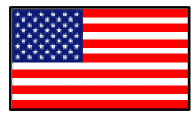
Publication No.: FHWA-OP-03-XXX
October 2003

# Washington State – British Columbia

# International Mobility and Trade Corridor (IMTC)




# ITS – CVO Border Crossing Deployment

# Evaluation Final Report

U.S. Department
of Transportation

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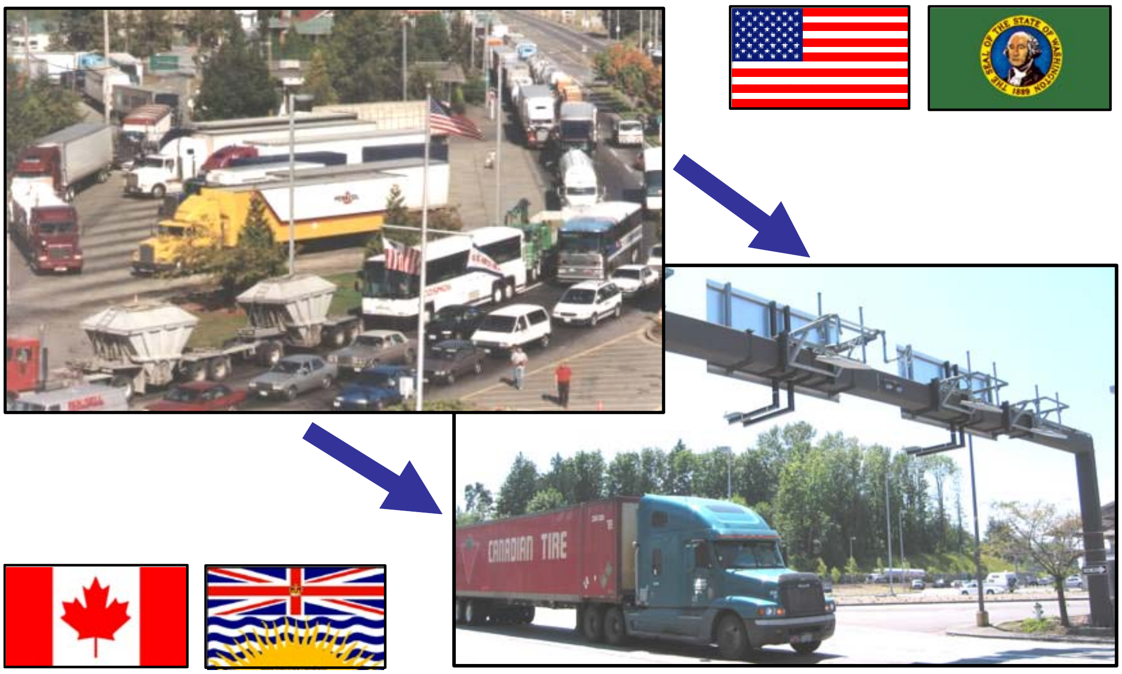


# ITS – CVO Border Crossing Deployment

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of Transportation

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http://www.its.dot.gov

FHWA Office of Freight Management
http://ops.fhwa.dot.gov/freight/

USDOT Office of Intermodalism
http://www.dot.gov/intermodal/freight.html

ITS Cooperative Deployment Network (ICDN):

http://www.nawgits.com/jpo/icdn.html

ITS Electronic Document Library (EDL):

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**USDOT ITS Joint Program Office**
**FHWA Office of Freight Management and Operations**
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Mr. Mike Onder (Task Manager); Dr. Joseph I. Peters (COTR)

**16. Abstract**

The Washington State – British Columbia International Mobility and Trade Corridor (IMTC) ITS-CVO Border Crossing Deployment is allowing for the completion of a bi-national freight border crossing ITS system at the border, and is a follow-on effort to a multiyear border freight ITS deployment program funded by WSDOT, FHWA, and Transport Canada. However, while the ITS systems have now been fully deployed under this system, the physical infrastructure (i.e., additional lanes and revamped customs booth areas) on both sides that would allow for expedited clearance and travel time reductions to occur are still awaiting final funding decisions by WSDOT and Transport Canada. Therefore, it is not yet possible to measure the benefits of this system, since ITS-equipped trucks continue to have to wait in the same lanes and lines as non-ITS trucks.

Based on this context, the SAIC-TranSys bi-national evaluation team, with the support of the FHWA Office of Freight Management and Operations and the ITS-JPO, decided in early 2002 to focus this evaluation effort on modeling the corridor benefits associated with future ITS dedicated truck lanes on both sides of the border, as well as associated trade and regulator benefits including weigh-in-motion data sharing and elimination of broker visits through enhanced systems. Here, the primary objective of this evaluation was to quantify, as much as possible, the relevant benefits and costs associated with the dedicated ITS truck lanes and associated corridor freight systems to IMTC stakeholders, and provide valuable data inputs and insight for future border crossing/corridor ITS technology programs.

Based on the significant benefits and benefit-cost ratios, especially for the motor industry, that are highlighted in this Executive Summary, it is intended that the results of this report may serve as an input to the United States and Canadian effort to finalize funding for the infrastructure portions of the Dedicated ITS Truck Lanes concept in the near future.

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# ABBREVIATIONS

| | |
|---|---|
| ABI | Automated Broker Interface |
| ACE | Automated Commercial Environment |
| ACS | Automated Commercial System |
| ACROSS | Accelerated Commercial Release Operations Support System |
| AMS | Automated Manifest System |
| APL | American Presidents Line |
| ATIS | Advanced Traveler Information System |
| AVI | Automatic Vehicle Identification |
| BC | British Columbia |
| BIF | Border Infrastructure Fund |
| BCTI | Border Crossing Transportation Initiatives |
| BNSF | Burlington Northern Santa Fe Railroad |
| BRASS | Border Release Advanced Selectivity System |
| CADEX | Canadian Electronic Information Exchange Software |
| CBP | U.S. Bureau of Customs and Border Protection |
| CCD | Cargo Control Document |
| CCRA | Canadian Customs and Revenue Agency |
| CN | Canadian National Railroad |
| CO | Carbon Monoxide |
| CPI | Consumer Price Index |
| CSI | U.S. Customs Container Security Initiative |
| C-TPAT | Customs Trade Partnerships Against Terrorism |
| CUSP | Canada - U.S. Partnership Agreement |
| CVIEW | Commercial Vehicle Information Exchange Window |
| CVISN | Commercial Vehicle Information Systems and Networks |
| CVO | Commercial Vehicle Operations |
| DSRC | Dedicated Short-Range Communication |
| EDI | Electronic Data Interchange |
| FAST | Free and Secure Trade Program |
| FIRST | Frequent Importer Release System |
| FHWA | Federal Highway Administration |
| FOT | Field Operational Test |
| GEH | Quantitative Error Approach |
| IBC | International Border Clearance |
| IMTC | International Mobility Trade Corridor |
| INS | U.S. Immigration and Naturalization Service |
| IPIL | Integrated Primary Inspection Lane |
| ISP | Internet Service Provider |

| | |
|---|---|
| IT | Information Technology |
| ITDS | International Trade Data Systems |
| ITS | Intelligent Transportation Systems |
| JPO | Joint Program Office |
| N2O | Nitrous Oxide |
| NAFTA | North American Free Trade Agreement |
| NATAP | North American Trade Automation Project |
| NB | Northbound |
| NORPASS | North American Pre-Clearance and Safety System |
| NPV | Net Present Value |
| NSB | National Safety Board |
| PACE | Peace Arch Crossing Entry |
| PAPS | Pre-Arrival Processing System |
| PARS | Pre-Arrival Review System |
| PIP | Partnership Information Program |
| PM | Particulate Matter |
| POE | Port of Entry |
| RMD | Release on Minimum Documentation |
| SAIC | Science Applications International Corporation |
| SHIP | Strategic Highway Infrastructure Program |
| TCC | Traffic Control Centers |
| TCOS | TransCorridor Operating System |
| TMC | Traffic Management Center |
| TSi | TranSys International Consultants Limited |
| USDA | United States Department of Agriculture |
| USDOT | United States Department of Transportation |
| VACIS™ | Vehicle and Cargo Inspection System |
| VMS | Variable Message Signs |
| VOC | Volatile Organic Compounds |
| WA | Washington |
| WCOG | Whatcom Council of Governments |
| WIM | Weigh-in-Motion |
| WSDOT | Washington State Department of Transportation |
| WSP | Washington State Patrol |

# EXECUTIVE SUMMARY

The Executive Summary has been provided as a separate stand-alone document.

# 1. INTRODUCTION

## 1.1 CURRENT CHALLENGES

Driven largely by a general increase in economic growth and specific growth generated by the North American Free Trade Agreement (NAFTA), new demands for cross border commercial transportation have risen over the past decade. Many stakeholders see the need for improvements to infrastructure, border operations, and information systems to link information dissemination between stakeholders to facilitate safe, efficient, and secure movement of United States – Canada cross-border shipments.

Canada represents the United States' largest trading partner. Between 1994 and 2000, United States – Canada trade rose from $243 billion to $406 billion, a growth rate averaging 8.9 percent annually.[1] This bi-national trade steadily increased over the last 10 years, with commercial truck traffic increasing by 80 percent over the Washington State – British Columbian border since NAFTA was implemented.[2] The Province of British Columbia and Washington State share a common international border, and trade across this border is economically significant for both countries. Bilateral trade at the Blaine Border Crossing between Washington State and British Columbia was valued at more than $35 million per day in 2000.[3]

This sharp rise in commercial vehicle traffic places increasing pressure on both border crossing facilities and U.S. and Canadian enforcement agencies. As a result, commercial vehicle crossings are often delayed and long truck queues waiting to cross in either direction are a common sight near border crossings. A 1998 Whatcom County Council of Governments survey of British Columbia and Washington State trucking companies estimated that $40 million (U.S. dollars) is lost annually to the regional freight industries due to border crossing delays.

The existing international border-crossing infrastructure is not sufficient for these levels of commercial vehicle traffic, and clearly inadequate for future demands. In addition to increased bi-national trade and strained border infrastructure, new demands were placed on international enforcement agencies following the events of September 11, 2001. United States and Canadian inspection agencies are demonstrating increased awareness towards national security through tougher scrutiny of incoming shipments and individuals. It is no longer sufficient to enforce national laws and regulations or collect customs' duties, fees, and taxes due. The U.S. Department of Homeland Security Bureau of Customs and Border Protection (CBP)[4] and the Canadian Customs and Revenue Agency (CCRA) are now combining forces on the front lines in the war against terrorism and related security threats.

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[1] U.S. Department of Transportation, Bureau of Transportation Statistics, *North American Trade and Travel Trends*, BTS02-07, Washington, D.C., 2001.

[2] Whatcom Council of Governments, www.wcog.org, 2002.

[3] U.S. Department of Transportation, Bureau of Transportation Statistics, *North American Trade and Travel Trends*, BTS02-07, Washington, D.C., 2001.

[4] The U.S. Department of Homeland Security Bureau of Customs and Border Protection (CBP) is the new name for the organization that was formerly the U.S. Customs Service. In this report, the terms "CBP" and "U.S. Customs" are both used to identify this new organization (see: http://www.customs.gov).

Security concerns prompted existing programs that promote pre-approval for individuals and commercial shipments to be reviewed and either be curtailed, or to be reinvented with increased emphasis on security. Commercial traffic took an immediate, temporary hit that reduced border crossings, but the levels are beginning to return to approach pre-September 11 levels.

Both the United States and Canada need to accelerate efforts to address necessary improvements to facilitate cross-border commercial mobility. These improvements will involve embracing new technology applied to modern infrastructure enabling appropriate information sharing between United States and Canadian private and public sector organizations. This can only be achieved through a collaborative effort between bi-national public and private endeavors, resulting in creative solutions yielding improved of commercial vehicle shipment movements on both sides of the United States – Canadian border.

## 1.2 POTENTIAL UNITED STATES – CANADA COLLABORATIVE SOLUTIONS

### 1.2.1 The Washington State – British Columbia IMTC ITS – CVO Border Crossing Deployment

The Washington State – British Columbia International Mobility and Trade Corridor (IMTC) Intelligent Transportation System (ITS) Commercial Vehicle Operations (CVO) Border Crossing Deployment is attempting to become the first fully operational and bi-national electronic CVO border crossing system in North America. With a total United States and Canadian investment of $4.35 million, this ITS deployment is the largest single investment in CVO border crossing ITS technology in history. This deployment is providing a unique opportunity to examine the development of a working model system that coordinates shippers, motor carriers, and selected international governmental agencies linked to a single information system. Unlike past and current dedicated short-range communications (DSRC)[5]-based border crossing systems (e.g., North American Trade Automation Project (NATAP), Ambassador Bridge), which focused on very limited tests of ITS technologies, this project will deploy an operational prototype system, allowing for a more thorough system analysis and leading to valuable “lessons learned” for future ITS international border crossing initiatives. The deployment will be supported by a unique and already mature regional and international public-private partnership – the IMTC.

This ongoing deployment provides the core concepts for this advanced ITS-enabled bi-national CVO border crossing system evaluation. This evaluation effort is not designed to render judgment on the technical effectiveness of a completed operational test. The IMTC ITS – CVO Border Crossing Deployment is currently in the midst of Phase II operational testing. The basic technology system was previously evaluated during the Phase I deployment.[6] This evaluation is essentially an in-depth benefit-cost analysis

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[5]DSRC is the automated vehicle identification (AVI) technology tested at several border crossings and many toll roads in the United States. DSRC provides support of state trucking credentialing efforts (including the nation-wide Pre-Pass transponder network and the NORPASS system). The primary elements of this technology are in-vehicle transponders, roadside antennas, and a centralized computer database.

[6] WSDOT Intermodal Data Linkages Freight ITS Operational Test Evaluation Final Report, Part 1: Electronic Container Seals Evaluation, published by FHWA, December 2002.

that will review many of the concepts relating directly or indirectly to many of the primary benefits that will likely be derived from using an ITS-enabled border crossing system such as the system being deployed by Transcore in Phase II. This evaluation report describes the cost-benefit analysis materials for both Phase I and II.

### 1.2.2 United States and Canadian ITS Border Crossing Initiatives

The Federal Highway Administration (FHWA) has a vested interest in automated CVO border crossing systems development similar to the IMTC deployment. FHWA's International Border Clearance (IBC) program directs and coordinates ITS technology deployments at international border crossing sites to facilitate trade and enhance commercial vehicle safety. This program seeks to test the feasibility of using ITS at border crossings to facilitate trade, enhance safety, and promote more efficient processing of commercial vehicles at international points of entry. The IBC seeks to improve collection of trade statistics and more effective means of import/export processing. The IBC leverages advancements in information technology and vehicle identification to provide public sector agencies with timely and accurate information to aid in making effective decisions concerning cargo, driver and vehicles arriving at the US border. Advanced information allows for faster and more accurate shipment processing at the border than currently is the case.

Historically, operational tests of DSRC border crossing systems under the IBC program were largely focused on technological effectiveness and developing processes by which CBP personnel can interface with a particular technology. The IMTC ITS – CVO Border Crossing Deployment provides an opportunity for a more complete examination of a fully operational border crossing system that addresses multiple aspects of truck border clearance processes and network integration with previously unconnected public and private systems. This benefit-cost evaluation will provide ITS border crossing cost and benefit inputs to support the National ITS Costs and Benefits Database being implemented by Mitretek for the United States Department of Transportation (USDOT) ITS Joint Program Office (JPO). Since 1994, the USDOT's ITS/JPO has collected information on the impacts of various ITS projects throughout the United States.

In December 2001, Governor Tom Ridge and Canadian Deputy Prime Minister John Manley signed the "Smart Border" Declaration that outlined a 30-point action plan to enhance the security of our shared border, while facilitating the legitimate flow of people and goods. The action plan has four correlated sections: the secure flow of people; the secure flow of goods; secure infrastructure; and information sharing and coordination in the enforcement of these objectives.

One new joint United States – Canadian program resulting from the dialogue developed from the "Smart Border" Declaration is the Free and Secure Trade (FAST) program. FAST seeks to securely and efficiently move commercial shipments across our shared border. The FAST program is the result of a shared objective to enhance the security and safety of Canadians and Americans, while enhancing the economic prosperity of both countries. The FAST program will allow importers on the United States – Canada border to obtain expedited release for qualifying commercial shipments.

In the Greater Vancouver area, there is strong interest in pursuing ITS initiatives, both regionally and provincially. The ITS Corporation was established to define a regional British Columbia ITS program. The ITS Corporation membership is comprised of representatives from various local public and private transportation organizations. This organization was responsible for developing the strategic plan for ITS in British Columbia, which included recommendations for enhancing border clearance for commercial vehicles.

### 1.2.3 International Mobility and Trade Corridor (IMTC)

The IMTC is a coalition of over 60 United States and Canadian business and government entities whose mission is to identify and pursue improvements to cross-border mobility in the "Cascade Gateway". This area includes four land border crossings between British Columbia and Washington State. IMTC-sponsored projects are funded through bi-national financial partnerships at federal, regional, and local levels. The IMTC stretches geographically from Vancouver, British Columbia in the north to general areas south of Olympia, Washington.

Many bi-national organizations take part in regularly scheduled IMTC meetings. IMTC participants meet regularly to discuss projects and regional planning issues related to the cross-border transportation and inspection systems. Participants come from transportation agencies, inspection agencies, local jurisdictions, regional government, industry associations, and non-governmental organizations from both sides of the border. Some distinct features of the IMTC include:

- The IMTC provides a forum facilitating collaboration and communication between business, government, transportation agencies, and border inspection agencies to tackle pending problems.

- Being a bi-national coalition, the IMTC being can identify transportation needs and suggest proposals that can be developed by concerned participants on both sides of the border.

- A proactive response to TEA-21 that places Washington State in a better position to take advantage of federal funding to improve IMTC transportation initiatives.

The Blaine Border Crossing is plagued with a host of issues that occur at all busy ports of entry between the United States and Canada in dealing with processing incoming shipments being transported by commercial motor vehicles. Major issues concerning motor carrier traffic at the Blaine Border Crossing include:

- Long queue and delays due to congestion.

- Incorrect bond and customs paperwork.

- Insufficient waiting areas to resolve problems.

- Increased trade with limited investment into technology infrastructure.

- Limited shipment tracking or verification.

Figure 1-1realistically displays the congestion problems that can occur when southbound vehicles are waiting in queue to be processed at the border to cross into the United States.

**Figure 1-1. Southbound Traffic on Pacific Highway 15 Approaching U.S. Customs.**

The IMTC is attempting to advance bi-national projects to increase border capacity through amplified transaction speeds and reduced queue times at United States and Canadian border crossing facilities. The IMTC seeks to improve safety via sharing of credentialing information among selected regulatory agencies and cooperative bi-national practices. The IMTC supports activities to enhance efficient operations of truck, rail, and marine transportation modes through ITS and infrastructure improvement. The IMTC established the following goals specific to the motor carrier industry:

- More efficient use of enforcement resources through information sharing and technology.
- Reduction in wait times through the use of ITS.
- Reduced maintenance and operating costs through decreased delay at the border crossing.

### 1.2.4 Evaluation Primary Focus: Dedication ITS Truck Lane Corridor Benefits

In advancing the above IMTC concepts, both Transport Canada and the Washington Department of Transportation have identified ***Dedicated ITS Truck Lanes*** at the border as a major goal for potential future border improvements, which could ease freight traffic congestion in both directions. Such dedicated lanes could provide for significantly expedited border crossing times for motor carriers who enroll in the program and outfit their fleets with DSRC/CVISN transponder technology.

With these goals in mind, the IMTC partnered with the Washington Department of Transportation (WSDOT), Transport Canada, the Insurance Corporation of British Columbia (ICBC), and Whatcom County, Washington, to jointly secure the necessary federal TEA-21earmark and local matching funding required for the ITS deployment project described in this report to proceed.

This ITS deployment is allowing for the completion of a bi-national freight border crossing ITS system at the border, and is a follow-on effort to a multiyear border freight ITS deployment program funded by WSDOT, FHWA, and Transport Canada. However, while the ITS systems are now fully deployed under this system, the physical infrastructure (i.e., additional lanes and revamped customs booth areas) on both sides that would allow for expedited clearance and travel time reductions to occur are still unfunded by WSDOT and Transport Canada. Therefore, it is not yet possible to measure the benefits of this system, since ITS-equipped trucks continue to have to wait in the same lanes and lines as non-ITS trucks.

Based on this context, the SAIC-TranSys bi-national Evaluation Team, with the support of the FHWA Office of Freight Management and Operations and the ITS-JPO, decided in early 2002 to focus this evaluation effort on modeling the corridor benefits associated with future ITS dedicated truck lanes on both sides of the border, as well as associated trade and regulator benefits including weigh-in-motion data sharing and elimination of broker visits through enhanced systems.  Here, the primary objective of this evaluation was to quantify, as much as possible, the relevant benefits and costs associated with the dedicated ITS truck lanes and associated corridor freight systems to IMTC stakeholders, and provide valuable data inputs and insight for future border crossing/corridor ITS technology programs.

Moreover, based on the significant benefits and benefit-cost ratios, especially for the motor industry, that are highlighted in the conclusions of this report, it is intended that the results of this report may serve as an input to U.S. and Canadian effort to fund the infrastructure portions of the Dedicated ITS Truck Lanes concept in the near future.

## 1.3 ORGANIZATION OF THIS REPORT

This evaluation focuses on an initial assessment of a number of vital ITS bi-national CVO border crossing/IMTC areas. The organization of this evaluation final report is as follows:

- **Section 2 – IMTC Border Crossing Project Phase Descriptions:** This section describes the scope of ITS deployments, the technologies used, and operational results for the first two phases of the deployment:
  - Phase I: Northbound Truck and Container Tracking to Blaine Border Crossing.
  - Phase II: Southbound British Columbia – Washington State Truck and Container In-Bond Clearance.

- **Section 3 – Case Study of Processes for IMTC Trade and Regulatory Operations:** This section provides a case study examination of the current commercial freight trade and regulatory operations workflow processes required for customs clearance for both CBP and CCRA, leading to a comparison with an ITS-enabled customs clearance process. Examination also focuses on qualifying the public- and private-sector benefits created by utilizing bi-national data/information exchange between Washington State and British Columbia via weigh-in-motion technology.

- **Section 4 – Commercial Motor Vehicle Border Operations Survey and Benefits Estimation:** This section provides a travel time modeling of commercial freight transportation operations, with travel time savings attributable to the motor carrier at the international border crossing at Blaine, Washington (Pacific Highway 15), through ITS technology. Vehicle operations will be tested in conjunction with a Dedicated ITS Truck Lane and via weigh-in-motion data exchange between inspection facilities in Washington State and British Columbia.

  The travel time benefits of ITS deployment at the Blaine Border Crossing are estimated using the Strategic Logistics Model-49 (SLM-49) developed by TSi. This model is based upon data results from the border operations survey conducted in June 2002 and the IMTC Cross-Border Trade and Travel Survey. SLM-49 was used to approximate the potential impact of ITS technologies on bi-national commercial freight transportation operations of typical truck trip approaches northbound from the United States into Canada, and southbound from Canada into the United States at the Pacific Highway Border Crossing. For further detail concerning this border survey and modeling effort, see this document's **Appendix**, which provides the full TSi **Evaluation Modeling Report**.

- **Section 5 – IMTC ITS Cost and Benefit Analysis:** This section provides for the quantitative estimation of benefits from the modeling effort in Section 4, in addition to quantifying additional corridor benefits, including those introduced in Section 3. The analysis here incorporates these into a financial framework that quantifies the present and future cost and benefit streams, net present values, benefit-cost ratios, and investment payback periods for the IMTC ITS deployments. Conclusions are then presented which cover estimated benefits and benefit-cost ratios for numerous categories, including corridor-wide, public-sector and private-sector benefits.

- **Section 6 – IMTC Case Study:** This section defines the overall objectives and participants of the International Mobility and Trade Corridor, comprised of a joint coalition between the United States and Canada. The case study offers guidance to other international public- and private-sector collaborations in seeking innovative ITS solutions to increase capacity, improve safety, and more effectively utilize rail and marine transportation to alleviate commercial motor vehicle congestion at shared border crossings. Topics including security initiatives by U.S. Customs since 9-11 and transponder interoperability are also presented.

- **Section 7 – Findings and Recommendations:** This section presents a summary of the salient findings of this evaluation and recommendations based on these findings. The benefit-cost results presented should be placed in context of the "bigger picture" which includes future ITS work in the IMTC region as well as for other United States – Canadian border regions, and possibly the United States – Mexico southern border region. Recommendations are largely based on future ITS opportunities and IMTC stakeholder reaction to improve the border crossing process and expedite corridor travel time for commercial motor vehicles throughout the IMTC.

# 2. IMTC BORDER CROSSING PROJECT PHASE DESCRIPTIONS

## 2.1 INTRODUCTION

For Phase I, the major goal of the IMTC ITS - CVO Border Crossing Deployment project was to establish the electronic and institutional foundation for a multifaceted, comprehensive border crossing and commercial vehicle data information system. This foundation was expected to enable real-time information access to commercial, regulatory, and enforcement entities.

The Phase II goal is to provide information access for system users in advance of physical container arrival at any future trip destination. This information allows for more effective decision-making and better resource allocation for both public- and private-sector system users.

The Evaluation Team established an overall IMTC commercial motor vehicle travel time cost-benefit framework that takes into account both proven Phase I concepts and Phase II efforts to extend these ITS capabilities more comprehensively throughout the IMTC. Together, the Phase I and II projects are expected to result in developing a region-wide network of automatic vehicle identification (AVI) readers and tracking systems, giving visibility to cargo and assets for the Ports of Tacoma and Seattle and both sides of the international border crossing at Blaine. Another expected result is the integration of AVI readers at state and provincial weigh-in-motion (WIM) stations on major highway approaches to both sides of the border.

The remainder of this section is organized as follows:

- 2.2 Phase I
- 2.3 Phase I E-Seal Test
- 2.4 Phase II
- 2.5 Effects of the IMTC Efforts

## 2.2 PHASE 1

In 1997, WSDOT received $1.85 million (in U.S. dollars) from FHWA to apply ITS technologies to border operations at the Washington State – British Columbian border.

The first part of the Phase I effort was to develop the TransCorridor Operating System (TCOS), a freight-tracking information system (managed by TransCore from its Trade Corridor Service Center in San Diego, California) that formed the backbone of the ITS communication system. This system was augmented by a regional deployment that included the Commercial Vehicle Information Systems and Networks (CVISN) AVI readers and WIM sensors.

Phase I efforts expanded by instituting a field operational test (FOT) to develop a chain-of-custody freight management system along the Seattle to Vancouver trade corridor. As the system integrator selected by WSDOT for Phase I, TransCore oversaw and integrated the various technologies associated with the electronic seal (E-seal) system. This public-private FOT used a combination of AVI sensors, E-seal sensors, and the Internet to assimilate information to be accessed by authorized public and private sector stakeholders.

The E-seal test included the development and deployment of a new disposable electronic seal system. This system was comprised of electronic container seals; portable hand-held E-seal readers; a stationary E-seal reader located at the U.S. Customs approach at the Blaine commercial vehicle border crossing; and dedicated AVI truck transponder readers[7] at three sites: the Blaine crossing; the Port of Tacoma (at the Maersk Sealand terminal); and the Port of Seattle (at the APL/Westwood Shipping terminal). The container E-seal reads were "associated" with the truck cab AVI transponder reads within the TCOS, providing for complete visibility of the truck-container movement through various regional choke points where AVI antennas and/or E-seal antennas are located.

