those routes which look promising (substantial demand, serve trade corridors directly), identify possible border crossing locations. These should consider:
    - alignment
    - land availability (road and border station sites)
    - adjacent land use (existing and planned)
    - major environmental sensitivities
    - consistency with local and regional plans, including transportation
    - ability to serve both regional and local demand
5. Review projected travel volumes and revise as needed to comply with apparently possible crossing locations. Identify major improvements which might be needed for each option (e.g., additional lanes, significant additional right-of-way).
6. Review findings with study sponsor and others as appropriate. Discuss possible crossing locations and roadway system connections. Identify those to be considered further.
7. For those crossing locations which still should be considered, identify the following:
    - access roads
    - border station sites

- estimate sizes needed (area and minimum dimensions, based on the latest version of the GSA *U.S. Border Station Design Guide* for U.S. border stations.
- SECODAM needs to provide a similar set of guidelines for Mexican border stations.

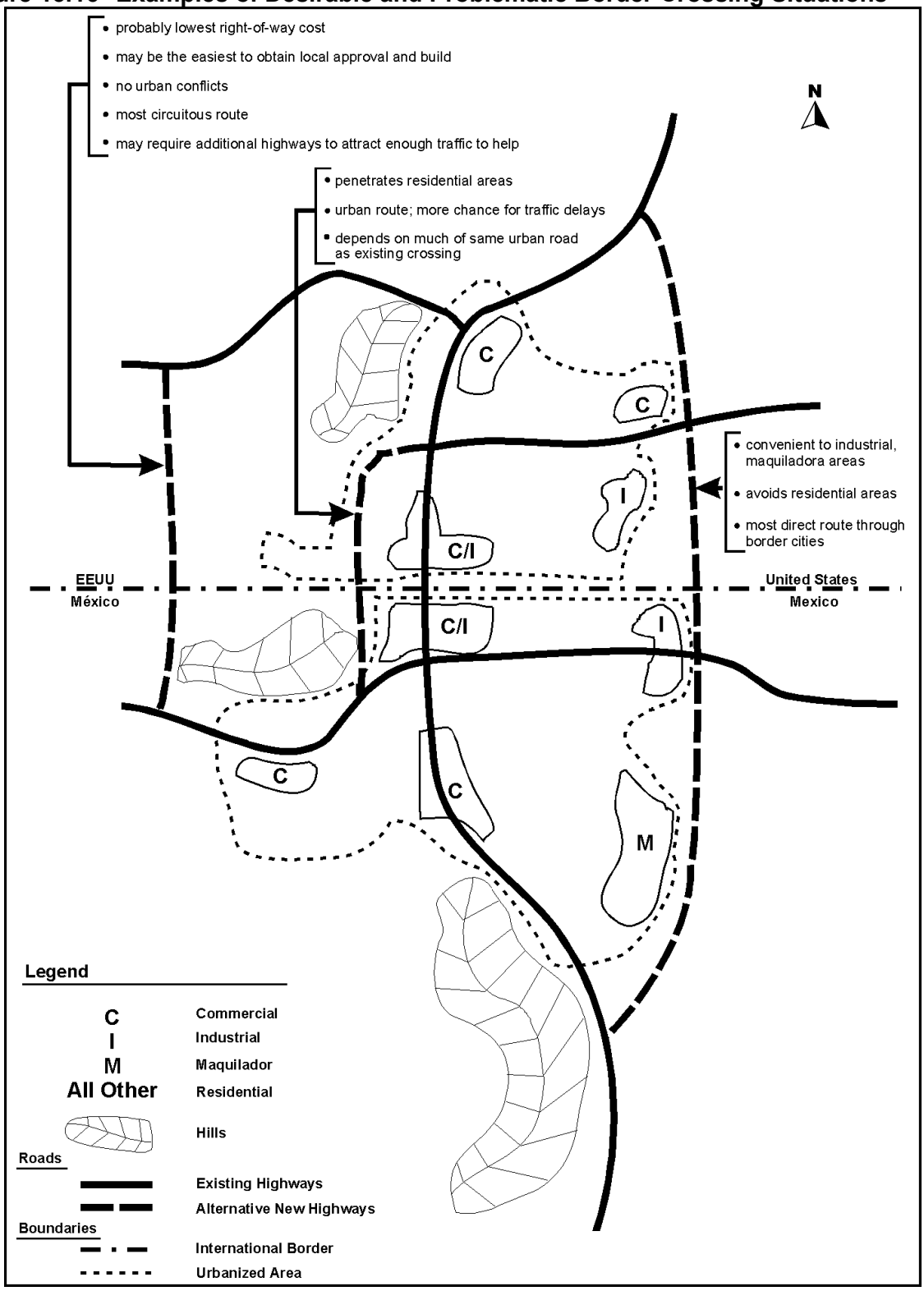
8. Meet with GSA, USCS, SCT and SECODAM to discuss operational charcteristics to be assumed for preliminary border station site sizing. These may be default values described in Chapter 6 or other values based on local surveys or agancy prefernce.
9. Based on the projected volumes and border station characteristics discussed with the U.S. GSA and SCT and SECODAM in Mexico, use the border station capacity analysis model to estimate component sizes.
10. Investigate available sites which could accommodate a new crossing and associated border stations. Note any particularly restrictive or advantageous characteristics which will influence the site layout.
11. Prepare initial layouts of border stations using information generated in steps 8-10. Use the site plan principles described in Chapter 7 of this report.
12. Establish criteria for comparing new crossing locations, including the border stations. These should include applicable criteria considered in the binational border crossing approval process, although the detail may be less at this time.
13. Compare crossing locations and select one or more for serious consideration. All of these should be generally workable and should meet the objective of efficient connection across the border and efficient connection with the regional highway system. Figure 13.16 shows some hypothetical crossings which make sense and others which do not.
14. Refine traffic/truck usage estimates as appropriate.
15. Based on local needs, complete enough additional planning and design to permit a rough cost estimate for building the crossing. This should include land acquisition, environmental mitigation (based on what can be projected at this time), permitting and approvals, financing, design, and construction.
16. Review results with sponsor and refine analyses as appropriate.