The e-Logicity/E. J. Brooks prototype E-seal system was selected by WSDOT and TransCore as the disposable E-seal system to be tested in this field operational test. The primary goal of this system is to validate the audit trail for seal status through the supply chain of a container shipment. This validation process includes determining the integrity of the E-seal and recording the time and place of each seal each transaction (i.e., each location where the E-seal was "read" by a device). This is accomplished remotely by reader antennas or by humans with hand-held readers in a fashion similar to the manual seal validation process.

### 2.2.1 Phase I Northbound In-Bond Container Tracking

The Phase I project utilized a transponder tag to track in-bond containers traveling from the ports of Seattle or Tacoma into Canada. The transponder tags were installed in the motor vehicle cabs and provided reference shipment, carrier, and vehicle credentials information at select points between the test ports and the Blaine international border crossing.

**<u>AVI Transponders</u>**

AVI transponder readers were installed at the exit gates of the American President Lines terminal at the Port of Seattle and at the Maersk- Sealand terminal at the Port of Tacoma. Figure 2-1presents a sample AVI transponder unit. When a commercial motor vehicle exits the port facility, the gate reader detects the tag, and software references the container and in-bond information and posts it on the TCOS Website. The TCOS

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[7] AVI truck transponder technology is based on the DSRC 915-MHz standard. This technology includes in-vehicle transponders that can communicate with roadside or gate system reader antennas. This technology is currently utilized in a number of trucking applications, and supports state commercial vehicle enforcement under CVISN, and a similar system being deployed in Canada. As part of CVISN in the Pacific Northwest, truckers can enroll in the NORPASS transponder program. Trucks outfitted with the NORPASS transponder enables drivers to use automated truck inspection station bypass lanes being deployed throughout the region. When approaching a CVISN-equipped weigh station, the system reads the transponder and typically sends a "green light" message to the truck, notifying the driver to proceed through the bypass lane at the weigh station. A "red light" message indicates that the driver must proceed into the main station lane for inspection. WIM systems are typically integrated into these automated stations as well.

alerts inspection agencies and other authorized system users when a container has left the port and is heading northbound. AVI readers were also installed at inspection stations along I-5 in order to provide additional container progress information.

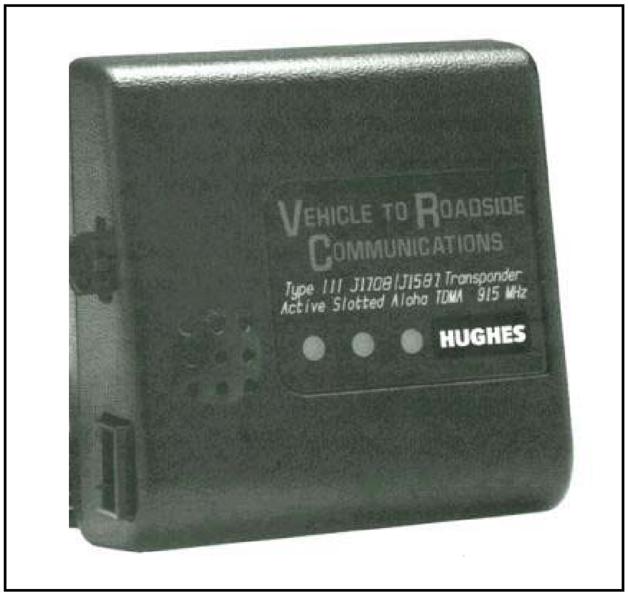



**Figure 2-1. Typical AVI Transponder Unit (3.5 inches square).**

An AVI reader installed a quarter of a mile south of the Blaine border crossing facility enables CBP officials to preview the in-bond container transaction status prior to physical arrival. One last AVI reader at the Blaine border crossing automatically clears out the bond on the shipment and transmits to the TCOS that the container is out of the United States. Figure 2-2 shows a sample transponder reader installed at the northbound Blaine Border Crossing.

**Figure 2-2. Transponder Reader Antenna (flat panel) and E-Seal Reader Antennas (3-prongs each) Installed at the Northbound Crossing Overhang.**

As the truck and container pass through a Maersk-Sealand or APL terminal gate, the following data can be recorded or verified and communicated over the Internet to the TransCore "TransCorridor" AVI System[8]: Vehicle ID (Transponder Serial Number); Date & Time of Entrance Event; and Shipping Facility ID. Figure 2-3 provides an overview of the current TransCore AVI transponder system architecture.

**Trade Corridor Operations System**

TCOS is an Internet-based system that links the shipping line's information system and CBP' Automated Manifest System (AMS). The TCOS information management system supported and integrated the hardware. The system is based out of San Diego, California, at a TransCore Service Center. For security and privacy protection, information from TCOS is only available to authorized users.

The TransCore system provides for all tracking and data functions to be viewed and managed over the Internet. This is accomplished by an authorized user logging on to the TransCorridor Website, and entering in a user name and designated password. A WSDOT and a CBP view of TCOS are captured in Figure 2-4.

[8] The design of the TransCore AVI system and TransCorridor Website will provide future access to the following additional information: Gate/Lane Number; In-Bond (yes or no); Container Weight; and HAZMAT ID Code. The TransCore AVI system is designed so it can be interoperable with the Washington State CVISN prototype system being deployed at the Bow Hill weigh station.

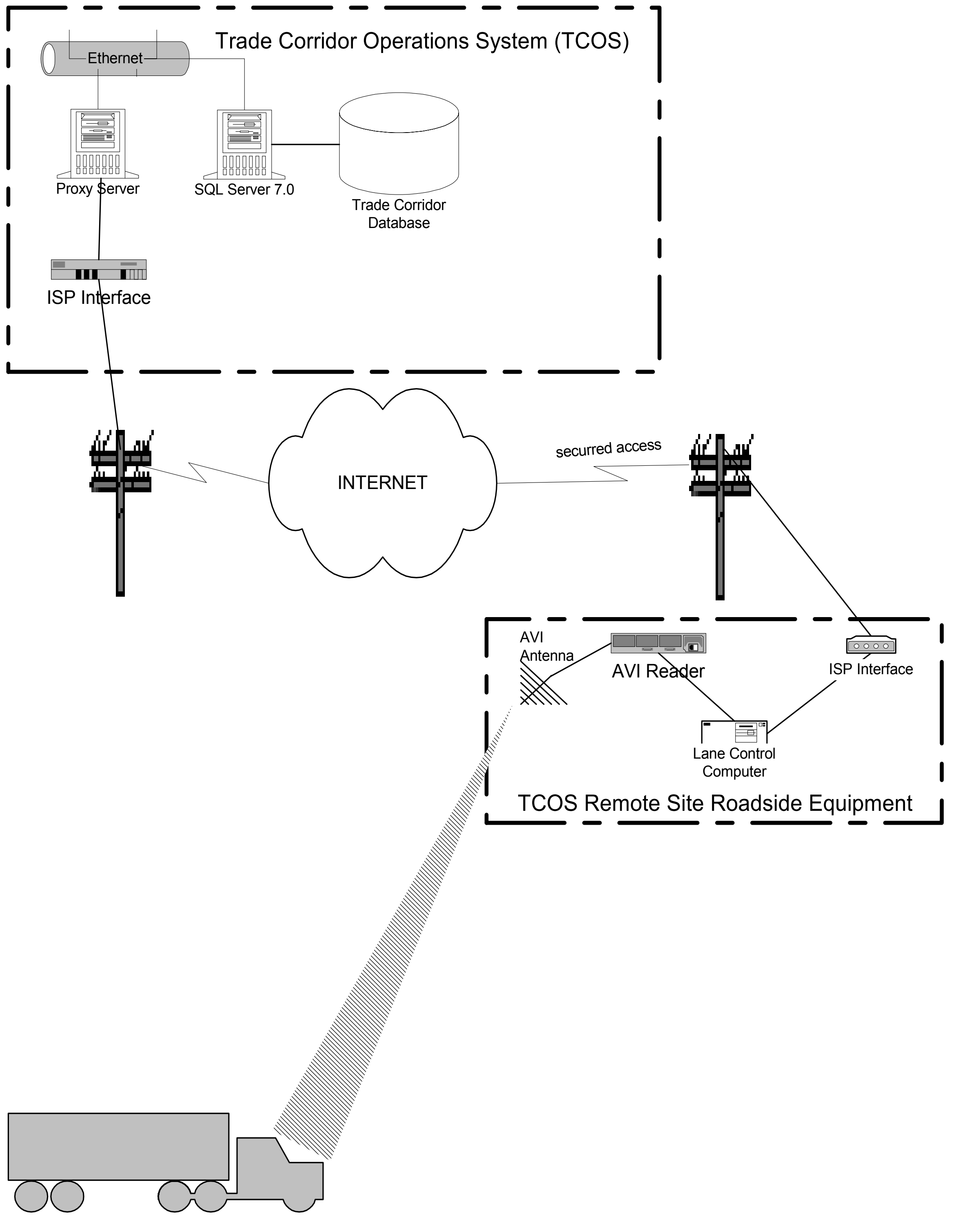
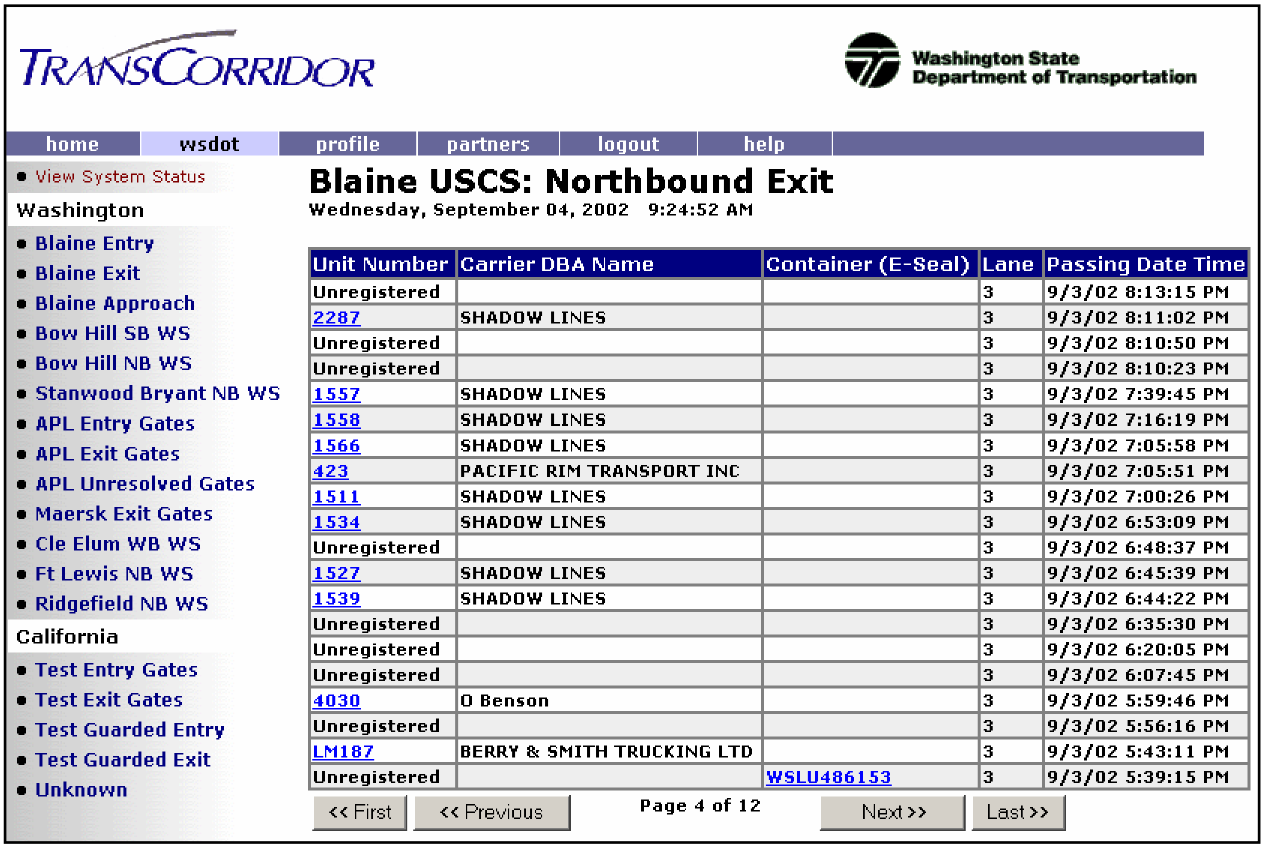



**Figure 2-3. Current TransCore AVI Transponder System Architecture.**



TRANSCORRIDOR

Washington State Department of Transportation

home | wsdot | profile | partners | logout | help

- View System Status

Washington

- Blaine Entry
- Blaine Exit
- Blaine Approach
- Bow Hill SB WS
- Bow Hill NB WS
- Stanwood Bryant NB WS
- APL Entry Gates
- APL Exit Gates
- APL Unresolved Gates
- Maersk Exit Gates
- Cle Elum WB WS
- Ft Lewis NB WS
- Ridgefield NB WS

California

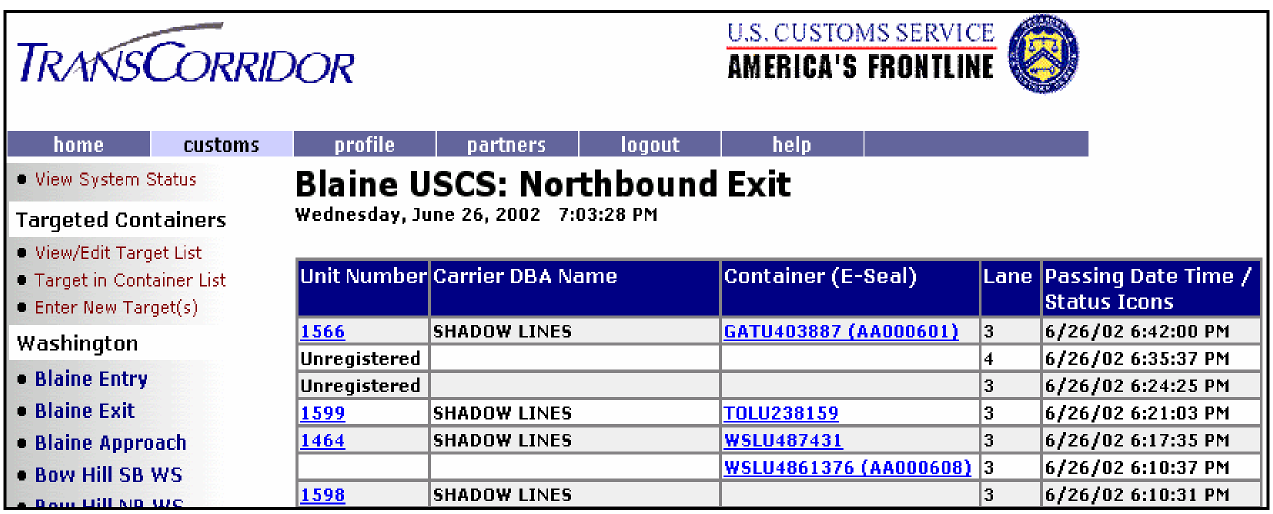
- Test Entry Gates
- Test Exit Gates
- Test Guarded Entry
- Test Guarded Exit
- Unknown

**Blaine USCS: Northbound Exit**

Wednesday, September 04, 2002 9:24:52 AM

| Unit Number | Carrier DBA Name | Container (E-Seal) | Lane | Passing Date Time |
|---|---|---|---|---|
| Unregistered | | | 3 | 9/3/02 8:13:15 PM |
| 2287 | SHADOW LINES | | 3 | 9/3/02 8:11:02 PM |
| Unregistered | | | 3 | 9/3/02 8:10:50 PM |
| Unregistered | | | 3 | 9/3/02 8:10:23 PM |
| 1557 | SHADOW LINES | | 3 | 9/3/02 7:39:45 PM |
| 1558 | SHADOW LINES | | 3 | 9/3/02 7:16:19 PM |
| 1566 | SHADOW LINES | | 3 | 9/3/02 7:05:58 PM |
| 423 | PACIFIC RIM TRANSPORT INC | | 3 | 9/3/02 7:05:51 PM |
| 1511 | SHADOW LINES | | 3 | 9/3/02 7:00:26 PM |
| 1534 | SHADOW LINES | | 3 | 9/3/02 6:53:09 PM |
| Unregistered | | | 3 | 9/3/02 6:48:37 PM |
| 1527 | SHADOW LINES | | 3 | 9/3/02 6:45:39 PM |
| 1539 | SHADOW LINES | | 3 | 9/3/02 6:44:22 PM |
| Unregistered | | | 3 | 9/3/02 6:35:30 PM |
| Unregistered | | | 3 | 9/3/02 6:20:05 PM |
| Unregistered | | | 3 | 9/3/02 6:07:45 PM |
| 4030 | O Benson | | 3 | 9/3/02 5:59:46 PM |
| Unregistered | | | 3 | 9/3/02 5:56:16 PM |
| LM187 | BERRY & SMITH TRUCKING LTD | | 3 | 9/3/02 5:43:11 PM |
| Unregistered | | WSLU486153 | 3 | 9/3/02 5:39:15 PM |

<< First | << Previous | Page 4 of 12 | Next >> | Last >>



TRANSCORRIDOR

U.S. CUSTOMS SERVICE
AMERICA'S FRONTLINE

home | customs | profile | partners | logout | help

- View System Status

Targeted Containers

- View/Edit Target List
- Target in Container List
- Enter New Target(s)

Washington

- Blaine Entry
- Blaine Exit
- Blaine Approach
- Bow Hill SB WS

**Blaine USCS: Northbound Exit**

Wednesday, June 26, 2002 7:03:28 PM

| Unit Number | Carrier DBA Name | Container (E-Seal) | Lane | Passing Date Time / Status Icons |
|---|---|---|---|---|
| 1566 | SHADOW LINES | GATU403887 (AA000601) | 3 | 6/26/02 6:42:00 PM |
| Unregistered | | | 4 | 6/26/02 6:35:37 PM |
| Unregistered | | | 3 | 6/26/02 6:24:25 PM |
| 1599 | SHADOW LINES | TOLU238159 | 3 | 6/26/02 6:21:03 PM |
| 1464 | SHADOW LINES | WSLU487431 | 3 | 6/26/02 6:17:35 PM |
| | | WSLU4861376 (AA000608) | 3 | 6/26/02 6:10:37 PM |
| 1598 | SHADOW LINES | | 3 | 6/26/02 6:10:31 PM |

**Figure 2-4. TransCorridor Website Views for WSDOT and U.S. Customs.**

**Weigh-In-Motion System**

The Phase I WIM system enabled commercial vehicle enforcement officers at the Bow Hill weigh station (located approximately 43 miles south of the border) a preview of vehicle and driver information, and the option to allow approved drivers to bypass the station. The Phase I project is a tag-based WIM facility that operates in coordination with the Washington State Patrol (WSP) as part of its CVISN program. Figure 2-5 depicts a truck being automatically weighed using the CVISN system at Bow Hill.


**Figure 2-5. Truck Automatically Weighed Using the CVISN System at Bow Hill.**

Tag (transponder) readers and a WIM scale system were installed ahead of the weigh station. The tags (which are the same as those used for the border crossing system) contain links to a database related to safety, weight, permits, and licensing. This system was enhanced by transmitting video images from the WIM site to the border station for viewing by enforcement and regulatory personnel. WSP officers view this information to decide which vehicles are granted bypass approval. Drivers considered to be traveling safely, legally, and whose vehicles were deemed not to be overweight, received a green light and were able to continue down Highway I-5 without further stopping. Figure 2-6 shows a sample WIM pad installation.

**Figure 2-6. Typical Installed Weigh-In-Motion Pad.**

## 2.3 PHASE I E-SEAL TEST

The E-seal test consisted of developing and deploying a disposable electronic seal system. This system contained electronic container seals; portable hand-held electronic seal readers; a fixed electronic seal reader at the U.S. Customs approach at the Blaine Border Crossing; and AVI transponder readers at the Port of Tacoma Maersk-Sealand terminal, the Port of Seattle at the APL shipping terminal, and at the Blaine Border Crossing. This disposable electronic seal system is connected by multiple AVI CVISN readers installed at WIM facilities. The test successfully demonstrated that container E-seals can be associated with motor carrier cab AVI transponder reads within the structure of an integrated freight information management system, such as TCOS. This test provided complete in transit visibility of truck-container movement from the Ports of Seattle/Tacoma to the Blaine Border Crossing. Figure 2-7 shows the electronic seal hardware.

The following data can be recorded or verified and communicated over the Internet to the TransCore AVI system when a commercial motor vehicle and container passes under an E-seal antenna and/or an “associated” AVI antenna.

- Container Seal Number
- Container Number
- Vehicle ID (transponder serial number)
- Date and Time of Entrance Event
- Shipping Facility ID

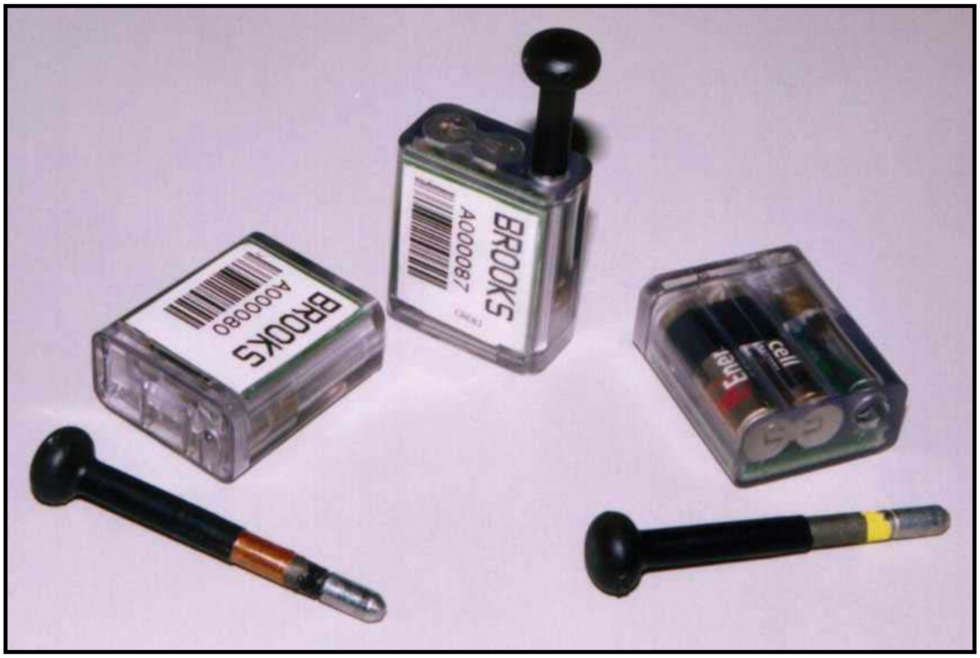



**Figure 2-7. Electronic Bolt Seal/Tag Hardware.**

There were three major test elements comprising the Phase I E-seal FOT:

- USDA/Maersk Sealand successfully deployed the first test group of 47 E-seals on in-bond agricultural shipments moving in a supply chain from the Port of Tacoma across the U.S./Canadian border via truck. Seals in this test group were in place for a 12-month period between December 2001 and December 2002.

- CBP/Westwood Shipping successfully installed the second test group of 30 E-seals on a supply chain involving in-bond auto part shipments moving from Japan to the Port of Seattle via steamship, and then on to the U.S./Canadian border via truck. Seals in this test group were in place from May to December 2002.

- TransCore and Shadow Lines successfully deployed an E-seal on a transponder-equipped truck for one load as a proof-of-concept to show that transponder-equipped trucks could be “associated” with E-seal-equipped containers.

The analysis of the ability of the TransCorridor/e-Logicity system to effectively read E-seals in an operational environment was key to validating the E-seal operational concept. A summary of the results of this analysis is presented in the following text.

As shown in Figure 2-8, the first phase of the USDA/Maersk Sealand test occurred from December 2001 to July 2002, and consisted of installing 47 E-seals (two or less per week). The TransCorridor data showed a read rate for these E-seals at 55 percent, with 26 out of 47 E-seals being successfully read. A number of operational issues, including inadequate system training and truck drivers using the wrong border crossing at Blaine, were responsible for this initially low read rate. However, these operational issues were corrected in the second portion of this test, which took place between August and December 2002. During the second test, 12 out of 12 E-sealed containers (100 percent) were successfully read by USDA inspectors. This second test highlighted the more robust operational capability of the re-engineered Transcore/e-Logicity system as applied to the Maersk Sealand/USDA E-seal supply chain.

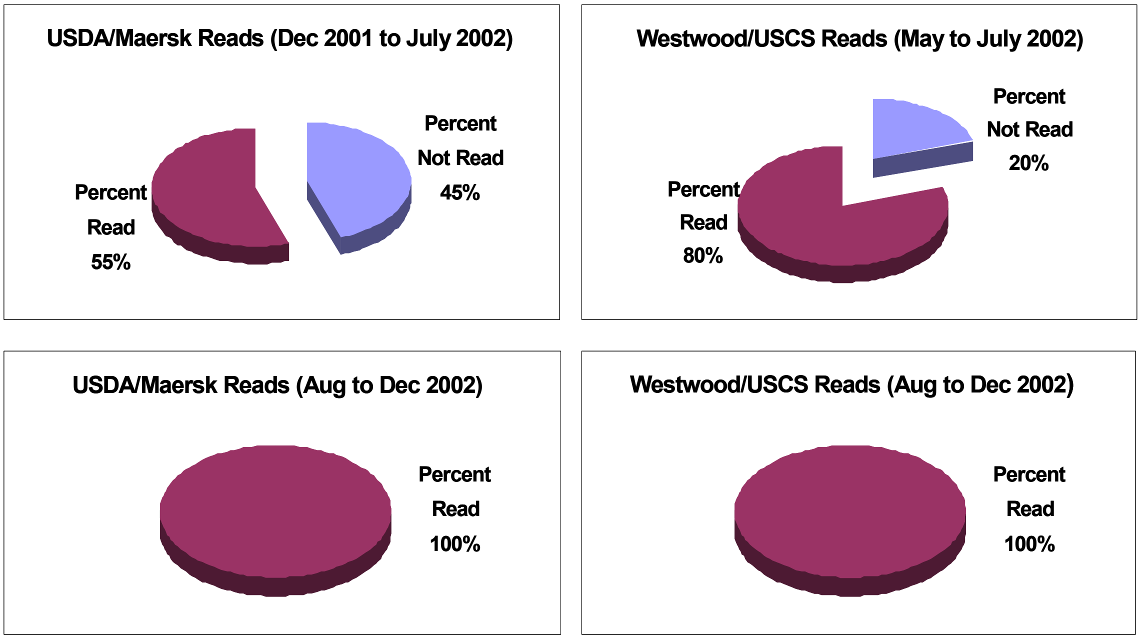



**Figure 2-8. E-Seal Read Results.**

Also shown in Figure 2-8, between May and July 2002, Westwood installed 30 E-seals in Japan as part of the initial portion of this test. All 30 E-seals were inspected and read using hand-held readers by CBP officers at the Port of Seattle. Three E-seals registered as “tampered” during the read process. Of the 30 E-seals installed, 20 percent (or six) were not read at the Blaine Border Crossing. Participants believe read failures were due to a malfunctioning fixed reader at the border and not the actual seal. This problem was corrected in the second portion of the CBP/Westwood test, which took place between August and December 2002. During the second test, 28 of 28 E-sealed containers (100 percent) were successfully read at the Blaine CBP station.

Taken together, in the second phases of the Transcore/elogicity system tests for the USDA/Maersk and Wetstwood/CBP supply chains, the results showed 40 out of 40 successful E-Seal reads over a several month period. With these results, the Transcore/elogicity E-seal system can preliminarily be considered a validated success at the technology-operational level. However, to take a system like this to full deployment, additional data covering hundreds, if not thousands, of data points concerning E-Seal reads would be necessary to provide for an unqualified validation of the system and operational concept.

During this FOT, Transcore also conducted a proof-of-concept demonstration to show that e-Logicity E-seal reads could be “associated” with TransCorridor AVI system reads in an operational environment. For this test, a single Shadow Lines truck equipped with an AVI transponder was married with a container that was affixed with an E-seal, and sent through the Blaine Border Crossing northbound approach. On June 26, 2002 at 6:42:00 p.m., the Shadow Lines vehicle (Unit # 1566 – Tag #20876BC1) passed through the Blaine Northbound Exit and successfully demonstrated that the system correlated the vehicle to a container (GATU403887) with an attached E-seal (AA000601).

The technical effectiveness evaluation investigated the ability of the system tested to perform the functions described in the Northwest International Trade Corridor Program Functional Specification. As described in this document, the system must: positively identify the vehicle and container; reliably associate an E-Seal container read with a truck AVI read; and have a low failure rate. The system should have the capability to detect tags; correlate container number and vehicle number; record the vehicle number, container number, and departure time in the database; and perform other required data processing. The findings of this evaluation concluded that the functional requirements of the original system design were either met or exceeded during the FOT system operations.

Phase I demonstrated the technical viability of an integrated corridor-wide freight information system. The efforts conducted during this phase served as the building block for further electronic integration of information collected at the Blaine international border implemented under Phase II.

## 2.4 PHASE II

Funding for Phase II was initially made available through a TEA-21 earmark grant to the IMTC. Transport Canada, WSDOT, the British Columbia Transportation Finance Authority, and the Insurance Corporation of British Columbia added matching funds to the project. The total project funding is $2.5 million (U.S. dollars). Combined with the $1.85 million for the Phase I funding, the total deployed system represents the largest single investment ($4.35 million total) in CVO border crossing ITS technology to date in North America. The Phase II system intends to use data and information from both the United States and Canada to evaluate the current border crossing conditions and the value of any future utility of ITS deployments.

### 2.4.1 Phase II Monitoring Efforts

Phase II is monitoring southbound in-bond[9] container movement from point of origin in the Vancouver area to the Ports of Seattle and Tacoma. Containers leaving Vancouver are linked to the cab transponder to the associated truck and the electronic seal to the associated container in the TCOS database. The motor carrier sends TCOS an electronic message to identify cargo (electronic seal serial number and the container number); vehicle (vehicle transponder serial number); and authorized driver (commercial driver license number).

The shipment is first detected at the Port Mann WIM station and then at the U.S. Customs commercial vehicle facility at Blaine. The advance information is verified at the U.S. Customs booth and an in-bond transaction report is generated. Authorized system users are provided with a list of in-bond containers/transactions being processed through the Blaine Border Crossing.

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[9] "In-Bond" can be defined as a procedure under which goods are transported or warehoused under customs supervision until they are either formally entered into the customs territory of the United States and duties paid, or until they are exported from the United States. This freight has not yet been cleared by U.S. Customs, but has entered the United States with the approval of U.S. Customs; it may then pass into Canada or Mexico from the U.S.


**Figure 2-9. IMTC Phase II Locations.**

Both CCRA and CBP officials monitor container flow into the United States and flag a container for inspection when it reaches the U.S. Customs Blaine facility. A truck and container are detected as they pass the Bow Hill south AVI antenna. The entry gates at the Ports of Seattle and Tacoma are equipped with AVI antennas to positively identify transponder-equipped commercial trucks entering their facilities. At this point, the in-bond transaction is closed with U.S. Customs. Figure 2-9 above displays the geographic locations for the various relevant Phase II deployment sites.

The following technology elements are new or expanded IMTC deployments in Phase II.

### 2.4.2 Truck Transponder Tags, Electronic Seals, and AVI Expansion

Phase II expanded the overall AVI truck/E-seal container tracking system to the Canadian side to accommodate additional international trade and container monitoring along the corridor. Trucks originating from British Columbia are outfitted with significant numbers of transponders. The completed AVI/E-seal tracking system now includes the Ports of Tacoma and Seattle, both sides of the international border crossing at Blaine, and integration with AVI-electronic seal readers at WIM stations on major highway approaches to both sides of the border.

### 2.4.3 TCOS Expansion

The Phase II project expands the reach of TCOS northward into Canada and provides CBP with advance notice of imports. This was accomplished by installing tag readers on Highway 15 in British Columbia. This system uses the same transponder tags as in Phase I. This system can be expanded to assist in transferring vehicle, driver, and cargo status information between CBP and CCRA databases. Figure 2-10 illustrates the concept of operations[10].

[10] Graphic courtesy of TransCore; modifications made by SAIC.

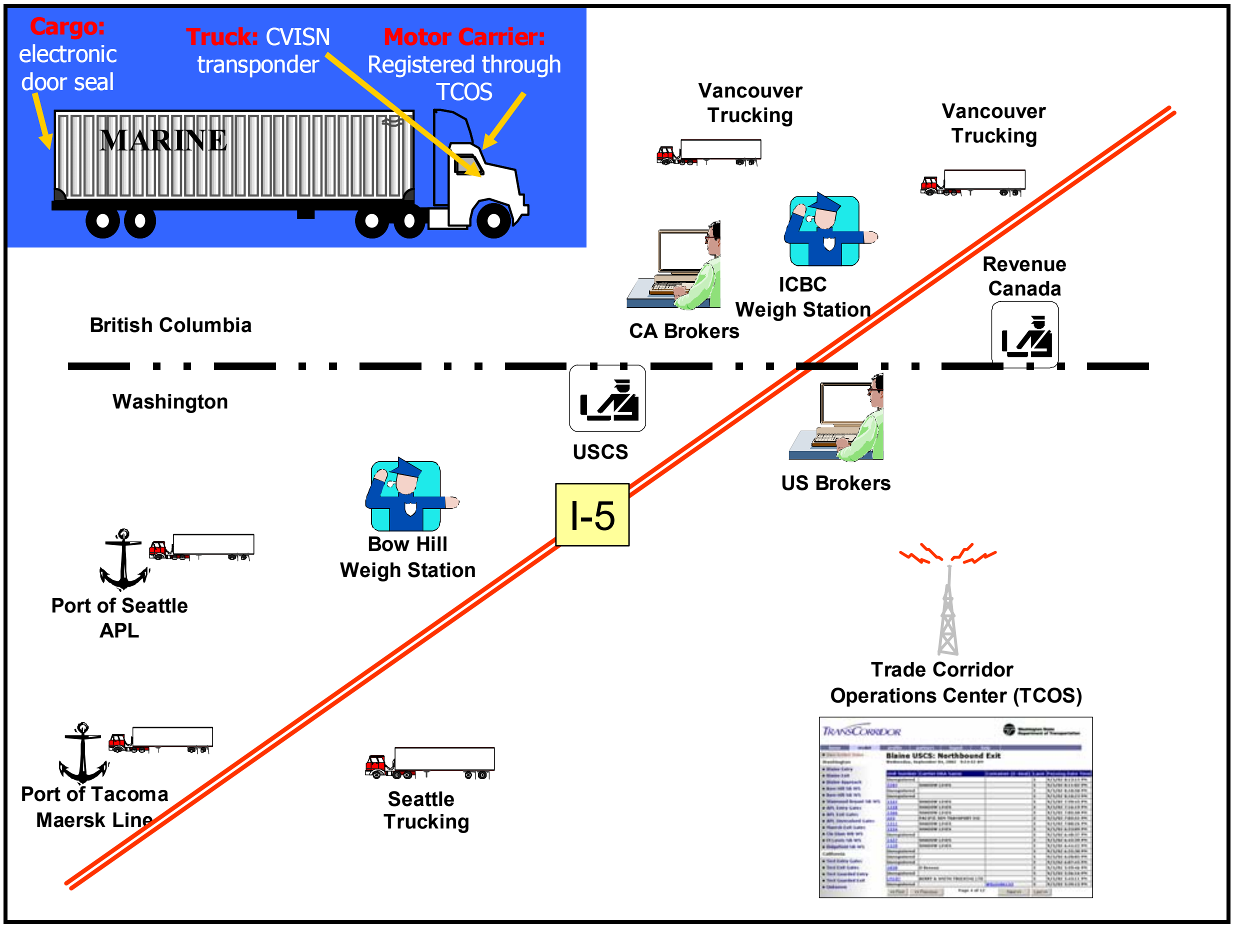


**Figure 2-10. Phase II Overview.**

### 2.4.4 Virtual Weigh-In-Motion Technology

In conjunction with ITS Phase II deployment, the British Columbia Port Mann weigh station site is equipped with WIM technology to allow virtual weighing and identification using AVI technology of commercial motor vehicles on Highway 1. At the same time, a video image of the vehicle will be captured and displayed to the weigh station operator. The vehicle's weight can then be compared against regulations to check compliance with British Columbia regulations. After the vehicle's weight and credentials are checked, the driver is directed to either report or bypass the weigh station using in-cab notification.

At any time prior to the truck reaching the weigh station, the inspector can direct the driver to bypass or pull in for inspection. The identification is then forwarded to the validation database using information supplied by ICBC (via the WSDOT CVISN software) to check the status of the vehicle in terms of safety history, registrations, permits, etc., to verify that it is allowed to bypass the station. The CVISN software will also forward a record of each passing transponder-equipped vehicle to the automated border crossing system.

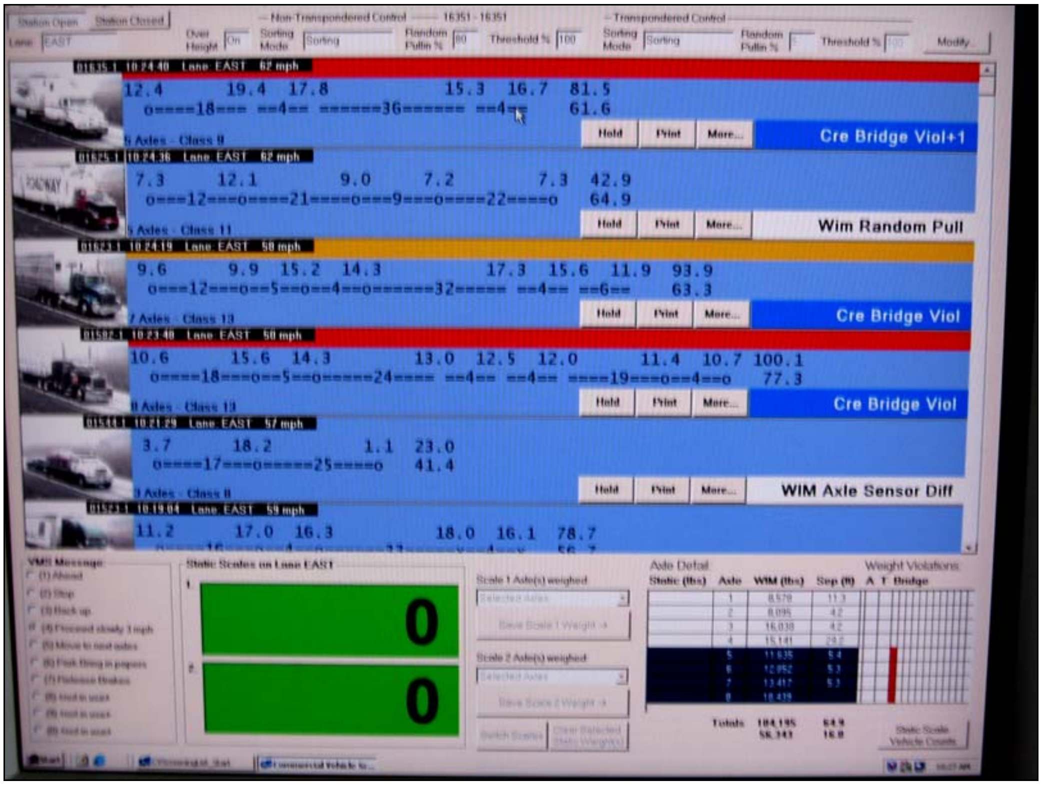


**Figure 2-11. Bow Hill WIM System Screen Capture Showing Shared Data.**

A network for assimilating and exchanging information was recently coordinated between British Columbia and Washington State to enable bi-national information exchange between ICBC and WSDOT. This bi-national communication sharing permits timely, accurate electronic motor carrier information transfer between British Columbia regulatory agencies and their counterparts in Washington State. This system will expand upon the Commercial Vehicle Information Exchange Window (CVIEW)/CVISN system currently operating in Washington State, facilitating the virtual screening of commercial vehicles operating on both sides of the international border. Both northbound and southbound trucks operating in the IMTC will be monitored for safe and legal compliance, allowing eligible carriers to bypass future IMTC weigh stations. Shown above in Figure 2-11 is a screen capture of Bow Hill WIM data from Washington's CVISN system that is shared with the ICBC.

Significant time savings are projected due to potential ITS enabled bi-national information exchange between British Columbia and Washington State-equipped WIM sites. Bypass savings capture the potential travel time benefits for commercial motor vehicles bypassing WIM stations once compliance is verified at one facility and other weigh station sites are notified of compliance.

### 2.4.5 Truck Staging Area

Construction of a truck staging area in British Columbia on the approach to the United States commercial inspection facility was recently completed. This staging area is beginning to improve access for tag-equipped trucks and will support U.S. brokerage activities. It is estimated that this paved staging area will alleviate congestion by increasing the waiting/parking area available to commercial motor vehicles on the Canadian side of the international border approach.

## 2.5 EFFECTS OF THE IMTC EFFORTS

To assess the effects on corridor freight-related operations, this evaluation examined the current state of regulatory and operational procedures and assessed how the implementing ITS technologies can impact these elements. The following sections detail commercial freight trade and regulatory operation and qualitatively assesses ITS impacts (Section 3), followed by the quantitative results of sophisticated traffic and financial modeling of the ITS impacts (Sections 4 and 5). The IMTC Case Study is presented in Section 6. Institutional challenges that may impact full deployment of ITS in the corridor are presented in Section 7. Section 8 presents the conclusions and recommendations derived from all IMTC efforts.

# 3. CASE STUDY OF PROCESSES FOR IMTC TRADE AND REGULATORY OPERATIONS

## 3.1 INTRODUCTION

To lay the groundwork for the cost-benefit analysis presented later in this report, the Evaluation Team conducted a rigorous analysis of the trade and regulatory processes that occur as a truck enters the United States from Canada, and vice-versa, at the Blaine-Surrey International Border Crossing. While the primary benefits from this evaluation are concerned with the reductions in truck queues at the border through the application of ITS (see Section 4), the case study outlined in this section identifies secondary, but significant benefits, due to improved information processes by CBP and CCRA, state/provincial truck safety/inspection agencies, and the motor carrier industry.

ITS technology applications may enable a variety of IMTC stakeholders (shippers, motor carriers, customs brokers, plus CBP and CCRA officials) to reap benefits from advanced document information. Successful pre-clearance activities from program-enrolled motor carriers and shippers prior to their physical arrival at the border may reduce queue delay and enable transaction time savings. ITS technology applications may also reduce paperwork and increase sharing of electronic credentialing data between the Washington CVISN system and the ICBC.

The many stakeholder groups represented in the corridor (various United States – Canadian regulatory bodies and the private sector entities involved in the flow of operations required to successfully move goods across the border) are presented in Table 3-1.

**Table 3-1. Case Study Primary Regulatory Stakeholders**

| Regulatory Entities | Industry Entities | Southbound Shipments Across Border (U.S. Customs) | Northbound Shipments Across Border (Canada Customs) |
|---|---|---|---|
| **Customs** | | CCRA and CBP Representatives | CBP and CCRA Representatives |
| | **Brokerage Firms** | Company Brokerage Representatives | Company Brokerage Representatives |
| **WIM Site** | | Port Mann Weigh Station – ICBC Representatives | Bow Hill Weigh Station – WSDOT CIVISN Representatives |
| | **Trucking Companies** | Canadian Trucking Company Representatives | U.S. Trucking Company Representatives |

To facilitate this case study, the following steps were undertaken in this analysis to examine the potential information process benefits for IMTC stakeholders:

- Identify and document existing information processes required for customs clearance (both United States and Canadian) for a motor carrier conveying freight across the international border at Blaine.[11] This information was collected through intensive interviews with CBP/CCRA officials, customs brokers representatives, and other IMTC stakeholders. This workflow represents a baseline against which to compare potential ITS-enabled integrated system benefits in this and future studies.
- Document potential ITS-enabled integrated systems operational workflow process to facilitate customs clearance. This workflow presents an improved process for automating many of the functions described above through a combination of current IT plans for U.S. Customs, and including the implementation of the ITS systems that are being deployed with the Phase II system described in Section 2.
- Document potential processes for CVO enforcement information sharing between Washington State and British Columbia. Here, a concept for bi-national WIM information exchange is presented, and administrative benefits for motor carriers and public sector enforcement agencies are briefly summarized.

The remainder of this section is organized as follows:

- 3.2 Customs Clearance Participant Roles
- 3.3 CBP Clearance Process (Southbound)
- 3.4 CCRA Importation Process (Northbound)
- 3.5 ITS-Enabled Electronic Customs Clearance
- 3.6 CVO Enforcement Weigh-in-Motion and Administrative Information Processes
- 3.7 Summary: Identified ITS Information Process Improvements

## 3.2 CUSTOMS CLEARANCE PARTICIPANT ROLES

Sections 3.2.1 through 3.2.5 provides a breakdown of participants and their roles in the clearance of commercial shipments southbound importation through CBP and northbound importation through CCRA.

### 3.2.1 Importer (Consignee)

The importer is responsible for everything that is declared and filed with CBP/CCRA. The importer must ensure that all necessary shipment information is available from the exporter/shipper who usually possesses the best knowledge pertaining to a specific product shipment. Among the importer's responsibilities are:

- Accuracy of all relevant information presented to CBP/CCRA for a shipment.

---

[11] "Existing" here assumes year 2002 conditions, and therefore does not include the FAST system (a limited ITS system for trucks at the border), which is currently being implemented at Blaine by CBP.

- Duty and tax payments to CBP/CCRA.
- Able to provide any import permits to CBP/CCRA.
- Payment of fines from inaccurate or omitted shipment information.
- Record keeping for 5 years for CBP on shipment details, including type of good imported, product quantity, price, and product origin. The CCRA requires record keeping for 6 years and records must be located in Canada, in either paper or electronic format. If an importer wants to keep records outside Canada, the importer must obtain written CCRA approval.

### 3.2.2 Exporter (Shipper)

Many times, the exporter is the seller of a product and arranges for transportation of a particular shipment. The exporter provides the motor carrier with customs documentation necessary to facilitate entry into either the United States or Canada. The information supplied by the exporter to the motor carrier includes:

- Company name and address location of the shipper.
- Company name and address location of item producer, if not the shipper.
- Consignee’s company name, address location, and Internal Revenue Service number.
- Specific product and shipment information, including complete description, value of product, quantity, packing, weight, monetary currency of sale transaction, and country of product origin. This information is usually contained in a CBP pro-forma invoice or a standard commercial invoice.

### 3.2.3 Motor Carrier

The motor carrier transports the shipment to and from Customs’ processing facilities. The carrier is normally responsible for reporting a pending shipment to CBP/CCRA. When a shipment arrives at the United States – Canada border, the motor carrier submits the necessary documentation to the designated broker, and then to Customs under a traditional manual paperwork-based process.

### 3.2.4 Customs Broker

The customs broker constantly reviews evolving customs practices plus enactment of laws and regulations that impact trans-border shipments to effectively represent the importer in dealing with CBP/CCRA. Customs brokers are licensed CBP/CCRA representatives to serve as an intermediary between the United States and Canadian governments and the importer. The importer grants the customs broker legal authority to act as the importer’s agent through a power of attorney arrangement. Some services rendered by the customs brokers include:

- Preparation and submission of required custom release documents and information to CBP/CCRA and other governmental agencies.

- Obtaining timely release of goods from CBP/CCRA custody.
- Filing entry documents with CBP/CCRA on behalf of the importer.
- Paying required duties, taxes, and fees to CBP/CCRA on behalf of importer.

### 3.2.5 CBP/CCRA

CBP/CCRA enforces laws, regulations, and administrative policies to ensure admittance of only approved goods into their respective nations, and prevent entry of potential goods that could represent a security risk, while minimizing any disturbance to the commercial community in the importing and exporting of goods. Following are some of the duties performed by CBP/CCRA:

- Reserve the right to search, seize, or request additional information concerning a shipment or goods being imported into their nation, and deny access, if applicable.
- Properly assess and collect customs duties, excise taxes, fees, and monetary penalties on imported goods, if applicable.
- Maintain detailed information profiles pertaining to all United States – Canadian importers past and present. This importer profile will determine the ability of an importer to participate in special customs initiatives designed to simplify and speed up the customs clearance process, such as the FAST program.
- Collect accurate import and export data to create international trade statistics.
- Enforce import prohibitions and restrictions.
- Prevent illegal trade practices from occurring, such as provisions relating to quota enforcement, anti-dumping regulations for specific products from designated countries, and patent/trademark infringements.

## 3.3 USCS CLEARANCE PROCESS (SOUTHBOUND)

Clearance of imported goods through U.S. Customs involves specific steps pertaining to entry (release and summary); inspection; appraisement and classification; and liquidation. Figure 3-1, developed by the Evaluation Team for this case study, illustrates the typical U.S. Customs clearance processes. The detailed descriptions of each of these processes are provided below in Sections 3.3.1 through 3.3.6.

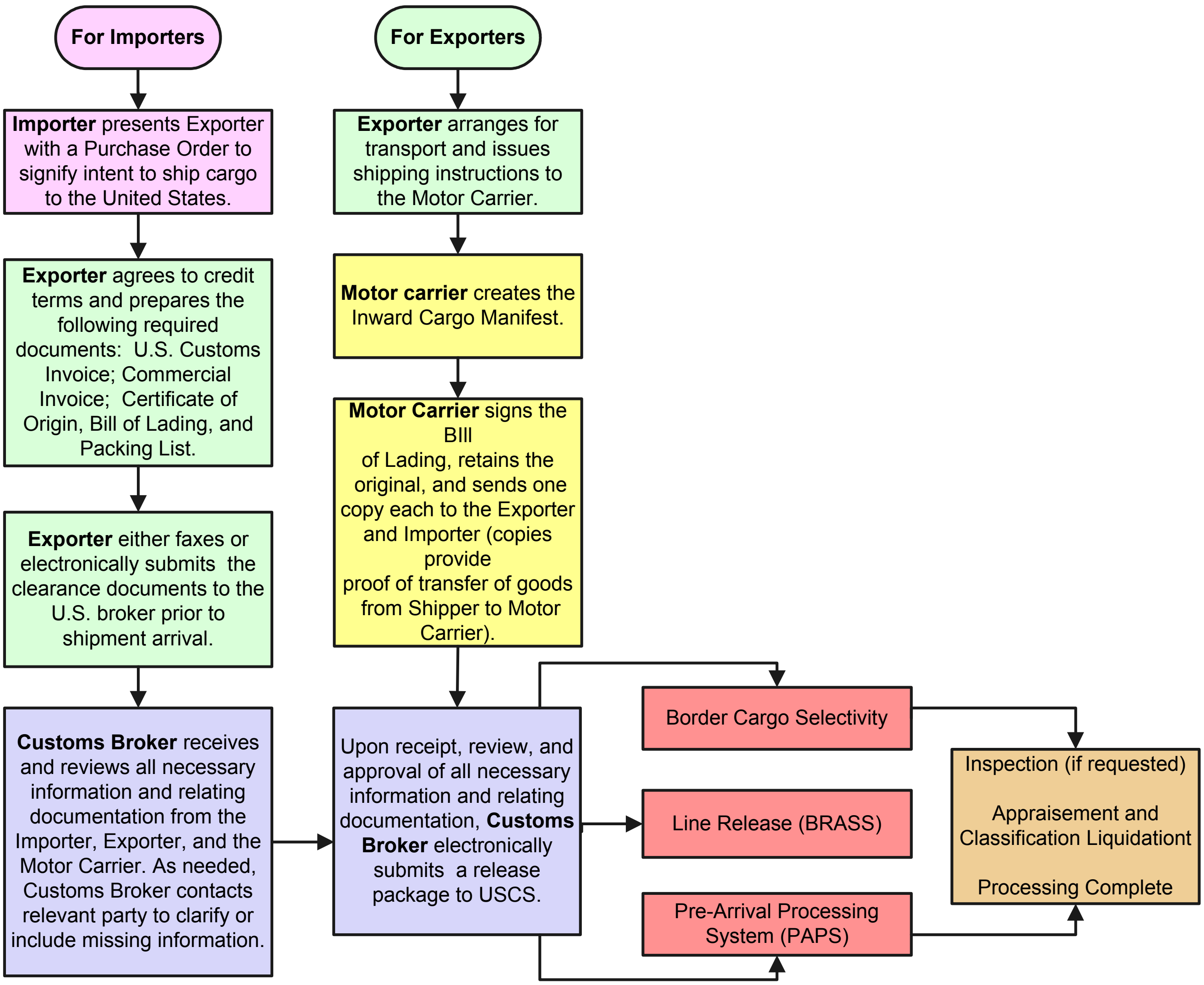


**Figure 3-1. Typical U.S. Customs Clearance Process.**

### 3.3.1 Step 1 – Customs Entry

The customs entry process entails the shipment arrival at the U.S. Customs border facility, and also comprises the process of presenting documentation for clearing the shipment through customs. Imported goods not entered in a timely manner are sent to a warehouse until it is claimed. The importer is held liable for storage fees relating to the holding of their goods. If goods go unclaimed for 1 year, the goods are auctioned off or destroyed.

Customs entry is normally a two-step process consisting of the physical release of goods from U.S. Customs custody and accounting of goods to U.S. Customs, known as entry summary.

The release is the authorization from U.S. Customs to proceed to deliver goods to a United States destination. Release documents must be filed within 5 days of a shipment's arrival at a United States port-of-entry, and is normally done prior to or at the time of physical arrival. Usually, these documents are given to the customs broker and contain the required information to make possible the release of goods from customs custody. Some of the required information includes:

- Company name and address location of the shipper.
- Company name and address location of item producer, if not the shipper.
- Company name, address location and Internal Revenue Service number of the consignee.
- Company name, address location, and Internal Revenue Service number of the shipment buyer, if not the consignee.
- Detailed product and shipment information, such as complete content description, shipment value, product quantity and packing, weight, monetary currency of sale transaction, and country of product origin.
- Information required by other governmental agencies if applicable. A permit, license, or other certification may be required on certain imported goods. The importer must comply with these agency regulations in order for the shipment to be released. Some agencies requiring import information include the U.S. Department of Agriculture, U.S. Department of Energy, Environmental Protection Agency, and the Food and Drug Administration.

**Required and Supplemental Documents**

The two traditional documents that cover the required information for CBP are the Inward Cargo Manifest that is created by the motor carrier and the U.S. Customs Invoice created by the exporter. In lieu of the U.S. Customs Invoice, other documents may be utilized to convey required information such as a Bill of Lading, Commercial Invoice, or packaging lists.