This will produce an analysis which will provide the basis for making a preliminary decision on the location for a new crossing. It will be the starting point for the more formal studies and preparation for public review, detailed planning, environmental studies, cost estimating and funding, binational approval, design, and permitting. The objective of the above analysis will be to reach the point that a tentatively preferred crossing site is selected and that the site and operational requirements for both the crossing and the border stations are know, at least in preliminary form.

13.8.7 Review Findings With Requesting Entities and Others

One of the shortcomings of recent planning efforts for new and improved border crossings and border stations has been insufficient coordination with the entities that must approve, own, build, operate, or otherwise be involved in such projects. The list of possible entities is large. The following is a list of commonly involved entities; others may be involved in specific locations:

Figure 13.16 Examples of Desirable and Problematic Border Crossing Situations



Source: Barton-Aschman - La Empresa, 1997

United States **Mexico**

- Department of State (Presidential Permits & binational coordination)
- U.S. and state Environmental Protection Agency
- U.S. and state departments of transportation
- U.S. Department of the Interior (Fish and Wildlife Service)
- U.S. Coast Guard (if bridge)
- International Boundary & Water Commission (IBWC - U.S. Section)
- State historic preservation agency
- State north of crossing
- City(s) through which access road(s) pass
- County(s) through which access road(s) pass
- Local Metropolitan Planning Organization (MPO)
- Other agencies which must sign off on environmental assessment and/or impact statement (EA/EIS)
- Funding entity(s)
- General Services Administration
- Project sponsor, if different from above
- Inspection agencies (usually at least USCS, INS, Department of Agriculture; may include state agriculture, safety or transportation agencies)
- Secretariat of Foreign Relations - SRE (Approval & binational coordination))
- Secretariat of Interior - SEGOB
- Secretariat of Environment, Natural Resources, and Fisheries - SEMARNAP
- Secretariat of the Comptroller and Administrative Planning - SECODAM
- Commission of Land (Property) Evaluation - CABIN
- International Boundary & Water Commission (CILA - Mexican Section)
- Secretariat of Communications and Transport - SCT
- Secretariat of Public Works (border states) - SAHOPE
- Federal Toll Highways and Bridges - CAPUFE
- Municipalities

Depending on what decisions are to be pursued, the correct agencies must be involved; the earlier the better. This is particularly true for planning of the border station sites (see GSA and inspection agencies as soon as possible for U.S. facilities and SCT, SHCP, and SECODAM for Mexican facilities).

13.8.8 Revise Findings and Prepare Documentation

The analyses will have to be refined and extended over a period of time to increasing detail. The type of documentation to be prepared will be specific to the purpose. For the initial studies it is suggested that a straight forward and concise report be prepared. It should define the need and desired output, then document what was done and the findings, conclusions, and recommendations. Assumptions, data summaries, analysis techniques, alternatives analyzed, and principal findings should all be described. Sketches of the crossing, border station sites, access roads should be provided in increasing detail. Important supporting data and other justification should be provided, although it is recognized that more detailed information may need to be provided later or to selected reviewers in some form. The study sponsor should specify the initial level of detail.

Appendix 1
Arrival Patterns for Case Study Locations