*Inward Cargo Manifest*

This cargo manifest supplies an itemized list of shipment contents that is presented to U.S. Customs to expedite customs clearance in either paper or preferably electronic copy. The motor carrier creates the manifest based on information provided by the shipper. The motor carrier must forward this manifest to the importer's customs broker in order to obtain a release from U.S. Customs. This manifest is designated a specific identifiable number by U.S. Customs that enables monitoring to ensure clearance and the shipment closure process are completed.

*U.S. Customs Invoice*

The Customs Invoice is the fundamental document ordinarily provided to the motor carrier, usually prepared by the exporter. The Customs Invoice is used to establish the classification of imported goods, shipment value for duty, tax and tariff rates. The accurate completion of this document aids in the customs clearance process.

*Bill of Lading*

The information on the Bill of Lading must be consistent with the information listed on the Commercial Invoice. It must contain a complete and accurate description of the goods including number of boxes/pallets/cartons, weight, shipping terms, and name and address of consignee. The motor carrier provides a copy of the Bill of Lading with the exporter as proof of the transfer of goods from shipper to motor carrier. A copy is also sent to the importer and the motor carrier keeps a third copy for their records.

*Commercial Invoice*

The Commercial Invoice provides a complete description of the goods being shipped, along with the proper valuations and currency information. This document forms the basis of the terms by which the importer pays the exporter, and is also used as a source to assist customs brokers in clearing goods through customs for the importer. Commercial Invoices come in many forms and do not conform to a rigid format. They may be substituted for a U.S. Customs Invoice as long as the same prescribed information is covered and must be pre-approved by CBP.

*Certificate of Origin*

The broker uses the Certificate of Origin to determine the correct rate of duty under NAFTA. If this document is missing, the highest rates may be applied to each consignment, and CBP may not allow the goods into the country.

*Packing List*

The Packing List contains a detailed listing of shipment contents including product quantities, model numbers, product dimensions, and net and gross weights. The packing list also specifies whether the shipment is configured by carton, crate, or pallet. This document is not required by CBP, but the customs broker uses it to supply additional shipment information to CBP officials. This information is especially useful should CBP officials request a physical examination of shipment contents.

*Transportation and Exportation (T&E) Customs Bond*

This document may be required if final destination of goods is outside the United States.

**Role of Customs Broker in Release**

The customs broker is presented with all the necessary information and relating documentation from importer, exporter, and the motor carrier. The customs broker then reviews the documents and contacts the relevant party if any necessary information is missing or to clarify inaccuracies. This allows the customs broker to submit a release package to U.S. Customs. Typically at Blaine, the brokerage houses still perform this activity by faxing these packages to U.S. Customs, rather then using available electronic systems. Anecdotally, it appears that there has been more resistance to the use of information exchange technology by brokers at Blaine then at other major U.S.-Canadian border crossings in the upper Midwest and Northeast.

Additionally, in some cases, a truck approaching the border will not have all of the necessary documentation available for U.S. Customs to grant clearance. In this case, the truck must physically park on the Canadian side of the border, and the driver must then walk to his brokerage company's office to finalize his or paperwork. This can be a significant dis-benefit to the motor carrier industry, as it causes delays in the freight shipment to occur as the driver has to stop for up to an hour at the border.

**Surety Bond**

This bond guarantees that the importer will pay all applicable duties, taxes, fees and fines to U.S. Customs for their shipment. Having a bond on file with U.S. Customs allows the importation of goods prior to the payment of duties, taxes, fees, and fines. The surety bond designates the importer of record to U.S. Customs.

Bonds can be obtained from a surety firm, which is an insurance company authorized by the U.S. Treasury Department to underwrite customs bonds. The firm issuing the surety bond will be called on to provide payment when an importer cannot or will not fully pay the United States government. There are single transaction bonds that cover only a single shipment at one point of entry. More common for commercial purposes in the continuous bond that covers multiple shipments at a point of entry for an annual premium.

**U.S. Customs Release Methods**

Truck shipments are typically released within minutes or hours. Ocean-arriving shipments may take several days, hence the 5-day window for customs release. There are three principal means of having goods released with each having impact on the rate of the release.

- **Border Cargo Selectivity.** This is the standard CBP release method. The motor carrier submits an Inward Cargo Manifest to U.S. Customs. The motor carrier then submits customs documentation from the shipper to the customs broker that includes the U.S. Customs Invoice and/or other supporting documents. The customs broker reviews this information and transmits a release package electronically to CBP via the Automated Broker Interface (ABI) that can result in expedited release. Nearly 96 percent of all entries are submitted to CBP by ABI.

This allows CBP minimal time to analyze shipment details prior to arrival and assign a “relative risk” to each shipment. The customs broker gives the motor carrier a paper release package. The motor carrier then proceeds to the U.S. Customs facility and presents the release package along with the Inward Cargo Manifest. CBP officials review this information, along with the transmitted information from the customs broker, and make a decision to either release the shipment or direct a physical inspection.

- **Line Release.** The current line release system for CBP is the Border Release Advanced Selectivity System (BRASS). This is an expedited release method for repetitive land border crossing shipments. For a shipment to be eligible for line release, the customs broker must submit a line release application for each distinct product that an importer intends to ship. When accepted for line release, an exporter affixes the line release barcode label to the top right section of the Customs Invoice. A CBP officer wands the barcode into the Customs system, matches the barcode and invoice information, and releases the shipment. The cargo release data is transmitted to the current CBP Automated Commercial System (ACS), which establishes an entry and the requirement for an entry summary, and forwards release information to relevant parties to the transaction (customs broker, importer, motor carrier, and exporter).

- **Pre-Arrival Processing System.** The Pre-Arrival Processing System (PAPS) is a motor carrier-driven CBP system devised to speed up customs releases and reduce congestion at border crossings. This system allows for advance customs clearance of motor carrier shipments prior to the shipment physically crossing the border. The process is initiated when a motor carrier or the shipment’s importer or exporter requests a PAPS release by forwarding the necessary documentation to the customs broker in advance of the physical arrival of the goods. A specially formatted barcode must be attached to the PAPS documentation. When the motor carrier arrives at the inspection booth, a CBP officer will scan the barcode and verify that the broker has prepared the PAPS release. Unless CBP requests a secondary inspection, the motor carrier and the cargo are formally released.

**Entry Summary**

Imported goods are not legally entered (registered) until the goods are released by CBP and estimated duties and taxes are paid. Entry summary information must be filed within 10 days from the date of release and estimated duties and taxes paid. The customs brokers files the entry summary on behalf of the importer.

### 3.3.2 Step 2 – Border Inspection

In order to confirm admissibility and compliance, CBP officials have the discretion to search and seize any goods imported into the United States. There are many reasons that goods may need to be examined. Some of these reasons it may be deemed necessary to inspect shipments to determine:

- Value of the goods for CBP purposes for assessment of duties.

- Whether the shipment contains prohibited products or substances.

- Whether the requirements of other governmental agencies have been satisfied.

- Whether the amount of goods listed on an invoice is correct, and that no shortage or overage is present in the shipment.

- Country of origin marking is present and is accurate.

### 3.3.3 Step 3 – Appraisement and Classification

CBP officials determine the ultimate appraisement of the dutiable value and correct duty rate to be applied to a shipment. The dutiable value of goods is the value on which the assessment of duties and taxes is based. The Harmonized Schedule classification number determines the duty rate of goods. Rates of duty for imported goods vary depending upon the country of origin.

### 3.3.4 Step 4 – Liquidation

Liquidation is the final step in the entry process and is the finalization of the import transaction by CBP. At the point when CBP is satisfied with the entry including the payment of duties and taxes, the entry is liquidated. Usually, commercial entries are liquidated within 314 days) after the entry was filed. Most are liquidated much earlier.

## 3.4 CCRA IMPORTATION PROCESS (NORTHBOUND)

CCRA believes that most parties to a shipment voluntarily comply with relevant importation laws. Parties that comply with the law will only be subject to occasional random examinations. This examination policy reduces a shipment’s release time and ultimate costs to import commercial goods. CCRA maintains compliance and commodity profiles to target shipments for examination based on risk-management principles to determine if a shipment should be deemed high-risk or low-risk.

Figure 3-2, developed by the Evaluation Team for this case study, illustrates the typical CCRA clearance processes. The detailed descriptions of each of these processes are described below in Sections 3.4.1 through 3.4.6.

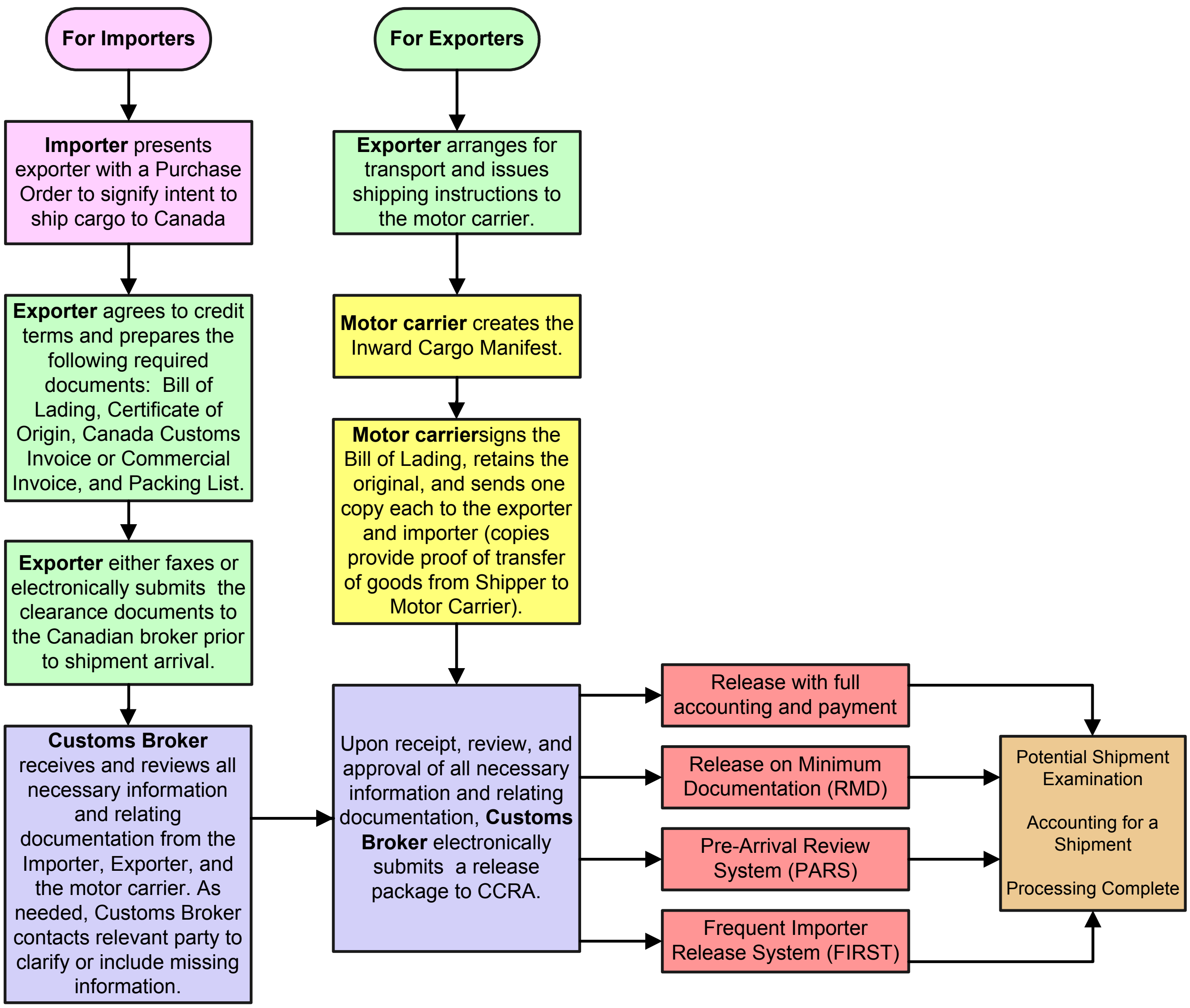


**Figure 3-2. Typical CCRA Clearance Process.**

### 3.4.1 Step 1 – Registering an Import Business

Commercial importers must acquire a Business Number for their CCRA import account. The Business Number consists of 15 digits that identify the import business account to CCRA. The Business Number must be displayed on most customs documents being presented to CCRA.

### 3.4.2 Step 2 – Reporting a Shipment

Under traditional circumstances, the carrier under reports the shipment to the CCRA when it arrives at the international border entry point. The motor carrier must report commercial goods imported into Canada on an approved Cargo Control Document (CCD). It is not necessary to utilize a CCD when using line release processing options.

- The motor carrier uses the cargo control document to report a shipment to the CCRA. The CCD serves as the initial record of the shipment's arrival to the CCRA. This document is also used for all shipments moved in-bond to an inland customs office, sufferance warehouse, or bonded warehouse. The motor carrier also sends a copy of the CCD to the importer and shipper to notify them that the shipment has arrived. The CCD contains a bar-coded cargo control number where the first four numbers represent a unique carrier code to identify the motor carrier.

- Required documents for import entry. The shipper prepares any required documents for import entry. These documents are normally faxed or sent electronically to the Canadian broker prior to the shipment arrival. In some cases, these documents can be filed with CCRA up to 5 days ahead of shipment arrival. If required documents are missing, the broker contacts the shipper to obtain the needed paperwork. The required documents include the Bill of Lading, Certificate of Origin, Canada Customs Invoice or Commercial Invoice and Packing List.

### 3.4.3 Step 3 – Getting Shipment Release

There are two methods through which a shipment can be released from CCRA: The first method is release with full accounting and payment at that time; and the second method is release on minimum documentation.

**Release on Minimum Documentation**

Release on Minimum Documentation (RMD) is a method to fast-track shipment release by accounting for and paying for shipments after CCRA releases them. The importer or broker must affix the transaction number in bar-coded format to the release documents. CCRA identifies each shipment with a unique 14-digit transaction number. This transaction number is used to identify shipments throughout the customs process. Each importer using RMD is assigned a unique 5-digit account security number. This number will always appear as the first 5 digits of the transaction number.

For an importer to utilize RMD, the importer must post security with CCRA to ensure payment. This monetary security can be posted either locally or nationally depending on the nature of the importer's business. An importer may use any of the following as monetary security:

- Cash.

- Certified check.
- Transferable Government of Canada bonds.
- CCRA customs bonds issued by a registered Canadian bank or approved financial institution.

The goal of RMD is to facilitate processing import release requests that are complete, accurate, and do not require CCRA examination of goods or review of permits. CCRA set the following time processing goals for RMD transactions:

- EDI submission to CCRA – 45 minutes.
- EDI machine submission to CCRA – 5 minutes.
- Paper-based submission to CCRA – 2 hours.

**RMD Release Documentation Requirements**

Unless an examination is requested on a shipment, CCRA will release a shipment under RMD when presented a completed cargo control document, any necessary import permits and two copies of a properly completed invoice by the motor carrier at the border entry. RMD requires that a shipment’s invoice must contain:

- Importers name and the import account number.
- Exporter's name.
- Unit of measure and quantity of goods.
- Estimated value of the goods in Canadian dollars.
- Detailed description of the goods.
- Country of origin for the goods.
- Bar-coded transaction number affixed to the invoice.

**CCRA Line Release**

There are two basic CCRA line release options speed up the release processing times of commercial goods and reduce traffic congestion at international border crossings: Pre-Arrival Review and Frequent Importer Release System.

- **Pre-Arrival Review System (PARS).** The PARS process enables release information that contains a shipment's estimated time and date of arrival, the invoice data, and the original copy of any required permits. PARS documentation can be submitted up to 30 days before the goods physically arrive in Canada. CCRA officials can process this advance documentation; enter the cargo control number; and either a recommend a shipment for release or recommend an examination take place once the goods arrive at the border. The release recommendation will be ready when the expected goods arrive if submitted to PARS at least:

- EDI: 1 hour in advance.
- Paper: 2 hours in advance.

- **Frequent Importer Release System (FIRST).** FIRST is the other prominent line release option. If an importer has an established compliance record, the importer can apply for FIRST privileges to obtain release of low-risk, low-revenue shipments that are imported on a regular basis. If an importer qualifies, CCRA supplies an authorization number that appears on an importer's pre-approved import document that identifies the importer's FIRST shipments. When the goods arrive at the border, the motor carrier presents the import document with the bar-coded authorization and transaction number, a description of the goods, and necessary invoices. CCRA officials input the bar code into their computer system to confirm that the importer has FIRST privileges for the shipment in question. The CCRA officer then decides whether to release the shipment or refer it for examination.

**Electronic Data Interchange Release**

The Electronic Data Interchange (EDI) release allows electronic transmission of release data, including invoice information, to the Accelerated Commercial Release Operations Support System (ACROSS). A CCRA officer reviews the information and transmits the release decision back electronically, normally to the customs broker.

### 3.4.4 Step 4 – Examining a Shipment

CCRA has the authority to randomly select shipments for examination to verify compliance with CCRA regulatory requirements, detect prohibited or restricted items, and fulfill other government agency regulatory requirements. The frequency of examinations depends in part on an importer's established compliance pattern and that of other organizations involved with the shipment as well as the type of goods being imported.

### 3.4.5 Step 5 – Accounting for a Shipment

The final step in the CCRA importing process is to submit a final accounting package for shipments imported into Canada. A typical complete accounting package consists of the following documents:

- 2 copies of the cargo control document.
- 2 copies of the invoice.
- 2 copies of a completed Canada Customs Coding Form.
- Import permits, health certificates, or forms required by other Canadian federal government agencies.
- Certificate of Origin (for example NAFTA).

These documents can be presented as either paper copies or if granted CCRA authorization, the documents can be transmitted via EDI.

**The Invoice**

Three available invoicing options are permitted to CCRA:

- A Canada Customs Invoice that either the importer or the shipper can fill out.
- A commercial invoice containing the same information as the Canada Customs Invoice.
- A Commercial Invoice that indicates the buyer, seller, country of origin, price paid or payable, and a detailed description of the goods, including quantity, and a Canada Customs Invoice that provides the remaining information.

**Canada Customs Coding Form**

When accounting for imported commercial goods, the importation is documented on the Canada Customs Coding Form. This form must include the following shipment information:

- Importer's name and the import account number.
- Description of the goods.
- Direct shipment date.
- Tariff treatment.
- Country of origin.
- Tariff classification.
- Shipment value for duty.
- Appropriate duty or tax rates.
- Calculation of duties payable to CCRA and other Canadian federal agencies.

CCRA receives 96 percent of all the Canada Customs Coding Forms using electronic submission. This system is called CADEX (Canadian Electronic Information Exchange software) and provides parties to a shipment with access to reports and files to assist in the electronic preparation of the Canada Customs Coding Form. CADEX enables direct electronic transmission of Canada Customs Coding Form information to the CCRA computer system over telecommunications lines.

#### 3.4.6. Step 6 – Payment

CCRA allows to methods to pay any duties on goods under RMD release. The importer can pay every month based on a CCRA monthly bill or the importer can make any number of interim payments based on the daily statements sent by CCRA. If an accounting package is not presented or if the CCRA is unable to validate the package within the 5-day time period, CCRA will charge a late-accounting penalty for each shipment. If an importer repeatedly files accounting packages late, an importer may receive a notice requiring accounting for the goods on time for a specified period.

## 3.5 ITS-ENABLED ELECTRONIC CUSTOMS CLEARANCE

ITS-enabled electronic customs clearance allows for seamless, secure, and efficient automated information flow for all parties involved in the creation, transmission, storage and retrieval of electronic documents necessary to facilitate either CBP/CCRA shipment clearance. It also provides customs personnel with advance shipment information on which to assess the relative risk for each shipment. The goal is eventually to move as much customs clearance transactions to a true paperless electronic system where no reproduction of supporting documentation is necessary.

Some of the institutional issues associated with implementing true paperless electronic customs clearance are presented in Section 7: International Institutional Challenges.

Improved efficiencies are already evident for many stakeholders utilizing electronic customs clearance due to less repetitious entry of documentation, and more accurate information flow while providing secure information transmission. This is especially true of both CBP and CCRA who both receive approximately 96 percent of their incoming release materials via electronic submissions usually prepared by customs brokers. For brokers, expected process improvements due to implementation of electronic data information exchange with CBP/CCRA, and in reduced stops for trucks at brokerage houses, can be expected. The process described in Sections 3.5.1 through 3.5.6 can apply generically to either the CBP or CCRA processes without examining specific system interfaces or software programs.

Figure 3-3 depicts the integrated electronic customs clearance process following ITS deployment. This figure has been developed by the Evaluation Team based on the previously presented assessment of the non-ITS processes, the Team's understanding of the current TransCore Phase II design, and the Team's understanding of the customs information technology (IT) environment and future systems plans on both sides of the border. This clearance process is broad enough to include initial incremental ITS steps such as the FAST initiative, and broader future technology initiatives such as Automated Commercial Environment (ACE) and the International Trade Data System (ITDS).

### 3.5.1 Step 1 – Purchase Order

The importer transmits electronically a purchase order detailing the sale of goods including statement to any terms of credit and providing a letter of credit if not already on file with the shipper.

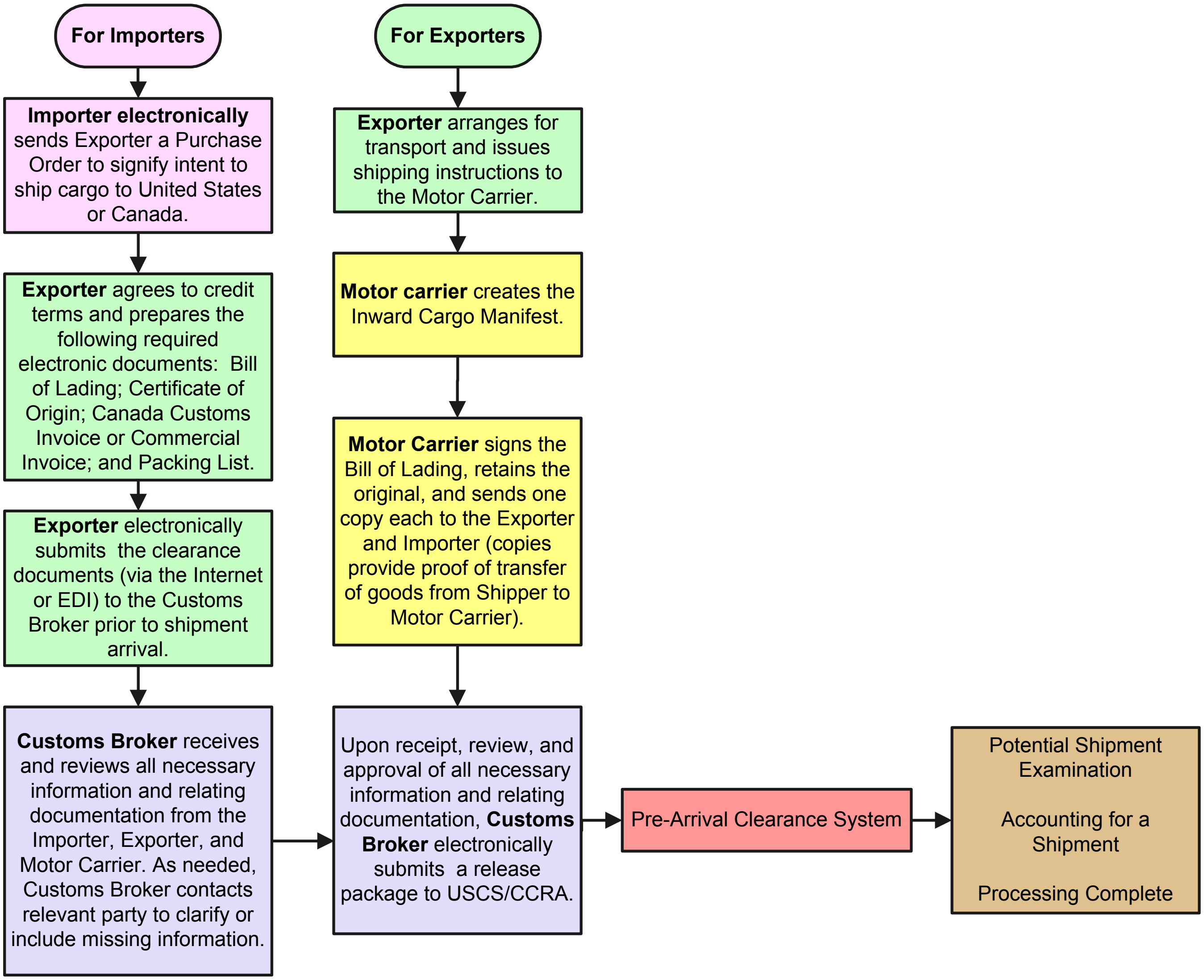


**Figure 3-3. Potential Electronic Customs Clearance Process.**

### 3.5.2 Step 2 – Import Entry Documents

The shipper utilizes the electronic documents from the importer to prepare all documents needed for import entry. The information provided from the importer in electronic format is easily incorporated, often in an automated fashion, along with information generated by the shipper into the following documents all in electronic form:

- CBP/CCRA Invoice
- Commercial Invoice
- Certificate of Origin
- Packing List

The shipper then forwards this information electronically to a licensed CBP/CCRA customs broker far in advance of actual physical shipment arrival. If it has not already been arranged, the shipper is arranged for transportation of the shipment with the selected motor carrier and forwarding electronic shipment instructions to this motor carrier.

The shipper or motor carrier will create a specially formatted email containing the motor carrier, the AVI transponder tag ID, departure time and container ID/electronic seal ID if applicable and transmit this information to TCOS database via email. This data is received by TCOS, entered into its database and correlated with the truck's AVI transponder tag ID. This allows the shipment to be followed throughout the IMTC through AVI transponder tag reads at specified interface points such as the border and WIM inspection stations.

### 3.5.3 Step 3 – Proof of Transfer of Goods

The motor carrier creates an electronic version of the Inward Cargo Manifest from information provided electronically by the shipper and forwards the Inward Cargo Manifest to CBP. No Customs Control Document is necessary when using CCRA line release options. The motor carrier prepares an electronic Bill of Lading, retains a copy and forwards a copy of this Bill of lading to both the exporter and importer as proof of the transfer of goods from shipper to motor carrier.

### 3.5.4 Step 4 – Electronic File Review

The customs broker provides all the necessary information files and relating documentation from importer, exporter, and the motor carrier via electronic transaction (Internet or EDI). The customs broker then reviews the documents and contacts the relevant party if any necessary information is missing or to clarify inaccuracies. This allows the customs broker to submit an electronic release package to CBP/CCRA via ABI, CADEX, or the planned Automated Commercial Environment (ACE) system for U.S. Customs in the near future. Use of these systems by the brokerage industry at Blaine would be a major advance over the current fax-based information exchange practice.

This electronic process for the broker would be expected to significantly reduce the number of trucks that have to stop at the brokerages houses at the border today to finalize paperwork in order to be granted clearance by customs. This would be of significant benefit to the motor carrier industry, as it causes delays in the freight shipment to occur as the driver has to stop for up to an hour at the border.

### 3.5.5 Step 5 – Pre-Arrival Expedited Clearance

CBP/CCRA will process ITS-enabled transactions much in the same manner as selected programs such as PAPS/PARS are processed currently. ITS will enable visibility for customs officials as the truck approaches the border and advance information flow to the customs booth.

As the truck reaches the United States – Canadian Border Commercial Vehicle Facility at the Pacific Highway facility, it passes under an AVI antenna. This action notifies TCOS that the truck and associated container is arriving at the United States – Canadian border and is approaching the customs booth. TCOS, in turn, can display this activity to authorized users at their Internet-connected workstations to enable both CBP/CCRA officials the ability to observe the truck/shipment movement approaching the international border crossing.

The AVI transponder read will facilitate the proper release information from CBP/CCRA systems and forward this information to customs booth personnel in advance of commercial vehicle arrival. CBP/CCRA still and always will have the discretion to order a shipment inspection at this point. As the shipment clears the border, TCOS will be notified via as the shipment is released. This release notification will then be available to all authorized TCOS users.

### 3.5.6 Step 6 – Accounting for a Shipment

Accounting following electronic release involves automated exchange of information allowing for the expedited closing of shipment cycle faster than via manual information exchange.

## 3.6 CVO ENFORCMENT WEIGH-IN-MOTION AND ADMINISTRATIVE INFORMATION PROCESSES

### 3.6.1 CVO Enforcement Weigh-in-Motion Information Processes

Currently, in Washington State and in British Columbia, the state/provincial government of each separately enforces truck safety through inspections and through weight enforcement. To a motor carrier, the effect of this is that on numerous occasions on a cross-border trip, his or her truck will get weighed separately on each side of the border.

From the Washington side, the process involves a state-of-the-art CVISN-based weigh station system that is being deployed statewide, and that is already deployed near the border at the Bow Hill Weigh Station. This station is based on the CVISN program guidelines for the electronic clearance user service. As such, truck drivers approaching the weigh station on I-5 are notified (through a green or red light on their in-vehicle AVI transponder) whether they can bypass the weigh station entirely, or whether they need to proceed to the WIM lane. Typically, trucks that have already been weighed in another part of Washington State the same day can be expected to get a “green” bypass light on their transponder.

Additionally, in Washington, at any time prior to the truck reaching the weigh station, the inspector can direct the driver to bypass or pull in for inspection. The identification is then forwarded to the Washington State Patrol’s CVISN database to check the status of the vehicle in terms of safety history, registrations, permits, etc., to verify that it is allowed to bypass the station.

On the British Columbia side, in conjunction with the ITS Phase II deployment, the British Columbia Port Mann weigh station site is being equipped with similar “CVISN-like” and WIM technology to allow automated weighing and identification using AVI transponders of commercial motor vehicles on Highway 1. At the same time, a video image of the vehicle will be captured and displayed to the weigh station operator. The vehicle’s weight can then be compared against regulations to check compliance with British Columbia regulations. After the vehicle’s weight and credentials are checked, the driver is directed to either report or bypass the weigh station using the in-cab transponder green or red light notification.

Also in British Columbia, in a manner very similar to Washington State, at any time prior to the truck reaching the weigh station, the inspector can direct the driver to bypass or pull in for inspection. The identification information is then forwarded to the validation database using information supplied by ICBC (via open-source CVISN software provided to ICBC by WSDOT) to check the status of the vehicle in terms of safety history, registrations, permits, etc., to verify that it is allowed to bypass the station. The CVISN software will also forward a record of each passing transponder-equipped vehicle to the automated border crossing system.

The future ITS process addressed in this report by the Evaluation Team will involve the sharing of WIM data between Washington State and British Columbia. The benefits to the regional motor carrier industry are obvious from this process – “double stops” for transponder-equipped trucks traveling across this border corridor will be largely eliminated, thus saving valuable time and fuel to the industry. Additionally, enforcement personnel on both sides of the border should be able to work more efficiently due to an overall reduction in the number of trucks that need to be weighed, since those trucks that were weighed previously across the border within the past couple of hours will not need to be weighed again. Finally, this process can be expected to result in the secondary benefit of emissions reductions due to the reduction of truck idling times in queue or at weigh stations on either side of the border.

To facilitate this ITS process, a network for assimilating and exchanging information was recently coordinated between British Columbia and Washington State to enable bi-national information exchange between ICBC and WSDOT. This bi-national communication sharing will permit timely, accurate electronic motor carrier information transfer between British Columbia regulatory agencies and their counterparts in Washington State. This system will expand upon the CVISN/CVIEW system currently operating in Washington State, facilitating the virtual screening of commercial vehicles operating on both sides of the international border. Both northbound and southbound trucks operating in the IMTC will be monitored for safe and legal compliance, allowing eligible carriers to bypass future IMTC weigh stations.

It is also important to note that the CVISN system used here by both governments will also forward a record of each passing transponder-equipped vehicle to the automated border crossing system.

### 3.6.2 Administrative Information Processes

A comprehensive assessment of administrative information processes by U.S. Customs, Washington State, and British Columbia officials associated with border operations is beyond the scope of this study. In addressing administrative information processes, the Evaluation Team has, therefore, primarily focused on the efficiency savings due to converting paper tasks and paper communication to electronic information. Here, administrative benefits are to be derived from reduced data entry, paper handling, and errors via electronic data exchange among stakeholders. Some of the parameters of interest here are the expected level of customs-related transactions (releases) associated with non-empty truck border crossings; average time per transaction (shipment) by shippers, motor carriers, and customs brokers; and documented ranges of administrative savings using electronic information exchange mechanisms. Potential administrative time savings can be developed from observed driver time at the border crossing spent with customs brokers; interviews with customs brokers representatives; and published sources of shipping documentation preparation time, automation time savings, and wage rates for clerical occupations.

## 3.7 SUMMARY: IDENTIFIED ITS PROCESS IMPROVEMETNS

Based on the findings of the case study, identified primary benefit streams to IMTC stakeholders are presented below. Preliminary cost-benefit figures for these improvements are provided in Section 5. The results of this case study also will serve as an input to more robust analyses of these benefits streams, which will occur in the WSDOT E-Seal Phase II Evaluation recently begun by SAIC for the ITS-JPO.

The primary benefit steams identified in this case study are summarized as follows:

- **Commercial Trucking Industry ITS Process Improvements.** Identified benefits here for motor carriers include paperwork reduction, error reduction, and resource savings. ITS-enabled integrated systems generate resource savings for the motor carrier. This is achieved through a more efficient customs clearance information workflow process; reduced errors producing more accurate documents; and reduced transaction time necessary for the motor carrier to produce or forward required documentation to the customs brokers, CBP/CCRA, and other stakeholders.

- **Commercial Brokerage Industry ITS Process Improvements.** Identified benefits for brokers include paperwork reduction, error reduction, and resource savings associated with implementing an electronic data information exchange with CBP/CCRA. Another improvement includes reduced stops for trucks at brokerage houses due to the improved electronic documentation provided by brokers to CBP/CCRA.

- **State and Provincial Truck Safety Enforcement Process Improvements.** Identified benefits include paperwork reduction and resource savings by the sharing of electronic credentialing data. The Washington State CVISN system and the

ICBC's National Safety Board system will share electronic credentialing data. It is expected that regulatory processing will be decreased and efficiency improved through bi-national sharing of WIM-gathered data.

- **Customs (CBP/CCRA) Process Improvements.** Implementing electronic versus manual systems[12] for customs processes is expected to result in a more accurate information flow and leading to a reduction in transaction workflow process paperwork and errors. This should lead to cost and resource savings for both CBP/CCRA.

[12] Currently, a manifest is stored in a CBP system for an in-bond container shipment destined for Canada. This manifest is not transferred from the CBP system to the Canadian system, which requires that the shipper files the appropriate information separately with each Customs service. After these two systems are integrated, it is anticipated that reductions in the error rate for data entry and in the amount of paperwork will be realized.

# 4. COMMERCIAL VEHICLE BORDER OPERATIONS SURVEY AND BENEFITS ESTIMATION

## 4.1 INTRODUCTION

This major focus of this section is the Evaluation Team's analysis of the potential transportation system efficiency benefits for trucks through the implementation of a dedicated ITS truck lane at the Pacific Highway international border crossing at Blaine, Washington/Surrey, British Columbia. The evaluation approach here is to estimate the base and future year benefits based first on an empirical analysis of border operations observed during a border operations survey conducted in June 2002, and secondly, on the application of the Strategic Logistics Model for the 49$^{th}$ Parallel (SLM-49) developed specifically for this study to analyze border transportation operations.[13]

This section is organized as follows:

- 4.2 Commercial Vehicle Clearance Operations
- 4.3 Southbound Survey Results
- 4.4 Northbound Survey Results
- 4.5 Development of SLM-49
- 4.6 Base Year Representative Days
- 4.7 Horizon Year 2013 Representative Days
- 4.8 ITS Benefits Modeling
- 4.9 Limiting Factors
- 4.10 Summary of Findings
- 4.11 Future Considerations for Logistics Modeling of Border Delays

Figure 4-1 presents an overview of the ITS benefits modeling methodology. The travel time benefits of ITS deployment were estimated using SLM-49 which was validated using empirical observations from the border operations survey. SLM-49 was developed to isolate the following three primary components of border operations travel time benefits: the time on the approach to the customs booth; customs broker-related time; and customs booth-related time. The model was developed for the Base Year, and benefits of ITS deployment and a dedicated lane can be expected to accrue into the future towards a reasonable life of the project for Horizon Year 2013 (Year 10).

Daily benefits for the Base Year and Horizon Year were estimated through application of SLM-49, factored to annual benefits based upon relationships derived from observed data and converted to a monetary value using assumed values of time. The benefits for the Base and Horizon Years were converted to present value, and served as input into the overall study benefit-cost analysis, which is presented in Section 5. Additionally, the sensitivity of the commercial vehicle border operations benefits to realistic ITS demand scenarios was evaluated, thus presenting a range of estimated benefits.

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[13] For further detail concerning this border survey and modeling effort, see this document's Appendix, which provides the full TSi Evaluation Modeling Report.

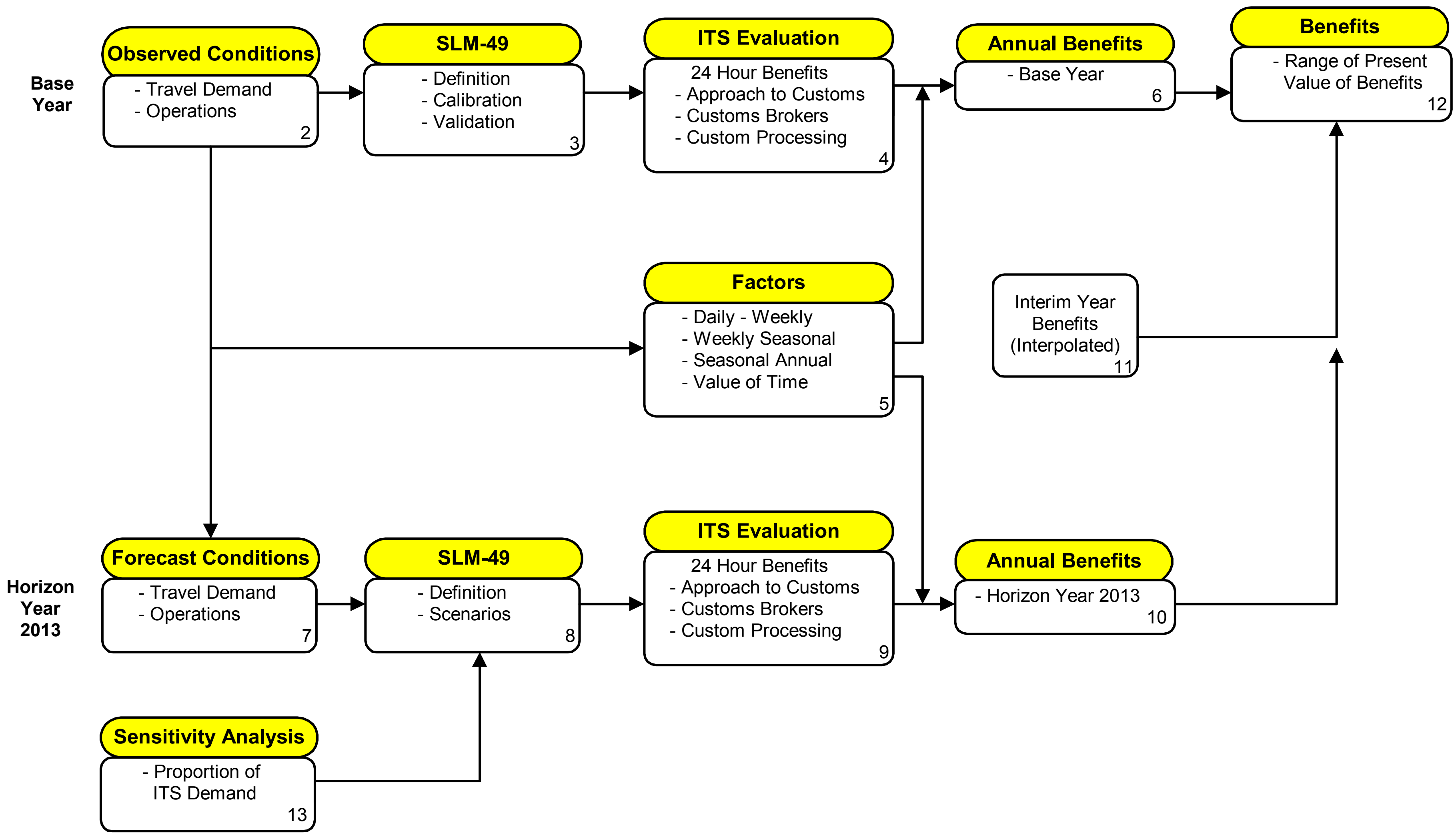


**Figure 4-1. Commercial Vehicle Operations ITS Evaluation Benefits Estimation Methodology.**

## 4.2 COMMERCIAL VEHICLE CLEARANCE OPERATIONS

A detailed survey of border operations at the Pacific Highway Crossing was conducted in June 2002. The primary purposes of the survey were to acquire a comprehensive understanding of operating conditions, and to gather data required to develop and validate the SLM-49. This section presents the salient features of commercial vehicle clearance operations and summarizes relevant survey results.

The existing operations for southbound and northbound commercial vehicles at the Pacific Highway Crossing are described in Figures 4-2 and 4-3. These exhibits show the border facilities prior to reconstruction for the U.S. Customs operations and the introduction of a new holding area in the southbound direction. The new gravel parking lot has provided some relief to southbound congestion, since the commercial vehicles requiring customs broker processing no longer park directly on Highway 15, and now line up only in the outside lane.

The clearance operations differ between CBP and CCRA approaches. In the southbound direction, commercial vehicles with pre-approved shipments (i.e., precleared commercial vehicles) are separated from those that require processing with customs brokers prior to proceeding to the customs booths (non-precleared commercial vehicles). Three commercial vehicle staging areas, including a relatively new gravel staging area, are identified as Staging Areas A – C in Figure 4-2. Commercial vehicles that are parked in Staging Area C (the duty-free commercial vehicle parking lot) can be parked there in order to shop at the duty free, visit the customs brokers, or both. Commercial vehicle drivers walk from the staging areas to customs brokers located on the south side of the border.

In the northbound direction, all commercial vehicles wait in queue on the approach to the CCRA booths. Commercial vehicles that require a secondary inspection or whose drivers require processing by customs brokers are directed to a holding area after passing through the Canada Customs. These vehicles exit the holding area via an automated customs booth.

The survey methodology was primarily developed to capture travel time by major segment from the moment a commercial vehicle entered the study area to the completion of a primary inspection at the customs booths. (The survey station locations are identified as red circles in Figures 4-2 and 4-3.) Surveyors used using personal digital assistants (PDAs) to collect data for travel time, vehicle classification, empty/laden status, and queue length.

**Southbound Commercial Vehicle Operations**

1) Commercial vehicles enter survey area one dedicated truck lane. The northern limit of the study area was defined by 8th Avenue, approximately 1.6 kilometres north of the border.
2) Commercial Vehicles have option to:
   i) If pre-cleared, continue to U.S. Customs booth. If an extensive queue exists, trck passengers have been known to walk from point 1 (or north) to customs brokers, thereby precluding the requirement to park in a staging area, and permitting the truck to stay in the through lane.
   ii) Use Duty Free parking entrance for access to: a) Duty Free commercial vehicle parking area (C); or b) new gravel staging area (A).

*Note: Commercial vehicles are required to wait in the truck lane until the Duty Free entrance. Those that try to jump the queue (using a passenger vehicle lane) in order to gain access to the Duty Free are waived through by a Duty Free attendant, and may have difficulty accessing Staging Area B.*

3) Access to Staging Area A or B– From this point truck drivers walk across the border to have shipments processed by customs brokers. Trucks with pre-approved cargo continue in one lane towards U.S. Customs booths.
4) Commercial vehicles that used the staging area re enter queue on approach to booth. A second lane (right hand lane- RHL) begins at the egress of staging area B.

*Note: A) Queues build up into the staging area. Commercial vehicles park and re -enter traffic stream at various places.*

*B) If pre-cleared commercial vehicles are present, the trucks leaving the staging area are generally confined to the RHL on the approach to booths.*

5) Customs Booths– Generally two of three booths are open after 8:00 AM. If sufficient demand is present, line-release trucks use LHL; In other words, trucks that use Staging Areas A– C use RHL unless capacity is available in the LHL.

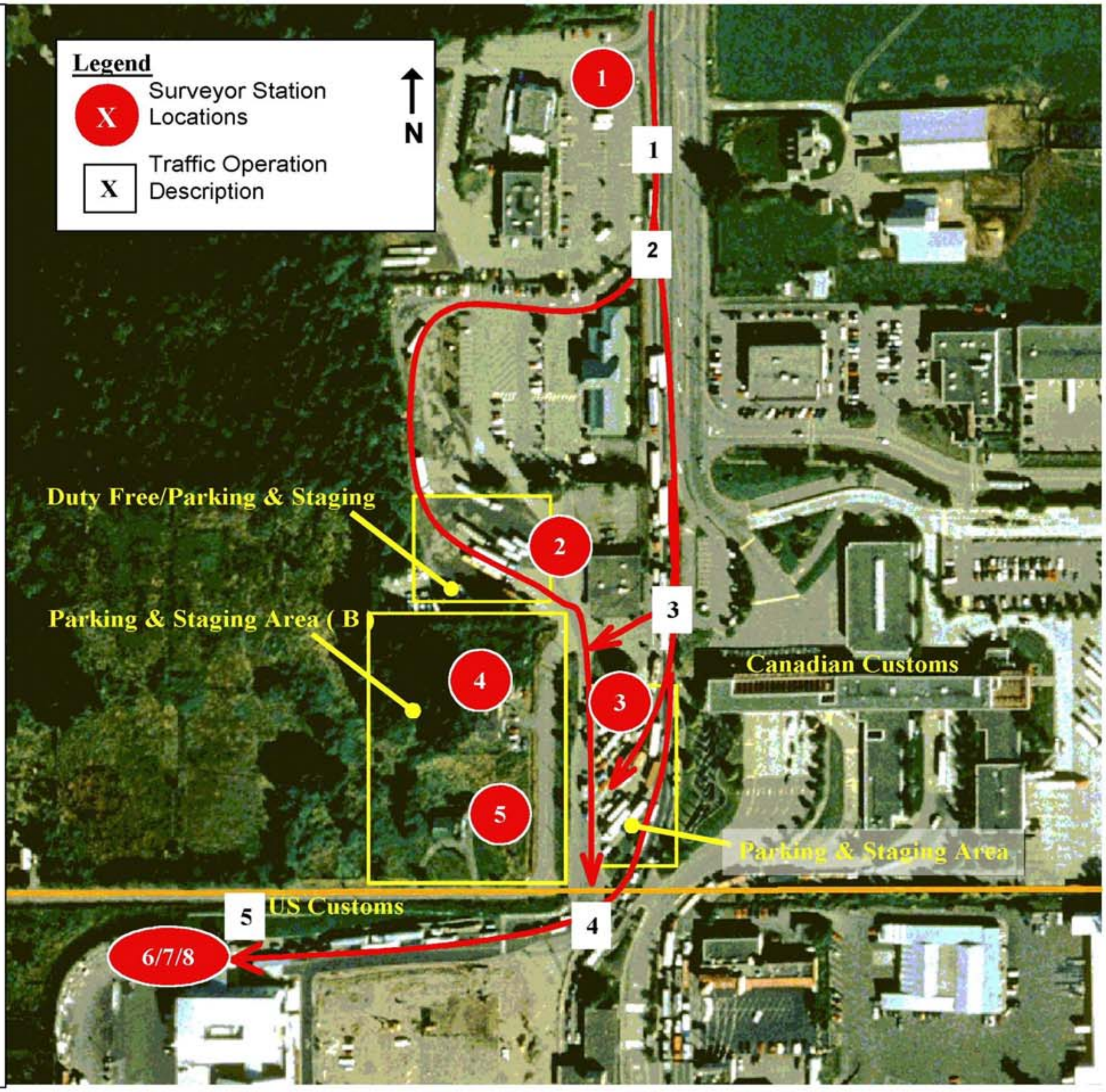


**Figure 4-2. Existing Southbound Commercial Vehicle Operations – Pacific Highway Crossing.**

**Northbound Commercial Vehicle Operations**

1) Commercial vehicles enter survey area – The RHL is dedicated lane for commercial vehicles on SR 543. Passenger vehicles have dedicated LHL. The southern limit of the study area was defined by Boblett Street (Near I-5).

2) Commercial vehicles have option to:

   i) Continue NB to booth.

   ii) Pullout to truck parking lot approx. 100-200 m south of NB Duty Free.

3) Pre-cleared and non-precleared commercial vehicles continue in towards booths on the east side of the Canada Customs building.

4) Commercial vehicles have two options at Canada Customs booths:

   i) Pre-cleared vehicles continue northbound on Highway 15.

   ii) Non-precleared commercial vehicles or those referred for a secondary inspection access CCRA holding area.

*Note: the number of open CCRA booths varies by demand and time of day.*

5) Commercial vehicles exit Canada Customs holding area via an automated customs booth.

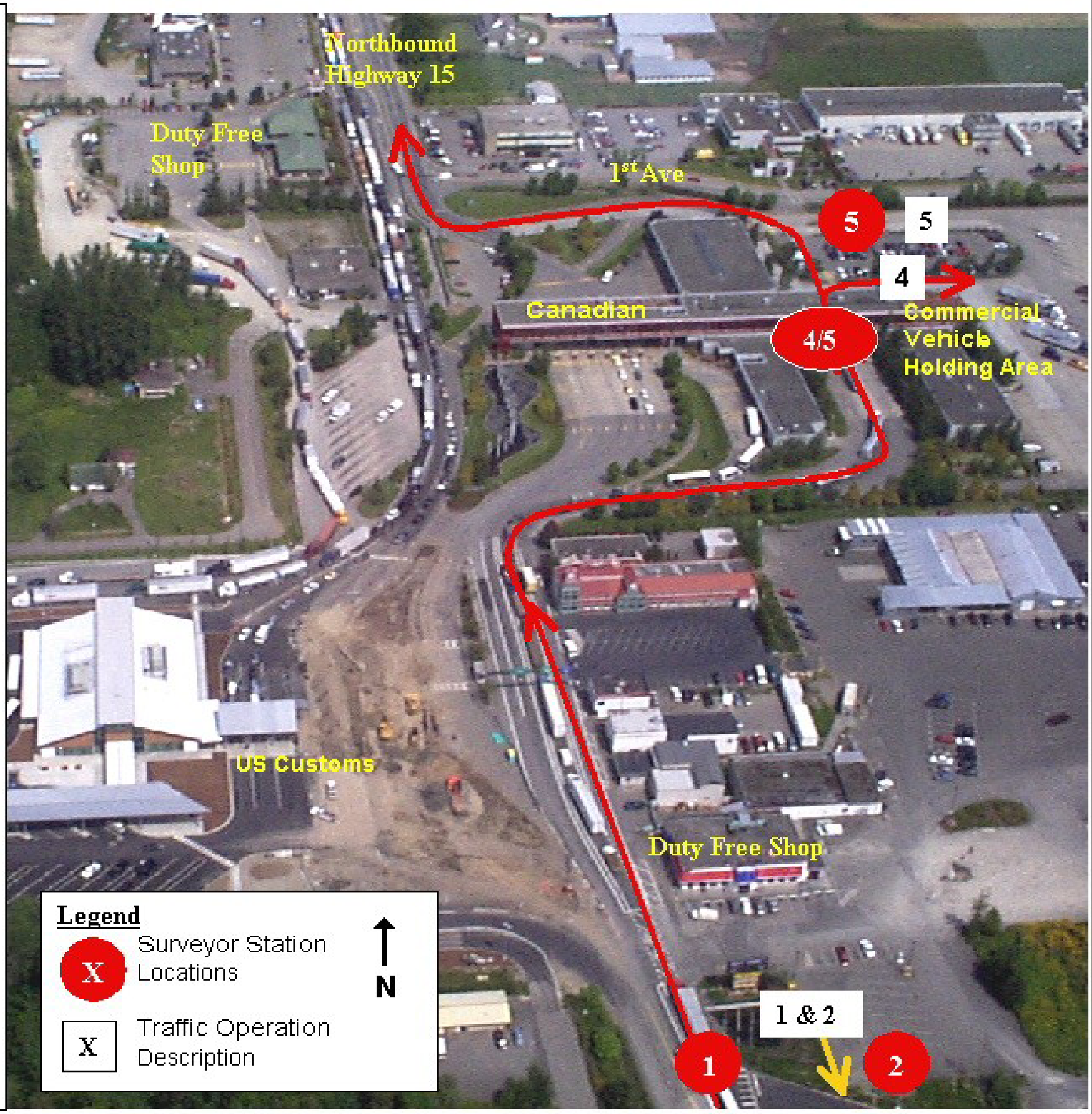


**Figure 4-3. Existing Northbound Commercial Vehicle Operations – Pacific Highway Crossing.**

## 4.3 SOUTHBOUND SURVEY RESULTS

The southbound direction was surveyed between Monday and Thursday, June 10 through June 14, 2002. Note that anecdotal discussions with customs staff and truckers during this time indicated that travel time and queuing on the final 2 days of the survey were unusually light.

Southbound commercial vehicle arrival rates observed during the survey are illustrated in Figure 4-4. The average demand during the survey period was 744 vehicles. The variation in demand, not only in total but also in distribution profile throughout the day, is noteworthy: approximately 10 percent of commercial vehicles were empty, and approximately 45 percent were carrying a commodity and precleared. Non-precleared vehicles were defined as those that stopped at holding areas A – C (see Figure 4-2), and also comprised approximately 45 percent of demand.

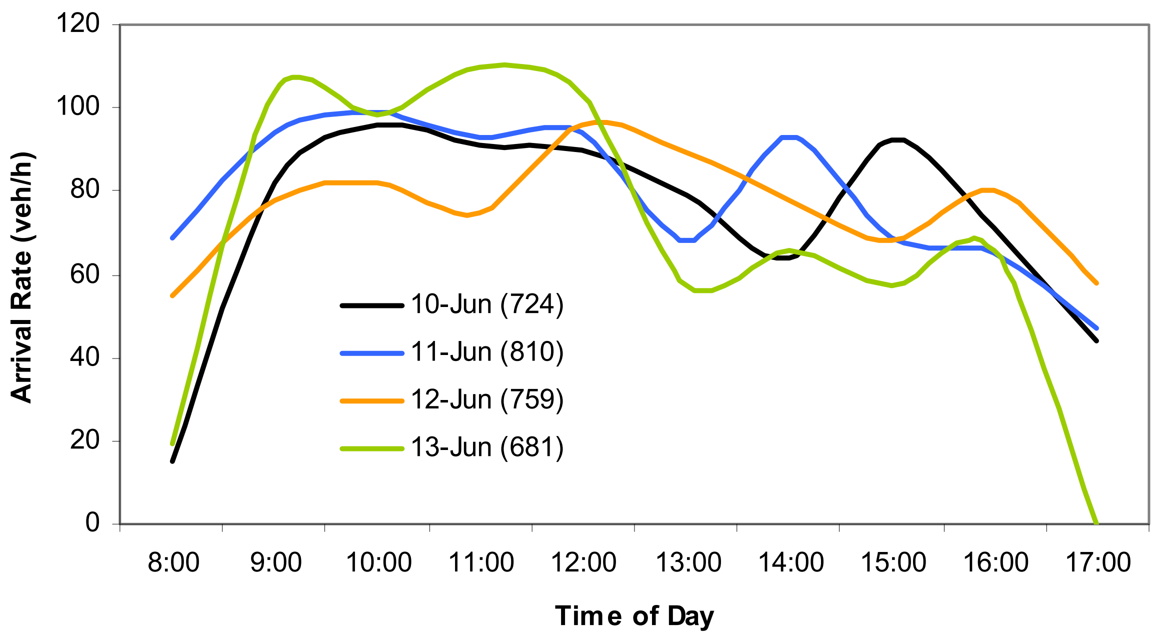


**Figure 4-4. Southbound Commercial Vehicle Arrival Rates (8:00 AM to 5:00 PM).**

Commercial vehicle drivers required to personally visit a customs broker generally park in any of the three holding areas, and walk across the border to the customs broker offices. The time that it took individual drivers to conduct business with the customers broker was explicitly recorded during the survey. The average travel *customs broker-related time* over the 4 days was 18 minutes**.**

*Customs booth-related time* consists of interview time with the customs official, and vehicle transit time from the stop position to the to the customs booth. The total average survey period customs booth-related time varied between 65 to 82 seconds per vehicle between days. This day-to-day variation can have a significant influence on border operations as illustrated in the following simple example:

As recorded, the service rate at 82 seconds per vehicle yields approximately 44 vehicles per hour per booth. Similarly, the service rate at 65 seconds per vehicle yields 55 vehicles per hour per booth. Assuming one open booth and an average commercial vehicle length and gap of 80 feet, for a *1-hour period*, these factors may be converted to a difference in queue length of close to *one-fifth of a mile*.

As an absolute value, the customs booth-related time is a small proportion of overall border operations time. The customs booth-related time does have a significant influence upon queue and travel time on the approach to the customs booths.

The surveyors found that the vehicle demand, customs broker-related time, and customs booth-related time varied within and between days, and produced a set of operating conditions that were unique to each day. For the purpose of this benefits analysis, the daily border operations produced through the convergence of these variables are described in terms of travel time and queue length.

A summary of average daily commercial vehicle travel time is provided in Table 4-1. Over the 4 survey days, the average time from the moment a truck entered the survey area to clearance from primary inspection was approximately 40 minutes per vehicle. It is notable that the average travel time ranged between 23 to 60 minutes among the 4 days.

**Table 4-1. Southbound Average Travel Time During Survey Period**

| Date (2002) | Travel Time (min) | | |
|---|---|---|---|
| | All Trucks | Empty or Precleared | Non-Precleared |
| June 10 | 60 | 51 | 70 |
| June 11 | 49 | 41 | 56 |
| June 12 | 30 | 22 | 36 |
| June 13 | 23 | 15 | 35 |
| **Average Time** | 40 | 32 | 50 |

The travel time for the average empty or precleared truck was approximately 32 minutes, or roughly 15 to 20 minutes less than the average non-precleared truck. This additional time is consistent with the observed customs broker-related time.

The maximum and minimum queue length distribution during each half hour period for each of the southbound survey days is provided in Figure 4-5. The minimum recorded length in the survey was one-eighth mile (200 m). Figure 4-5 also shows the distribution of open booths by half-hour periods throughout the day. In general, there were two booths open throughout the survey period. Of note:

- Vehicle queuing patterns for June 10 and 11 exhibit dramatically different from those on June 12 and 13. This can be attributed to the higher customs booth-related time as previously discussed.

- A period of sustained queuing occurred on June 10 and 11 beyond the maximum surveyed point of 1.1 miles (1,770 m). On these days, the queue extended westward on 8th Avenue towards 172nd Street (and at times, even beyond).

- The final time period beginning at 4 p.m. on June 10 is noteworthy. The maximum queue during that period was over 1 mile (1,600 m). This was reduced to *no queue* in a period of just over 20 minutes after a third CBP booth was opened.

- The morning queue on June 13 may have been precipitated by later than normal opening of the second booth.

Table 4-1 and Figure 4-5 demonstrate the variance of operating conditions from day to day. For example, the total number of arrivals over the survey period on June 13 exceeded those on June 10. However, the average travel time and queue profile on June 13 is considerably lower in magnitude than for June 10. This is likely related to the difference in arrival profile *and* customs booth related processing time. This difference between the 2 days would have been aggravated had the second booth opened at 8 a.m. on June 13.

June 13 and 14 experienced similar customs booth processing rates. However, the average travel time on June 14 was approximately 7 minutes, or 20 percent less. This may be attributed to a difference in demand over the survey period in terms of both profile and total demand.

The combination of commercial vehicle arrival rates, customs broker travel time, and customs booth-related processing time produced a set of volatile operating conditions that are unique to each day. Border travel time and queue are sensitive to changes in these variables such as opening of an additional booth, reduction in processing time, or a reduction in demand.

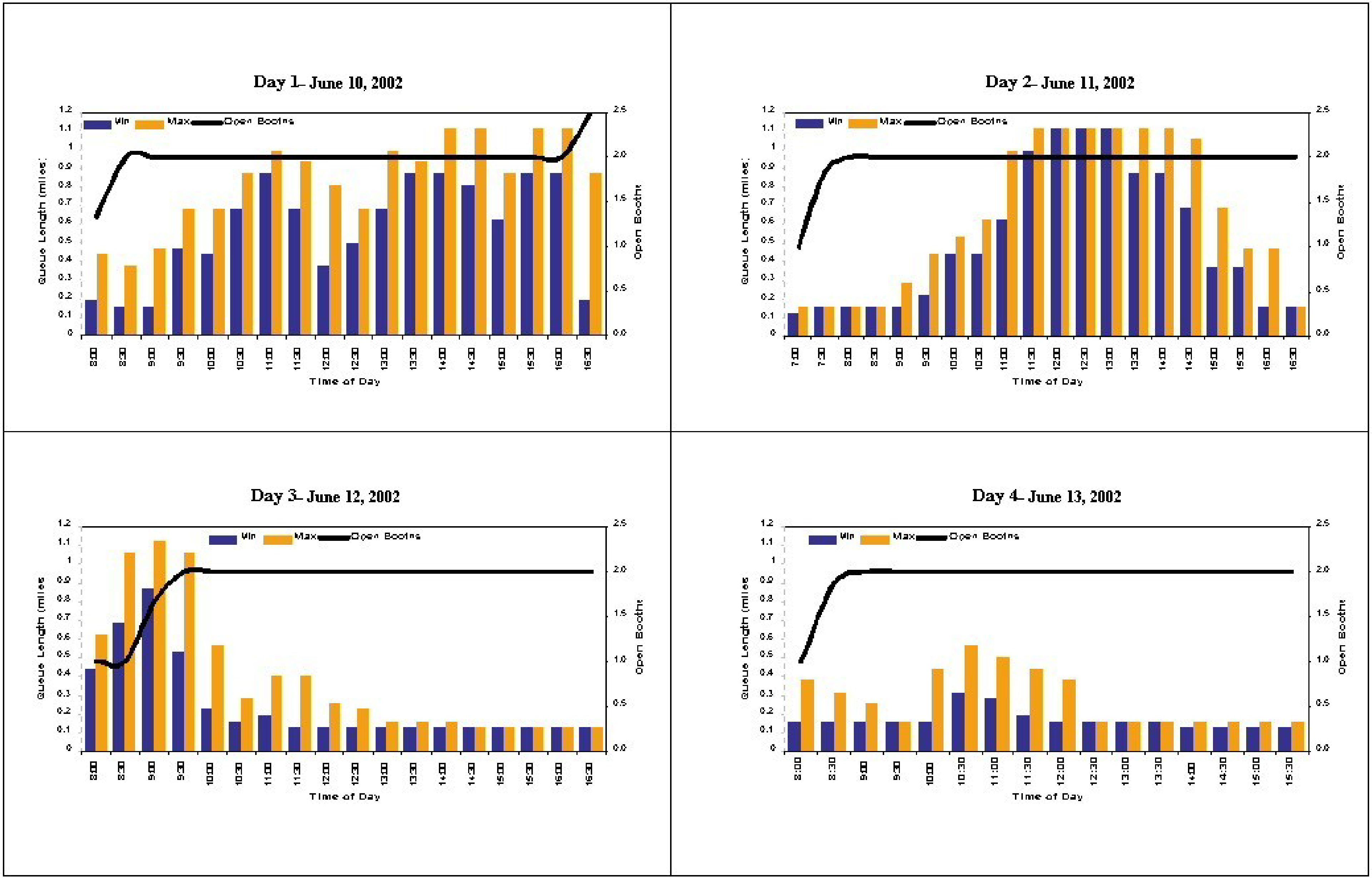


**Figure 4-5. Southbound Maximum and Minimum Queue Length and Number of Operating Booths.**

## 4.4 NORTHBOUND SURVEY RESULTS

The northbound direction was surveyed between Monday and Thursday, June 17 through 20, 2002. Similar to the final 2 days in the southbound direction, anecdotal discussions with truckers and customs staff indicated that overall travel conditions were lighter than normal.

Northbound commercial vehicle arrival rates observed during the survey are illustrated in Figure 4-6. The average volume during the survey period was 706 commercial vehicles (this volume ranged between 612 to 759 commercial vehicles over the 4 days). As in the southbound direction, the variation in demand, not only in total, but also in distribution throughout the day, is noteworthy and in part, influenced the variation in travel conditions between days.

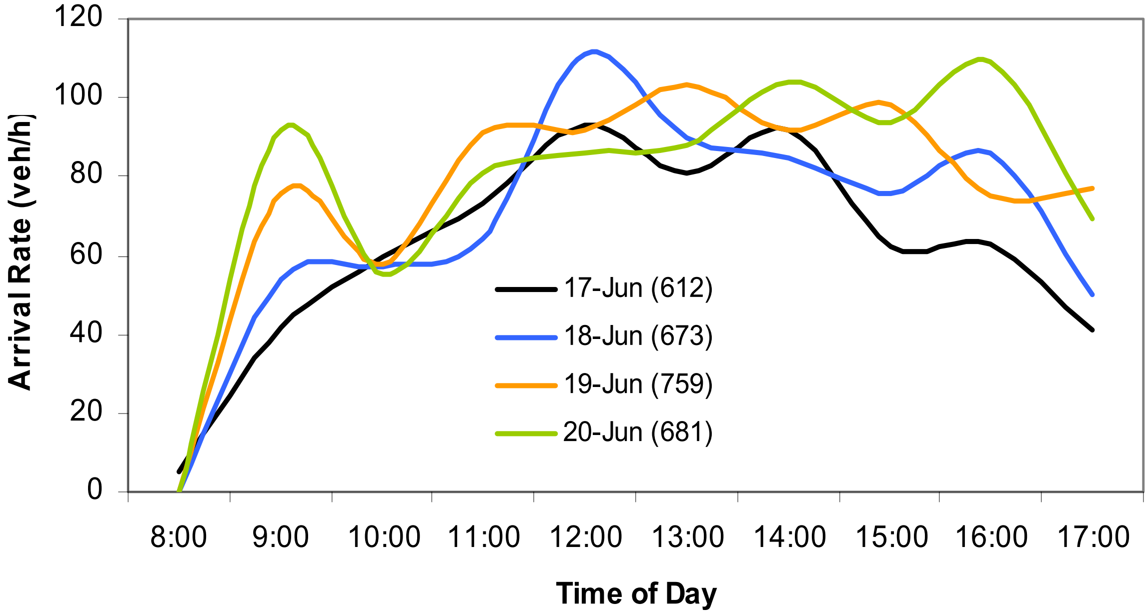


**Figure 4-6. Northbound Commercial Vehicle Arrival Rates (8:00 AM to 5:00 PM).**

In the northbound direction, approximately 37 percent of the commercial vehicles were empty. Approximately 45 percent carried a commodity and were precleared, while approximatley18 percent carried a commodity and were not precleared.

The primary staging area for customs broker-related activity in the northbound direction is located north of the border. Non-precleared commercial vehicles, as well as those referred for secondary inspection, are directed to this holding area after primary inspection at the CCRA booths. The time spent in the holding area consists of two components: visiting the customs broker and subsequent approval of documentation by CCRA. The average northbound customs broker-related time over the 4 survey days was 79 minutes per vehicle, and this was relatively consistent between days.

The average survey period customs booth interview time was 49 seconds per vehicle (73 vehicle/hr) and ranged between 43 to 54 seconds per vehicle over the survey period. Due to the configuration of border operations and sustained periods without a queue, vehicle transit time in the southbound direction was also applied to the northbound direction.

In the southbound direction, two customs booths are open throughout the survey period. In the northbound direction, the number of open booths is directly related to demand and queue length. For example, depending upon the situation, the second booth is opened if the queue ranges from 1,500 to 4,500 feet. This has a significant influence on operating conditions. The average number of open booths during the survey period ranged from 1.31 to 1.81. However, the two booths were open throughout the afternoons on June 17 and 18 due to staff training.

As noted, the number of open booths has a direct affect on the service rate at the border crossing, and, in combination with arrival rates, helps explain daily variation in travel time and queue length.

A summary of average daily commercial vehicle travel time is provided in Table 4-2. The average time from moment of entering the survey area to clearance from the customs booths was approximately 26 minutes per vehicle.

**Table 4-2. Northbound Average Travel Time During Survey Period**

| Date (2002) | Travel Time (min) | | |
|---|---|---|---|
| | All Trucks | Empty or Precleared | Non-Precleared |
| June 17 | 30 | 15 | 104 |
| June 18 | 24 | 12 | 88 |
| June 19 | 22 | 12 | 84 |
| June 20 | 26 | 15 | 91 |
| **Average Time** | 26 | 13 | 92 |

The non-precleared vehicles experienced an average travel time of approximately 1.5 hours, or approximately 80 minutes more than precleared vehicles.

The maximum and minimum queue length distribution during each half hour period for each of the northbound survey days is provided in Figure 4-7. Due to the curve in the road on the approach to the CCRA booths, the minimum recorded length in the survey was one-eighth of a mile. Figure 4-7 also shows the distribution of operating booths by half hour period throughout the day. Of note:

- Periods of sustained queuing of over on-half mile were not experienced.
- The maximum queue length experienced was close to one mile early in June 18.
- The shape of the queue length distribution varies from day to day and does not show a consistent pattern.

- The queue length distribution is directly related to the distribution of operating booths. This also varied significantly between days, e.g., two booths were open for most of the afternoon on June 17 and 18. This may be due to new officer training on these days.

- The number of operating booths varied within days, especially on June 17, and appeared to be directly responsive to demand.

Table 4-2 and Figure 4-7 demonstrate the variance of operating conditions from day to day. For example, the total number of arrivals over the survey period between June 19 and 20 exceeded June 17 and 18. However, the average travel time and queue profile on the final 2 days is considerably lower in magnitude than first 2 days. This is likely related to the difference number of open booths.

The combination of commercial vehicle arrival rates, customs booth related processing time, and the number of open booths all merge to produce a set of operating conditions that are unique to each day. Operating conditions are also very sensitive to changes in these variables such as opening of an additional booth, reduction in processing time, or a reduction in demand.

The methodology developed for the border operations survey was designed to capture the important components of commercial vehicle clearance operations at the Pacific Highway port-of-entry. The survey results maybe used to inform border operations planning and policy, and for the development of border operations models such as SLM-49.

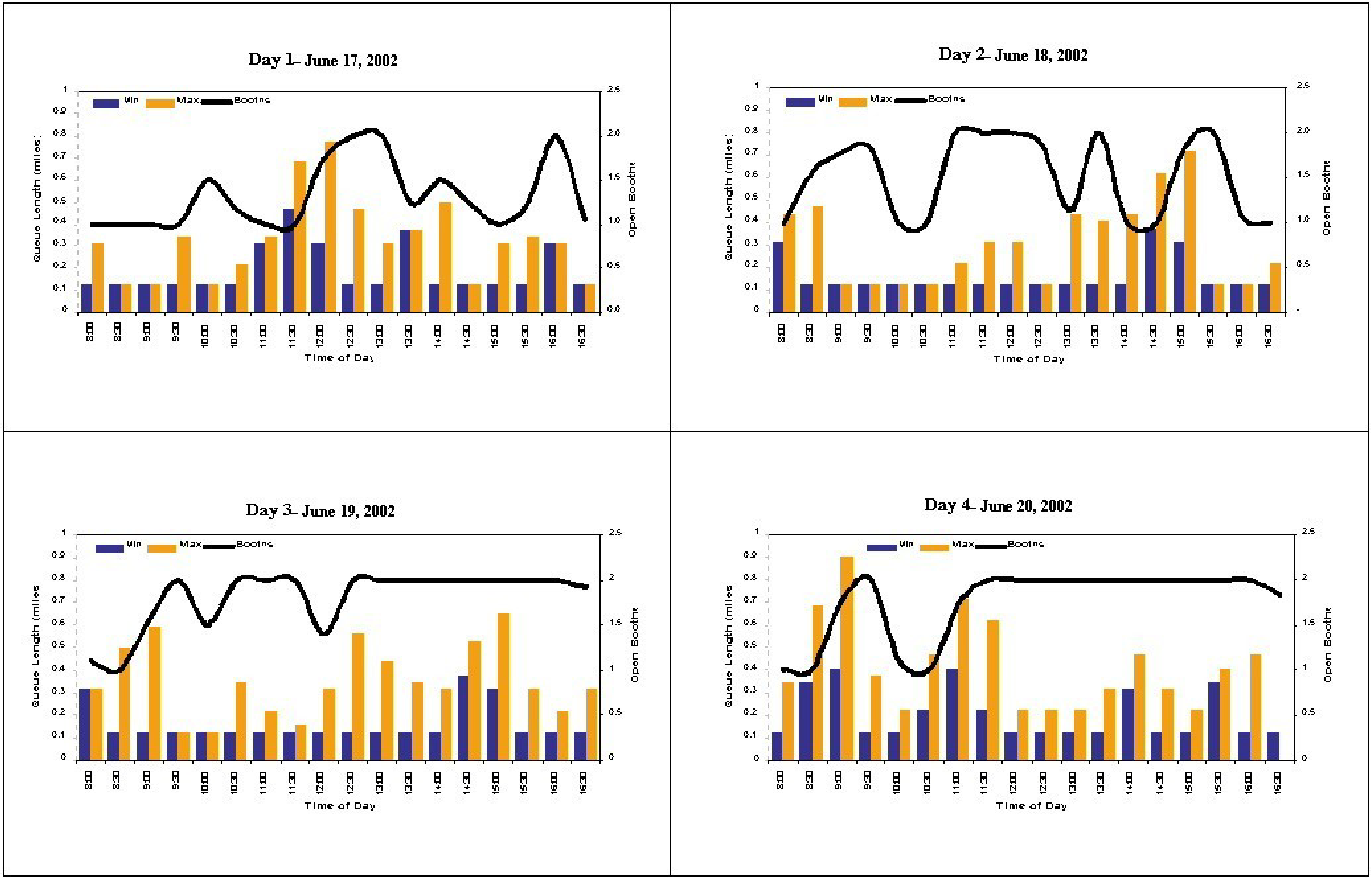


**Figure 4-7. Northbound Maximum and Minimum Queue Length and Number of Operating Booths.**

## 4.5 DEVELOPMENT OF SLM-49

Section 4.4 described commercial vehicle border operations at the Pacific Highway Crossing, and characterized border-operating conditions for the 4 days that were surveyed. This information provides an important baseline, and also enabled the development of the sketch planning Strategic Logistics Model (SLM-49) that estimates queue length and travel time for commercial vehicles in both directions at the Pacific Highway Crossing. Upon completing this model development, SLM-49 was used to estimate operating conditions for “representative” days for the Base Year (2003) and a selected Horizon Year (2013), and evaluate the benefits of ITS deployment with respect to commercial vehicle operations. A snapshot process view of some of the modeling steps in SLM-49 is provided in Figure 4-8.

SLM-49 combines the unique dynamics experienced at nodes on the logistics supply chain, such as border operations, with queuing theory. SLM-49 is a sketch planning queue model that simulates border operations over a 24-hour period, in 10-minute increments. The following elements were considered in model structure and specifications:

- The cost of border operations over a 24-hour period, and the potential benefits attributed to ITS can be broken into three time components. Hence travel time attributed to the approach to the ports of entry (POE), at the customs broker (if required), and at the customs booth for precleared and non-precleared commercial vehicles was explicitly considered.

- SLM-49 was designed such that, upon development and validation, it could accommodate the variation in demand and processing through simulation of “representative” or “typical” conditions. This enabled development of four models that are representative of summer and winter weekday and weekend days.

- SLM-49 was used to estimate the benefits of ITS deployment for the Base Year and a selected Horizon Year (2013), where the benefits for the interim years could be interpolated. The application of the model in any given horizon year would require the following key assumptions: the forecast number of commercial vehicles, use of ITS technology among commercial vehicles, the arrival pattern of commercial vehicles over a 24-hour period, and customs service rates/number of operating booths over a 24-hour period. As there is some uncertainty with respect to these Horizon Year assumptions, the SLM-49 was designed to represent a level of detail compatible with planning level benefit-cost analysis.

- Although SLM-49 was developed for the Pacific Highway Border Crossing, it was designed to be flexible and portable. The model structure and calibrated parameters may be:
  - Transferred to other border crossing ports of entry.
  - Extended to include other nodes on the logistics supply chain such as port container terminals and truck inspection sites (weigh scales).
  - Expanded to include passenger vehicles.
  - Incorporated into cross-border travel demand forecasting models.

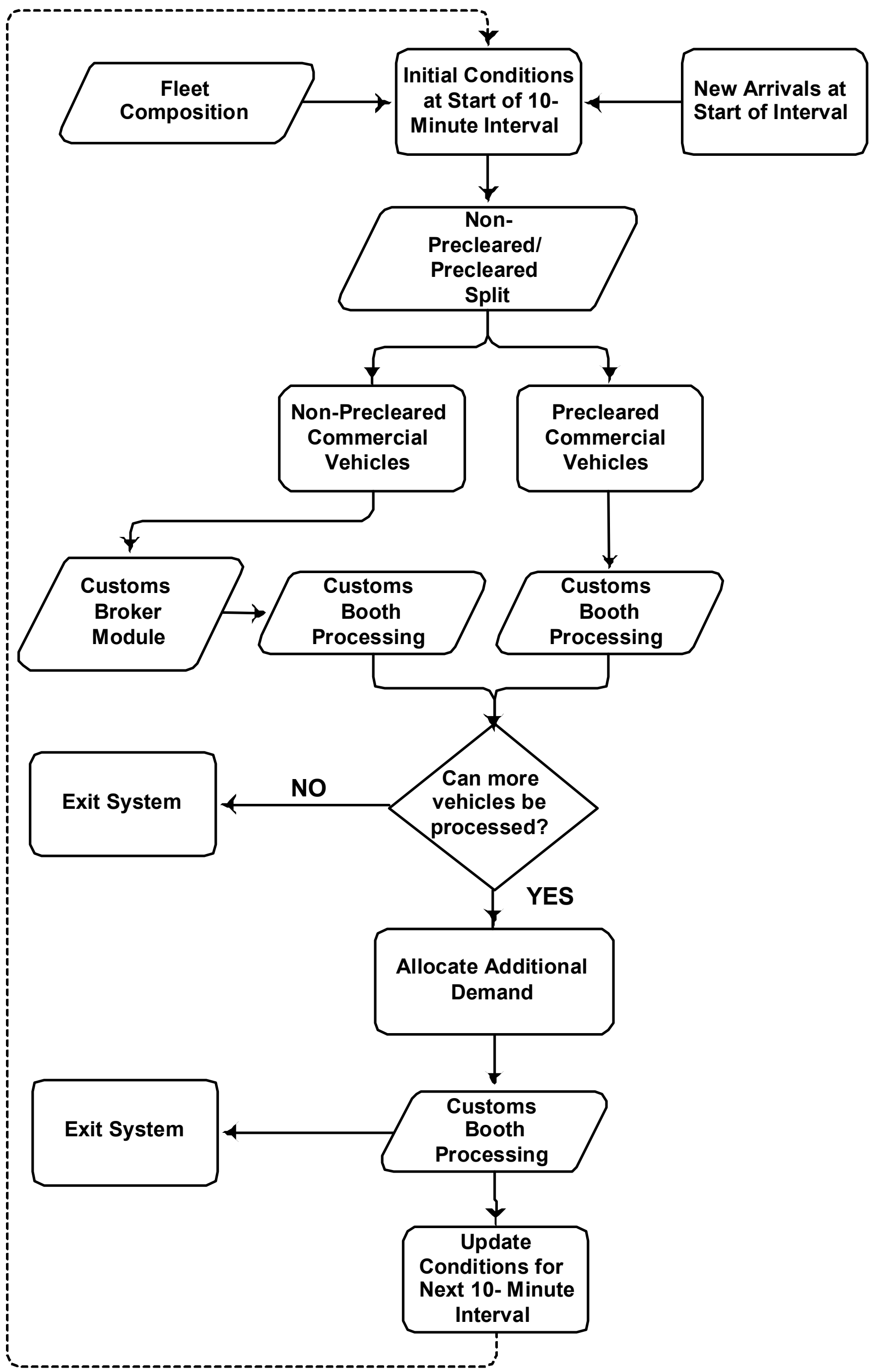


**Figure 4-8. Overview of SLM-49 for a Time Interval in the Southbound Direction.**

SLM-49 was validated using the statistical measures of root mean square (RMSE) and GEH (quantitative error approach) for measures of queue length and travel time. A RMSE of 1.0 suggests a perfect fit of the model to observed conditions, and a GEH under 10 also demonstrates an acceptable fit. Depending upon the truck trip type, the RMSE in the southbound direction ranged from 0.73 to 0.97, and the GEH was under 5. In the northbound direction, the RMSE ranged from 0.80 to 0.95, and the GEH was also under 5.

This validation of SLM-49 provided a reasonable level of confidence that the SLM-49 robustly simulates border operations at the Pacific Highway Crossing. Given confidence in the mechanics of SLM-49, representative day models were developed for summer and winter weekdays and weekends. The purpose of the representative day models was to account for variation in border operations and demand between days; extend the model’s time period to 24 hours; and establish a robust basis for converting border operations costs and ITS deployment benefits by season and day of week to annual estimates. This resulted in eight "representative day" 24-hour Base Year models, and these are identified in Table 4-3.

**Table 4-3. Base Year Representative Day Models**

| Direction | Summer | | Winter | |
|---|---|---|---|---|
| | Weekday | Weekend Day | Weekday | Weekend Day |
| Southbound | • | • | • | • |
| Northbound | • | • | • | • |

## 4.6 BASE YEAR REPRESENTATIVE DAYS

Given assumptions regarding average demand and the number of operating customs booth for each "representative day", four “representative day” models were developed for each direction. Travel characteristics that describe the "representative days" are provided in Tables 4-4 and 4-5, and average 24-hour queue profiles for each of these days are provided in Figures 4-9 and 4-10.

**Table 4-4. General Characteristics of Southbound Representative Days (8:00 AM to 5:00 PM)**

| Criteria | Summer | | Winter | |
|---|---|---|---|---|
| | Weekday | Weekend Day | Weekday | Weekend Day |
| Demand | 878 | 80 | 783 | 384 |
| Average Queue Length (miles) | 0.88 | 0.27 | 0.66 | 0.18 |
| Average Precleared Travel Time (min) | 49 | 23 | 40 | 21 |
| Average Non-Precleared Travel Time (min) | 72 | 39 | 69 | 30 |

In general, border operations in the southbound direction are most constrained during a representative summer weekday, where, at its peak, the queue can exceed 1 mile. Due to a decreased demand and different arrival rate throughout the day, the southbound maximum queue on a representative winter day is approximately 1 mile. The representative queue and travel time on weekends is less pronounced.

**Table 4-5. General Characteristics of Northbound Representative Days (8:00 AM to 5:00 PM)**

| Criteria | Summer | | Winter | |
|---|---|---|---|---|
| | Weekday | Weekend Day | Weekday | Weekend Day |
| Demand | 792 | 426 | 727 | 384 |
| Average Queue Length (miles) | 0.29 | 0.03 | 0.24 | 0.01 |
| Average Travel Time without Parking Lot (min) | 14 | 2 | 13 | 1 |
| Average Travel Time with Parking Lot (min) | 19 | 2 | 16 | 1 |

As in the southbound direction, border operations are most constrained during a representative summer weekday, where, at its peak, the queue can be approximately three-fourths of a mile. Due to a decreased demand and different arrival rate throughout the day, the northbound queue on a representative winter day is approximately one-half mile. The profiles illustrated in Figure 4-10 reflect the CCRA policy for opening the second customs booth. It is noteworthy that the representative queue on weekends is limited in the summer, and virtually non-existent in the winter.

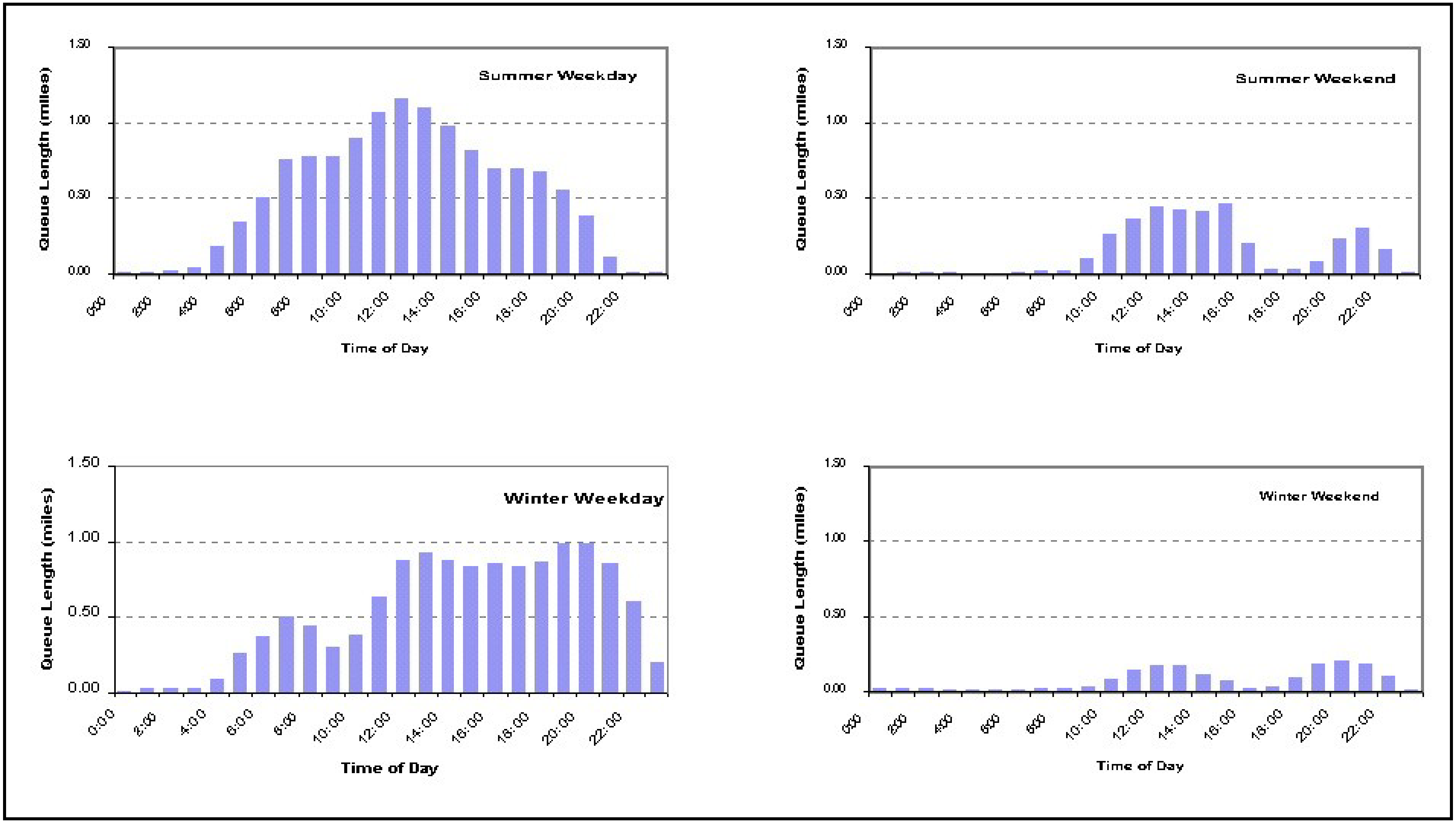


**Figure 4-9. Southbound Representative Daily Queue (Miles).**

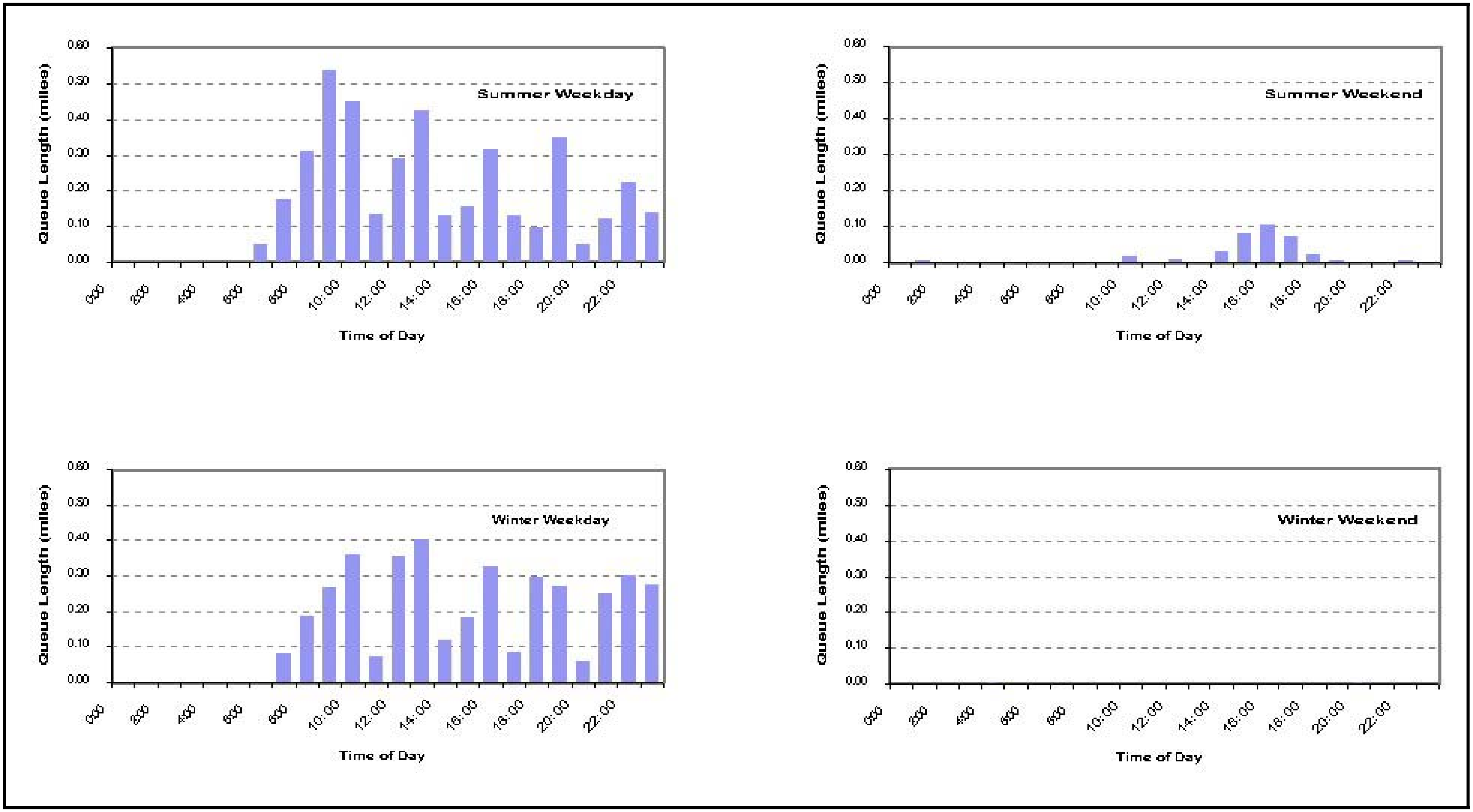


**Figure 4-10. Northbound Representative Day Hourly Queue Length (Miles).**

The development of the eight "representative day" models enabled estimation of Base Year annual[14] border operations average travel time and total costs to vehicles. The average annual travel time, including customs broker-related time in both directions, weighted by season and day of week over 24 hours, is provided in Table 4-6. The average travel time for southbound commercial vehicles ranges from between 31 to 46 minutes per vehicle. The precleared average travel time in the northbound direction is less than the southbound direction; however the non-precleared time is close to *double* the non-precleared time in the southbound direction.

**Table 4-6. Average Annual Border Operations Travel Time (min/veh)**

| Truck Trip Type | Travel Time (min) | |
|---|---|---|
| | SB | NB |
| Precleared | 31 | 9 |
| Non-Precleared | 45 | 91 |

The direct commercial vehicles costs of border operation the Pacific Highway Crossing are presented in Table 4-7[15].

**Table 4-7. Base Year Annual Cost of Border Operations by Source ($US Million)**

| Source of Cost | Annual Cost ($M) | | |
|---|---|---|---|
| | SB | NB | Total |
| Approach to Customs Booth | $11.1 | $2.7 | $13.8 |
| Customs Booth Related | $0.5 | $0.3 | $0.8 |
| Customs Broker Related | $2.1 | $5.3 | $7.4 |
| **Total Cost** | $13.6 | $8.4 | $22.0 |

The total annual commercial vehicle cost of border operations at the Pacific Highway Crossing is estimated at approximately $22 million, or $13.6 and $8.4 million in the southbound and northbound directions, respectively. The primary source of border operations cost varies by direction of travel. For example, in the southbound direction, approximately 80 percent of the cost of southbound border operations is attributed to travel time on the approach to the border, and much of this travel time is experienced by both precleared and non-precleared commercial vehicles.

[14] Assuming that “summer” and “winter” each represent 6 months of the year, and that there are 264 weekdays and 101 weekend days per year.

[15] This is based upon an assumed value of time of in U.S. dollars ($36 and $45 per hour, respectively) for light and heavy commercial vehicles from the source “Value Travel Time for Passengers Cars and Light & Heavy Commercial Vehicles in the Vancouver Region, British Columbia Ministry of Transportation and Highways, March 1995. Factors adjusted for currency conversion to US dollars and inflated to current dollars). Ration of 9:1 heavy/light trucks based on observations during the border survey is used.

However, in the northbound direction, only 30 percent of the cost of northbound border operations is attributed to travel time on the approach to CCRA booths. Approximately 65 percent of the cost of northbound border operations is attributed to the 18 percent of commercial vehicles that require processing through customs brokers/CCRA. Overall, approximately 35 percent of the cost of border operations is attributed to customs broker related time.

The estimated Base Year annual cost of border operations by truck trip type is provided in Table 4-8. Approximately 40 percent of the total annual cost of border operations ($7.8 million) is attributed to precleared trucks, where the majority of this cost is incurred in the southbound direction.

**Table 4-8. Base Year Annual Cost of Border Operations by Truck Trip Type ($US Million)**

| Truck Trip Type | Direction | | |
|---|---|---|---|
| | SB | NB | Total |
| Precleared | $6.5 | $2.6 | $9.0 |
| Non-Precleared | $7.2 | $5.8 | $13.0 |
| **Total Cost** | $13.6 | $8.4 | $22.0 |

Tables 4-7 and 4-8 may be used to inform public policy and to focus capital and operational investments. For example, a southbound lane dedicated to ITS will provide significant benefits to both precleared and non-precleared trucks. However, in the northbound direction, the primary value of ITS may be related to conversion of truck trips that are presently non-precleared.

## 4.7 HORIZON YEAR 2013 REPRESENTATIVE DAYS

As the ITS deployment will continue to provide value in the future, Horizon Year 2013 SLM-49 models were developed for each of the representative time periods. These models establish a basis for evaluating the benefits of ITS in Horizon Year 2013, and enable interpolation of benefits in the intervening years.

Forecasts of Horizon Year travel conditions require base input assumptions such as total demand and demand profile, number of operating customs booths, etc. Based upon the operations survey, it has been noted that border operations are sensitive to these assumptions. *Consequently, the Horizon Year models should be considered to represent potential border operations under a given set of realistic assumptions.* The Horizon Year assumptions are summarized in Table 4-9.

**Table 4-9. Summary of Horizon Year Assumptions**

| Assumption | Base Year | | Horizon Year 2013 | |
|---|---|---|---|---|
| | SB | NB | SB | NB |
| **Operating Customs Booth(s)** | | | | |
| Weekday | 2 | 2*[16] | 2 or 3 | 2[17] |
| Weekend Day | 1 or 2 | 1 or 2[18] | 1 or 2 | 1 or 2[19] |
| Customs Booth Processing Rate | Based on the observed data and the application of random number generator | | Same as base year conditions | |
| **Precleared and Non-Precleared Split** | | | | |
| Precleared | 0.45 | 0.45 | 0.40 | 0.40 |
| Non-Precleared | 0.55 | 0.55 | 0.60 | 0.60 |
| Fleet Composition | From the observed data | | Same as base year | |
| Travel Demand Profile | Based upon IMTC profile | | Based upon IMTC profile | |

In the southbound direction, it was assumed that a third operating booth would be available for the majority of the summer and winter weekdays. It was assumed that a second booth was available for approximately 12 hours on weekend days. In the northbound direction, it was assumed that a second booth would be open for the majority of the day, and a third booth would open based upon forecast queue length (demand responsive).

As the movement of commodities is the fundamental driver of commercial vehicle activity, forecasts of commercial vehicle movements were based upon the projection of commodity flow over the border in both directions[20]. Base Year and estimated Horizon Year 2013 commercial vehicle estimates are provided in Table 4-10.

Commercial vehicle movements are expected to grow at a rate of close to 5 percent per year towards Horizon Year 2013. The forecast summer weekday volume commercial vehicles at the Pacific border crossing is expected to grow by close to 75 percent to over 6,000 crossings per day by 2013. The peak southbound direction is estimated to carry over 3,200 commercial vehicle trips per day.

[16] One of the customs booths is demand responsive.
[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] Based upon Lower Mainland Border Crossing Commercial and Passenger Vehicle Forecasts, TSi Consultants in association with Cambridge Systematics for Transport Canada, 2002.

**Table 4-10. Base Year and Horizon Year 2013 Pacific Highway Crossing 24-Hour Commercial Vehicle Estimates**

| Time Period | 24-Hour Vehicles by Direction | | |
|---|---|---|---|
| | SB | NB | Total |
| **Base Year** | | | |
| Summer Weekday | 1,840 | 1,590 | 3,440 |
| Winter Weekday | 1,640 | 1,520 | 3,160 |
| Summer Weekend Day | 970 | 840 | 1,810 |
| Winter Weekend Day | 800 | 700 | 1,510 |
| **Horizon Year 2013** | | | |
| Summer Weekday | 3,200 | 2,820 | 6,020 |
| Winter Weekday | 2,950 | 2,710 | 5,670 |
| Summer Weekend Day | 1,700 | 1,540 | 3,240 |
| Winter Weekend Day | 1,670 | 1,210 | 2,880 |

The preceding assumptions were applied to SLM-49 by season and day of week to estimate travel time and cost associated with Horizon Year border operations. The estimated average annual travel time for the Base and Horizon Year are provided in Table 4-11.

**Table 4-11. Base Year and Horizon Year 2013 Average Annual Travel Time**

| Truck Trip Type | Base Year | | Horizon Year 2013 | |
|---|---|---|---|---|
| | SB | NB | SB | NB |
| Precleared | 31 | 9 | 56 | 9 |
| Non-Precleared | 46 | 91 | 71 | 92 |

Table 4-11 shows that the precleared travel time in the southbound direction are expected to increase to 56 minutes per vehicle by 2013. Non-precleared vehicles in the southbound direction are expected to experience a similar magnitude of increase in travel time.

The northbound direction is not expected to experience a significant increase in travel time. This is related to the “demand responsive” policy, which, by definition constrains travel time per vehicle to conditions similar to that presently observed.

Based on the conversion of the modeled travel time estimates to dollars, the estimated annual cost of border operations is provided in Table 4-12. The annual cost of border operations is expected to increase by 250 percent from $22 million in the Base Year to $54 million in year 2013. It is noted that the majority of this increase in border operation cost is expected in the southbound direction. In general, this reflects the near doubling of demand relative to a 50 percent increase in capacity at the customs booths (i.e., on additional booth)[21]. The cost of border operations is expected to diminish if additional booths were opened.

**Table 4-12. Base and Horizon Year 2013 Annual Cost of Border Operations by Source ($US Million)**

| Source of Cost | Base Year | | | Horizon Year 2013 | | |
|---|---|---|---|---|---|---|
| | SB | NB | Total | SB | NB | Total |
| Approach to Customs Booth | $11.1 | $2.7 | $13.8 | $36.0 | $4.5 | $40.6 |
| Customs Booth Related | $0.5 | $0.3 | $0.8 | $0.8 | $0.6 | $1.4 |
| Customs Broker elated | $2.1 | $5.1 | $7.4 | $3.4 | $9.0 | $12.4 |
| **Total Cost** | $13.6 | $8.4 | $22.0 | $40.3 | $14.1 | $54.4 |

The increase in border operations cost in the northbound direction is roughly proportional to the increase in demand. This is directly related to the assumption regarding the opening of a third booth, as demand requires.

The estimated Horizon Year 2013 border operation costs by truck trip type are provided in Table 4-13. The total cost of border operations are fairly evenly split between precleared and non-precleared commercial vehicles. Non-precleared vehicles account for approximately 70 percent of the border operations costs in the northbound direction.

**Table 4-13. Horizon Year 2013 Annual Cost of Border Operations by Truck Trip Type ($US Million)**

| Truck Trip Type | Base Year | | | Horizon Year 2013 | | |
|---|---|---|---|---|---|---|
| | SB | NB | Total | SB | NB | Total |
| Precleared | $6.5 | $2.6 | $9.0 | $22.0 | $4.4 | $26.4 |
| Non-Precleared | $7.2 | $5.8 | $13.0 | $18.3 | $9.7 | $28.0 |
| **Total Cost** | $13.6 | $8.4 | $22.0 | $40.3 | $14.1 | $54.4 |

## 4.8 ITS BENEFITS MODELING

Previous sections of this report described commercial vehicle operations at the Pacific Highway Crossing, the development of SLM-49, the characteristics of Base and Horizon Year "representative days", and cost estimates of border operations by source.

This section provides an analysis of the ITS deployment, including the dedicated ITS truck lane, for the ITS demand scenarios described in Table 4-14. These scenarios

[21] Based upon a “reasonable” scenario as discussed with U.S. Customs officials during the survey period.

represent the assumed proportion of demand that has been converted to ITS in the Base Year and Horizon Year 2013. The "low" scenario represents initial and final deployment levels nearly at current corridor-wide levels (as per transponders). The "medium" scenario, starting at 15 percent deployment and increasing 1percent per year to 25 percent is likely, given the current levels of ITS deployment, expected strong growth in corridor-wide and cross-border commercial vehicle traffic (78 percent increase) and the level of potential travel time savings obtainable through ITS participation. The "high" scenario, 25 percent initial deployment with a 35 percent participation rate in 2013, demonstrates diminishing marginal benefits for transponder equipped versus non-transponder equipped trucks as queue lengths diminish for the non-equipped trucks as increasing numbers of equipped trucks are processed through a dedicated ITS lane. Overall, benefits continue to increase for all trucks at the border, but the technology-based time differential lessens.

**Table 4-14. ITS Conversion Scenarios**

| Scenario | % ITS Conversion | |
|---|---|---|
| | Base Year | Horizon Year 2013 |
| Low | 10% | 15% |
| Medium | 15% | 25% |
| High | 25% | 35% |

The overall travel time savings from the SLM-49 modeling effort for the three scenarios are provided below in Table 4-15. Table 4-16 provides these results in terms of dollars. These two tables serve as a direct input to the cost-benefit analysis provided in Section 5, and are repeated there as Tables 5-10 and 5-11 for consistency.

**Table 4-15. Estimated Travel Time Savings at the Blaine Border Crossing**

| Hours of Travel Time Saved by Trip Type and ITS Scenario | Direction | | Total Hours Saved |
|---|---|---|---|
| | SB | NB | |
| **Base Year** | | | |
| 10 | 171,000 | 24,150 | 195,150 |
| 15 | 206,154 | 43,265 | 249,420 |
| 25 | 229,342 | 68,571 | 297,914 |
| **Year 10** | | | |
| 15 | 598,211 | 65,283 | 663,494 |
| 25 | 696,451 | 121,383 | 817,834 |
| 35 | 697,991 | 171,542 | 869,533 |

**Table 4-16. Estimated Value of Travel Time Savings at the Blaine Border Crossing (In Millions of Dollars)**

| Value of Travel Time Saved by Trip Type and ITS Scenario | Direction | | Total Cost Savings |
|---|---|---|---|
| | SB | NB | |
| **Base Year** | | | |
| Low | $7.7 | $1.1 | $8.6 |
| Medium | $9.1 | $1.9 | $11.0 |
| High | $10.1 | $3.0 | $13.1 |
| **Year 10** | | | |
| Low | $26.4 | $2.9 | $29.3 |
| Medium | $30.7 | $5.4 | $36.1 |
| High | $30.8 | $7.6 | $38.3 |

The “low” scenario represents initial and final deployment levels nearly at current corridor-wide levels (as per transponders). The “medium” scenario, starting at 15 percent deployment and increasing 1 percent per year to 25 percent is likely, given the current levels of ITS deployment, expected strong growth in corridor-wide and cross-border commercial vehicle traffic (78 percent increase) and the level of potential travel time savings obtainable through ITS participation.

The “high” scenario, 25 percent initial deployment with a 35 percent participation rate in 2013, demonstrates diminishing marginal benefits for transponder equipped versus non-transponder equipped trucks as queue lengths diminish for the non-equipped trucks as increasing numbers of equipped trucks are processed through a dedicated ITS lane. Overall, benefits continue to increase for all trucks at the border, but the technology-based time differential lessens.

Assuming that 10 percent of the demand is converted to ITS, the total estimated benefit of ITS deployment/dedicated lane in the Base Year is $8.6 million. Under the high scenario of 25 percent ITS in the base year, the estimated benefits are $13.1 million. Given estimated project costs, the commercial vehicle border operations benefits are expected to justify the project in the very short term.

The majority of these benefits ($7.5 million) are derived in the southbound direction. Overall, approximately 90 percent of the benefits are related to the approach to the Customs booth, and 10 percent of total benefits are custom broker related.

As the conversion of demand from the non-ITS stream to ITS will reduce non-ITS demand, thereby relieving non-ITS border conditions, the benefits of the ITS deployment/dedicated lane was estimated for both ITS and non-ITS traffic streams. Table 4-17 provides an example of this by detailing the breakout of estimated benefits for the Base Year for the conservative “low” scenario of 10 percent of the truck demand converted to ITS.

**Table 4-17. Base Year Benefits by Source and Trip Type (10% ITS Conversion) ($US Million)**

| Cost Source and Trip Type | Direction | | Total |
|---|---|---|---|
| | SB | NB | |
| **Approach to Customs Booth** | | | |
| ITS (Converted from Precleared) | $0.8 | $0.2 | $1.3 |
| ITS (Converted from Non-Precleared) | $0.3 | | |
| ***Total ITS*** | $1.1 | $0.2 | $1.3 |
| Precleared (remainder) | $3.6 | $0.1 | $6.4 |
| Non-Precleared (remainder) | $2.8 | | |
| ***Total Non-ITS*** | $6.3 | $0.1 | $6.4 |
| ***Total Approach to Customs*** | $7.4 | $0.3 | $7.7 |
| **Customs Broker Related** | | | |
| ITS (Converted from Non-Precleared) | $0.2 | $0.8 | $0.9 |
| **Total Benefit** | $7.5 | $1.1 | $8.6 |

In the southbound direction, the majority of these benefits are related to time savings on the approach to the customs booth. Again, it is noteworthy that the diversion of 10 percent of the traffic stream to ITS effectively reduces the general purpose queue and travel time. Consequently, over 85 percent of the benefits in the southbound direction are related to non-ITS commercial vehicles, and the total cost benefits related to ITS vehicles is approximately $1.3 million. In the southbound direction, the benefits related to the customs broker are limited.

The Base Year benefits in the northbound direction are approximately $1 million, or 15 percent of the total cost benefits. Of this, approximately 75 percent of the benefits are attributed to customs broker-related time savings. Although the proportion of commercial vehicles assumed to have converted from non-precleared to ITS is limited, the benefits attribute to this conversion are significant due to the relatively high customs broker-related time in the northbound direction (approximately 75 minutes per vehicle).

Approximately 25 percent ($0.2 million) of the benefits are attributed to travel time on the approach to customs in the northbound direction, and the majority of these benefits are attributed to ITS commercial vehicles. The benefits for non-ITS commercial vehicles in the northbound direction are constrained by the “demand responsive” opening of an additional booth. The reduction in demand due to conversion to ITS reduces demand sufficiently that the additional booth may not open as frequently throughout the day. This effectively creates overall daily conditions for non-ITS demand that is similar to the base condition.

The overall benefits of the ITS deployment/dedicated lane would include time savings related to customs brokers, and can be expected to vary by season and day of week. This variation is shown in Table 4-18.

**Table 4-18. Base Year Commercial Vehicle Border Operations Benefits by Season and Day of Week (10% ITS Conversion) ($US Million)**

| Season – Day | SB | NB | Total |
|---|---|---|---|
| **Summer** | | | |
| Weekday | 63% | 46% | 61% |
| Weekend Day | 4% | 10% | 5% |
| ***Total*** | 67% | 56% | 65% |
| **Winter** | | | |
| Weekday | 32% | 39% | 33% |
| Weekend Day | 2% | 5% | 2% |
| ***Total*** | 34% | 44% | 35% |
| **Total** | | | |
| Weekday | 94% | 85% | 93% |
| Weekend Day | 6% | 15% | 7% |

Due to higher demand and congestion during the summer season, approximately 65 percent of the commercial vehicle border operations benefits will be during the summer. Furthermore, 93 percent of the benefits can be expected on weekdays.

Based upon Horizon Year representative days, Year 2013 benefits assuming 15 percent ITS demand are provided in Table 4-19. The estimated overall benefits are $29.3 million, with 90 percent derived from the southbound direction. As with the Base Year scenario, the primary source for the benefits is on the southbound approach to the customs booths, with the majority being related to non-ITS commercial vehicles.

**Table 4-19. Horizon Year 2013 Benefits by Source and Trip Type (15% ITS Conversion) ($US Million)**

| Cost Source and Trip Type Precleared (PC) Non-Precleared (NPC) | Direction | | Total |
|---|---|---|---|
| | SB | NB | |
| **Approach to Customs Booth** | | | |
| ITS (converted from Precleared) | $3.1 | $0.5 | $5.1 |
| ITS (converted from Non-Precleared) | $1.5 | | |
| ***Total ITS*** | *$4.6* | *$0.5* | *$5.1* |
| Precleared (remainder) | $13.1 | $0.1 | $21.5 |
| Non-Precleared (remainder) | $8.3 | | |
| ***Total General Purpose*** | *$21.4* | *$0.1* | *$21.5* |
| **Total Approach to Customs** | $26.0 | $0.6 | $26.6 |
| **Customs Broker Related** | | | |
| ITS (converted from Non-Precleared) | $0.4 | $2.2 | $2.6 |
| **Total Benefit** | $26.4 | $2.9 | $29.3 |

In the northbound direction, the majority of the benefits are attributed to customs broker related time. The estimated Horizon Year benefits attributed to ITS vehicles in the northbound direction is approximately $ 2.5 million.

The benefits in the southbound direction also show a diminishing return with increased used of the ITS lane. This is primarily related to two items:

- Border operations are sensitive to changes in the demand, and the a large part of the reduction in non-ITS queue is experienced in the initial 10 to 15 percent shift in conversion to ITS.

- The benefits per ITS commercial vehicle diminishes as the ITS lane would begin to experience a queue at a level between 25 to 35 percent ITS. This may not be a concern with the implementation of the FAST system.

The benefits in the northbound direction are, relative to the southbound direction, limited. This is related to the “demand responsive” booth opening policy where, given a reduced non-ITS demand, the additional booth may not open as frequently. As the majority of the benefits in the northbound direction are derived from customs broker related time, the benefits in the northbound direction are closely related to the proportion of ITS demand that has been converted from the non-precleared traffic stream.

## 4.9 LIMITING FACTORS

The previous Section 4.8 demonstrated that the potential benefits of ITS deployment at the border crossing could be considerable. However, the estimation of benefits should be considered in the context of the following:

- The Horizon Year models assume that border customs officer staffing operations will increase relative to Base Year operations. However, without additional customs officer staffing, the benefits of the ITS deployment may be substantially higher.

- The benefits assume that the expected increase in demand between the Base and Horizon Years would remain constant. However, introduction of ITS or the reduced queue in the non-ITS lanes may potentially divert demand from other crossings. These “generated” trips would receive additional benefits. For example, a commercial vehicle driver would not divert to Pacific Highway Crossing from Huntingdon Crossing (Highway 13) if it did not provide travel time benefits. However, estimation of the benefits will require information regarding the operations at other border crossing ports of entry and network travel time between crossings. These potential benefits were not estimated as linking SLM-49 with other logistics supply chain nodes and network models were outside of the scope of this study.

- The improved border operations due to ITS may induce additional trips that have been foregone due to border congestion. These additional trips would create a direct economic benefit outside of the travel time benefits estimated by SLM-49.

- The benefits related to the approach to the customs booth in the southbound direction were substantial. Depending upon staffing policy, closing of a southbound booth commensurate with decreased demand may reduce the overall benefits for non-ITS demand.

## 4.10 SUMMARY OF FINDINGS

The primary purposes of this study were to describe current border operations and to estimate potential commercial vehicle travel time benefits of the proposed ITS deployment and dedicated lane at the Pacific Highway Border Crossing. The results of this modeling effort directly feed into the financial modeling of ITS impacts of corridor ITS deployment, as described in Section 5. A summary of the key findings from this section for the Border Operations Survey and the ITS Benefits Modeling effort are presented below.

### 4.10.1 Border Operations Survey Findings

The border operations survey conducted by the Evaluation Team in June 2002 demonstrated that the combination of commercial vehicle arrivals, customs broker-related time, and customs booth-related processing time produces a set of operating conditions that are unique to each survey day. Border operations are sensitive to changes in these variables, such as opening of an additional booth, reduction in processing time, or a change in commercial vehicle demand. The following bullets summarize some of the key findings presented in this section for the Border Operations Survey:

- The average southbound border operations travel time ranged between 23 to 60 minutes for the 4 survey days. This variation can in part be attributed to variation in the service rate at the CBP booths. The maximum queue length in the southbound direction extended beyond 1mile for sustained periods. A third CBP booth opening during one of these periods had a profound affect on the dissipation of the queue. Based upon commercial vehicle forecasts and customs operation assumptions, the daily average southbound border operations travel time would expect to increase to an average of 62 minutes per vehicle by 2013, resulting in a common situation of “truck gridlock” at the CBP border crossing.

- The daily average travel time in the northbound direction is not expected to increase significantly from Base Year observations due to the “demand responsive” operational policy of CCRA with opening an additional booth during heavy demand periods. This policy was confirmed by direct observation by the Evaluation Team – when the truck queue built up, CCRA would open another booth to compensate.

- The daily average annual border operations travel time in the southbound direction is estimated at 31 minutes for precleared commercial vehicles and 46 minutes for non-precleared commercial vehicles. In the northbound direction, the average travel time for non-precleared vehicles was approximately 80 minutes longer than precleared vehicles. Approximately 45 percent of vehicles were not precleared in the southbound direction. This compares to 18 percent in the northbound direction.

- The average time that it took individual drivers to conduct business with a brokerage house at the border was 18 minutes**.** This highlights the inefficiencies of the current brokerage services – most of these stops by trucks can be eliminated through electronic processing of documents by brokerage services and motor carriers.

- Customs booth-related time consists of interview time of the truck driver with the customs official, and the vehicle transit time from the stop position in front of the customs booth to the customs booth. The average customs booth-related time varied between 65 to 82 seconds per vehicle between days. This seemingly small day-to-day variation was shown to have a significant influence on queue and travel time on the approach to the customs booths.

- Close to 37 percent of vehicles in the northbound direction were empty. This compares to 10 percent in the northbound direction. These results reflect the overall trade imbalance in the region, as more goods are imported into Washington State from British Columbia than are exported to British Columbia from Washington State. The use of trucks carrying containers back and fourth from the Ports of Seattle and Tacoma to the Vancouver region also affects this imbalance, as empty containers are brought into British Columbia by truck from the ports to be replenished.

### 4.10.2 ITS Benefits Modeling Findings

The ITS Benefits model effort focused on the analysis of the potential transportation system efficiency benefits for trucks through the implementation of a dedicated ITS truck lane at the Blaine/Surrey border crossing. The analysis is based upon actual observed empirical baseline data collected in June 2002, which serves as an input to a specially developed sketch planning transportation flow model (SLM-49) that can assess the following three primary components of border operations travel time benefits: the time on the approach to the customs booth; customs broker-related time; and customs booth-related time. The model covers a 10-year time horizon from 2003 to 2013, and converts time measurements to monetary values using appropriate values of time. The following bullets summarize some of the key findings presented in this section for the Border Operations Survey:

- For the conservative “low” ITS scenario, the estimated overall benefits over the next 10 years will grow from $8.6 million in 2003 to $29.3 million in 2013. The vast majority of these benefits are realized on the southbound approach to the customs booths. The large majority of these benefits are attributed to reduced travel time on the approach to the border for both ITS and non-ITS-equipped trucks. Benefits for non-ITS commercial vehicles were actually higher then those for ITS commercial vehicles, as non-ITS vehicles benefit significantly from the reduced queues due to the ITS trucks using the Dedicated ITS Truck Lanes. In the southbound direction, the benefits related to the customs broker are limited.

- Depending upon the scenario, approximately 10 to 20 percent of the ITS benefits may be attributed to the northbound direction, and the majority of these benefits are attributed to trucks/drivers that are no longer required to pay personal visits to customs brokers and CCRA. This relatively low proportion of ITS benefits in the northbound direction is directly related to the ‘demand responsive’ booth opening policy of CCRA as detailed in the border operations survey findings above.

- The benefits estimated here were both day-of-week and seasonally dependent. Over 90 percent of the benefits may be expected on week days, while close to two-thirds of the benefits may be expected during the April – September (summer) period.

- It is important to note here that there might be additional benefits related to commercial vehicle trips diverted from other crossings, and induced trips due to less congestion at the border crossing. Estimating these benefits is beyond the scope of this study, and would require a regional transportation modeling approach encompassing both the Washington and British Columbia border regions.

- Based on the current levels of truck transponder and related ITS deployment, expected strong growth in corridor-wide and cross-border commercial vehicle traffic (78 percent increase), and the level of potential travel time savings obtainable through ITS participation, the “medium” ITS deployment scenario presented in this report (15 to 25 percent market penetration over the next 10 years) is expected to occur

- While the “high” scenario of ITS deployment presented in this report (25 to 35 percent market penetration over the next 10 years) may very well occur, there will be only marginal benefits for transponder-equipped versus non-transponder-equipped trucks. These marginal benefits will occur as queue lengths diminish for the non-equipped trucks as increasing numbers of equipped trucks are processed through a dedicated ITS lane. Overall, benefits continue to increase for all trucks at the border, but the technology-based time differential lessens; additional physical infrastructure improvements at the border to allow for more overall lanes and additional ITS truck lanes would be required to realize larger benefits.

## 4.11 FUTURE CONSIDERATIONS FOR LOGISTICS MODELING OF BORDER DELAYS

This study provided insight into border operations, and identified efficiencies that may be achieved at one node on the logistics supply chain and the survey methodology yielded important information regarding border operations in the IMTC. SLM-49 successfully combined the unique dynamics experienced at the Pacific Highway border crossing with standard queuing theory. SLM-49 extended the usefulness of the border operations data by providing an analytical basis for estimating commercial vehicle border operations costs by cost source, and enabling the estimation of benefits related to ITS deployment for both non-ITS and ITS traffic streams. Further analysis of the ITS benefits on the logistics supply chain can be supported by extension of SLM-49 to:

- Other border crossing ports of entry.

- Other nodes on the logistics supply chain such as port container terminals and truck inspection sites (weigh scales).

- Passenger vehicles nodes.

- Border operation component of cross-border travel demand forecasting models.

# 5. IMTC COST AND BENEFIT ANALYSIS

## 5.1 COST AND BENEFIT ANALYSIS FRAMEWORK OVERVIEW

The previous sections of this report described in detail, many of the potential regulatory and operational enhancements related to IMTC ITS deployments. Based on these findings, this section rigorously examines the financial feasibility of the ITS deployments. This financial analysis is based on the analytical framework of “partial budgeting”. This approach examines only those line items that represent a change from a baseline environment. Specific to this analysis, only those cost and benefit streams directly associated with the ITS deployments along the IMTC are examined. Though there may exist synergies between the ITS deployments and other concurrent procedural-, regulatory-, or infrastructure-based enhancements of the corridor, these impacts can be readily identified and segregated enabling an enterprise-specific assessment of the ITS deployments.

The ITS-specific cost and benefit streams comprise initial and recurring budget line items. These streams are calculated over the 10-year time horizon of the analysis. Initial outlays for ITS deployments are assigned to Base Year (2003)[22], with recurring costs and benefit streams appropriately assigned to Years 1 through 10 (2013). The following subsections provide an overview of cost and benefit stream components.

The remainder of this section is organized as follows:

- 5.2 Cost Streams
- 5.3 Benefit Streams
- 5.4 Discounting Cost and Benefit Streams
- 5.5 Accounting for Variability of Information
- 5.6 IMTC Cost-Benefit Analysis
- 5.7 Deployment Scenarios
- 5.8 Public-Sector Deployment Costs
- 5.9 Private-Sector Deployment Costs
- 5.10 Public-Sector Benefits
- 5.11 Private-Sector Benefits
- 5.12 Base Benefit and Cost Streams

[22] Although the ITS deployments are staggered in time, the benefit streams are assumed to come from integrated corridor-wide ITS deployment; therefore all “Investment costs” are assigned to “Base Year”.

- 5.13 Ranges of Benefits, Costs, Net Present Values, and Benefit-Cost Ratios
- 5.14 Estimated Payback Periods
- 5.15 Benefit-Cost Analysis Conclusions

## 5.2 COST STREAMS

The cost streams include "Investment costs" for the initial deployment of ITS assets, and ongoing service and upgrades to maintain asset functionality over the expected service life of the asset. Sections 5.2.1 and 5.2.2 provide a generalized description of these cost streams.

### 5.2.1 Investment Costs

**Infrastructure Investment costs**

- Design.
- New construction: new facilities construction supporting the ITS deployment, such as roadway widening for dedicated ITS lanes; new ramps; staging areas; and structures associated with weigh stations.
- Retrofit of existing facilities: infrastructure improvements of existing roadways and structures to support the ITS deployments.

**Systems Costs**

- Design/systems engineering: systems requirements; systems design; and implementation planning.
- Component acquisition: production; modification; or purchase of technology components. Within this analysis, these would include the hardware and software supporting WIM, AVI, and information exchange systems.
- Integration: hardware and software development or modification; testing; and installation. Also included is installation of communications links between sites/ system users.
- Miscellaneous construction: trenching, cabling, etc., to support ITS systems installation.

### 5.2.2. Service, Operations and Maintenance

- Ongoing asset maintenance. These costs include regular maintenance activities required to ensure the functionality of an asset, such as repairs, calibration, roadway resurfacing, etc.
- Periodic upgrades not representing total system overhauls. These costs can include updated software versions, modifications to assets to accommodate improved functionality.

- Labor for system operations[23]

## 5.3 BENEFIT STREAMS

Within the context of this analysis, the benefit streams include the incremental operational efficiencies that the ITS deployments may provide the various private-sector systems users. These private-sector benefits include:

- Travel time savings for motor carriers through reduced en-route delays.

- Reduced administrative costs for shippers, motor carriers, and customs brokers through automated collection and transmission of vehicle, driver, and shipment data.

Public-sector, or societal benefits estimated in this analytical framework include:

- Cost avoidance of negative health impacts of truck emissions during queuing at weigh stations and the border crossings.

- Truck crash cost avoidance associated with enhanced roadside safety enforcement focus.

Based on analysis of IMTC ITS functionality, extensive traffic flow, and demand modeling (presented in Section 4), stakeholder interviews, and an exhaustive review of the literature pertaining to ITS operational benefits, the aforementioned benefit streams are quantified in this analysis.

Positive externalities associated with the ITS deployments may include:

- Enhanced weight monitoring for roadway infrastructure protection.

- Improved security through enhanced screening capabilities by CBP and CCRA enabled by more timely access to shipment information.

- Improved security and operational efficiencies achieved through enhanced cargo visibility.

Numerous extraneous factors makes assessment of these latter potential benefits somewhat subjective based on the users' current level of deployment, participation in, and experience with ITS. Therefore, while these are not quantified in this analysis, they are examined qualitatively in other sections of this report. Section 5.3.1 through 5.3.4 provide a generalized description of the benefit streams quantified in this cost-benefit analysis.

[23] Based on input from Washington State Department of Transportation, IBCB, US Customs, CCRA, and O&M cost information from the FHWA ITS Benefit/Cost database.

### 5.3.1 Travel Time Savings

**Commercial Vehicle Operations**

- Border crossing time saved for ITS-equipped trucks.
- Border crossing time saved for non-ITS-equipped trucks due to taking the ITS-equipped trucks out of queue.
- Time saved via bypass of weigh/inspection stations for ITS-equipped trucks.

### 5.3.2 Administrative Efficiencies

- Reduced data input, paper handling, and errors throughout the supply chain – shippers, motor carriers and customs brokers – through real-time information exchange via secure ITS-enabled electronic transactions.

### 5.3.3 Environmental Benefits of Improved Air Quality

- Reduced health impacts of truck emissions of volatile organic compounds (VOCs) nitrous oxide (N2O), carbon monoxide (CO), and particulate matter associated with prolonged truck idling in weigh station and at the border crossing.

### 5.3.4 Safety Benefits

- Reduced truck crashes due to improved enforcement efficiencies associated with electronic screening.

## 5.4 DISCOUNTING COST AND BENEFIT STREAMS

To account for the time value of money, future cost and benefit streams are discounted to derive a net present value (NPV) of the streams to calculate the cost- benefit ratio for the ITS deployments. *NPV is the difference between the discounted present value of benefits and the discounted present value of costs over a specified time period.* For this analysis, the specified period is defined as 10 years. Per guidelines provided by the U.S. Office of Management and Budgets, a 7 percent discount rate is used in the development of the cost-benefit ratios.[24]

## 5.5 ACCOUNTING FOR VARIABILITY OF INFORMATION

Cost-benefit analysis, especially when dealing with monetary streams that may extend many years into the future, by nature contain a degree of uncertainty. Even when incorporating immediate-term or Base Year cost factors into analysis, there is often variability associated with these factors. For example, the cost of deploying new technology may be expressed as a range of probable costs – a new techno-widget, installed will cost between *X* and *Y* dollars. Or, time saved may range from *X* to *Y* percent.

[24] Office of Management and Budget. Circular No. A-94, "Benefit-Cost Analysis of Federal Programs; Guidelines and Discounts," November 1992.

To account for variability in factor estimates, probability distributions are assigned to the factors and iterative simulation is run until estimated error in the calculated outcomes is minimized. The sensitivities of the overall outcomes to discrete changes in the factors are tested and the simulation is run using logical assumed values within the most critical factors' ranges to develop a range of outcomes. These outcomes are often described using labels such as "high, "medium", and low"; "optimistic, realistic, and pessimistic"; or "aggressive, moderate, and passive", depending on the context analysis.

In assessing the IMTC ITS deployment costs and benefits, Monte Carlo simulation was used to emulate chance variations that exist in factor estimates. Monte Carlo simulation is a stochastic approach that uses randomly selected values and probability statistics to create outcome scenarios for mathematical problems. These values are taken from a fixed range for a factor (defined by the user by upper and lower bounds) and fitted to a probability distribution (e.g., bell curve, linear distribution, Poisson distribution, etc.) that best describes the distribution of the factor estimates.

The Monte Carlo simulation is repeated many times to create multiple scenarios and solutions to the problem, some with greater probability than others. The mathematical accuracy of Monte Carlo forecasts is directly proportional to the square root of the number of scenarios used. Therefore, running the simulation a large number of times (10,000 or more iterations) will yield an approximate answer to the problem. The outcome or forecast is expressed as a mean forecast value with a probability of the outcome occurring. For this Monte Carlo simulation, Crystal Ball was utilized as a fully integrated Excel spreadsheet add-in program.

## 5.6 IMTC COST-BENEFIT ANALYSIS

The IMTC ITS deployment scenario includes installing automated vehicle identification (AVI) and weigh in motion (WIM) technologies at weigh/inspection stations along the I-5 Pacific Highway corridor from Ridgefield, Washington to Port Mann, British Columbia, Canada. AVI will be installed at the APL facilities in Seattle, Washington. At the United States – Canadian Border at Blaine, Washington, dedicated ITS truck lanes will be constructed and AVI will be installed.

The scenarios also include developing an integrated Internet-based portal for the automated collection and access of carrier, vehicle, driver, and shipment information to authorized public and private stakeholders along the Pacific Highway corridor. The following sections summarize the key factors used in the cost-benefit analysis.

## 5.7 DEPLOYMENT SCENARIOS

### 5.7.1 ITS Participation Rates

The cost and benefit streams associated with these ITS deployments are estimated for three deployment scenarios. These scenarios represent levels of Base Year or initial ITS participation as represented by percent of weigh station or border crossing events involving ITS-equipped trucks. The scenarios were developed based on current, observed levels of ITS participation along the corridor (low scenario) and represent incremental Base Year and Year 10 increases in participation rates, with a maximum of

35 percent ITS participation (high scenario). The deployment scenarios modeled for this evaluation are presented in Table 5-1.

**Table 5-1. ITS Deployment Scenarios Participation Rates**

| ITS Deployment Scenario | Base Year Participation | Year 10 Participation |
|---|---|---|
| Low | 10% | 15% |
| Medium | 15% | 25% |
| High | 25% | 35% |

The upper limit of 35 percent was selected based on expert stakeholder opinion on high levels of participation and because the TSi modeling of congestion reduction at the border crossing showed minimal incremental gains between 25 and 35 percent participation levels. This increase was due to saturation of assumed dedicated ITS lanes at the border, which leads to developing ITS queues similar to those expected for non-ITS participants.

Although the 35 percent participation level demonstrates a point of minimal marginal returns at the border crossing, higher ITS benefits *may* be attainable throughout the corridor in the form of additional weigh/inspection station bypasses (the 35 percent maximum cap is used throughout). This assumption is based on two factors: initial discussion with ITS deployment experts who indicated that 35 percent is an aggressive penetration rate for transponder usage; and that the overwhelming proportion of time-savings benefits defined by this analysis are realized at the border.

For calculating benefit streams, it is assumed that the increase in percent of ITS participation will occur in equal increments per annum between the Base Year and Year 10. These percentages were applied to estimated levels of travel demand for the corridor as described in the following subsection.

### 5.7.2 Modeled Travel Demand

As described in detail in Section 4, the modeled demand was based on extensive analysis of projected cross border commodity flows. The results show travel demand at the border increasing approximately 78 percent over the 10-year study horizon. To calculate benefit streams, it is assumed that the increase in travel demand will occur in equal increments per annum between the Base Year and Year 10. The modeled travel demand levels are presented in Table 5-2. The 78 percent growth in travel demand at the border is also assumed to apply to the remainder of the corridor for the calculation of weigh station bypass benefits.[25]

[25] It is recognized that linear growth in travel demand is only one possible scenario that rates of actual demand increase between current time and 2013 will tend to vary from year to year due to primarily due to macroeconomic factors affecting freight demand. In future work of this type, investigation of ITS benefits could be considered for slack demand periods through sensitivity analysis of travel demand to overall national economic activity.

**Table 5-2. Cross Border Travel Demand – Base Year**

| Base Year | 24-Hour Vehicles by Direction | | |
|---|---|---|---|
| | SB | NB | Total |
| Summer Weekday | 1,840 | 1,590 | 3,440 |
| Winter Weekday | 1,640 | 1,520 | 3,160 |
| Summer Weekend Day | 970 | 840 | 1,810 |
| Winter Weekend Day | 800 | 700 | 1,510 |
| **Annual Total** | **544,440** | **484,380** | **1,030,640** |

**Table 5-3. Cross Border Travel Demand – Year 10**

| Year 10 | 24-Hour Vehicles by Direction | | |
|---|---|---|---|
| | SB | NB | Total |
| Summer Weekday | 3,200 | 2,820 | 6,020 |
| Winter Weekday | 2,950 | 2,710 | 5,670 |
| Summer Weekend Day | 1,700 | 1,540 | 3,240 |
| Winter Weekend Day | 1,670 | 1,210 | 2,880 |
| **Annual Total** | **974,740** | **861,900** | **1,837,940** |

## 5.8 PUBLIC-SECTOR DEPLOYMENT COSTS

Information supplied by WSDOT, ICBC, and TransCore provided the baseline first and recurring costs for ITS deployment in the corridor. Additionally, USDOT data for expected asset service life and maintenance costs were incorporated into the analysis. Relatively little variation exists in the estimated investment costs as these are based on actual recent deployment costs or near-future planned deployments. The expected service life of the ITS technologies equals or exceeds the 10-year study horizon (with the exception of transponders that are assumed to have a 5-year service life and are put into service according to the assumed growth in ITS participation rate). Recurring costs associated with the ITS deployments were modeled using Monte Carlo simulation based on a range of values for annual percent of investment costs for maintaining the functionality of the assets. Table 5-4 summarizes the estimated first and recurring costs for public sector ITS deployment in the corridor.

As previously described, public sector investment costs (Base Year) for ITS deployment in the corridor are estimated at approximately $10.8 million. Of this amount, $3.3 million represents ITS deployment at the north/southbound border crossing at Blaine, Washington and supporting ITS deployment at the APL intermodal facility[26]. Of this $3.3 million, approximately $2.6 million are estimated costs for construction of dedicated ITS truck lanes in the north- and south-bound directions.[27] Of the remaining $0.7 million, approximately $532K represents the costs of: site-specific systems engineering and system installation; AVI readers and supporting hardware; communications links; and computer system hardware and software. TCOS software enhancements account for the remaining $170K.

ITS deployments at four weigh/inspection stations in Washington State, and one in British Columbia account for approximately $7.5 million in investment costs.[28] Component-level cost estimates were not readily available from WSDOT and ICBC, but the agencies did provide gross estimates for combined infrastructure/facilities construction/upgrades and ITS installation for the sites. The gross cost estimates provided for the weigh/inspection stations are: $1.2 million each for the Ridgefield, Everett, and Bow Hill locations; $2.5 million for the Stanwood Bryant locations (construction of a new weigh/inspection station); and, $1.4 million for Port Mann. The costs include new construction/upgrades of ramps, staging, and inspection areas; buildings; and installation of WIM and AVI systems, including hardware, software, and communications links.

Recurring costs are estimated at approximately 2.5 percent per year of investment costs for ITS components and approximately 5 percent for dedicated ITS lanes.[29] This translates to $.32 million per year, of which $.14 million per year is expected to occur at the border facilities and $0.19 million per year at the weigh/inspection stations.

Using a discount rate of 7 percent, the total 10-year *discounted* public sector costs are estimated to be **$13 million** ($4.2 million for border facilities and $8.8 million across the remainder of the corridor). Of the $4.2 million for the border facilities improvements, approximately $3.5 million is for roadway infrastructure construction and maintenance for dedicated ITS lanes in both northbound and southbound directions.

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[26] The APL facility costs are included with the cross border cost estimates because the APL gate "reads" are considered to facilitate the cross border ITS clearance schemas.

[27] Although major construction is planned for the border crossing area, working with Washington State Department of Transportation, this analysis breaks out the cost for construction of two one-half mile dedicated ITS truck lanes (one northbound, the other southbound) at the border crossing in Blaine, WA.

[28] Weigh station facilities include the Washington State facilities at: Ridgefield; Everett; Stanwood Bryant; Bow Hill; and the British Columbia facility at Port Mann.

[29] Annual recurring costs are based on a range of expected O&M costs obtained from WSDOT and the USDOT ITS Joint Program Office ITS Unit Costs Database. Infrastructure recurring costs are represented by amortizing investment costs over an expected 20 year service life (with no O&M)-this was done because of trade offs between facility maintenance/resurfacing versus useful life.

**Table 5-4. Public Sector Deployment and Annual Recurring Costs**

| Location/Item | Investment Costs | Recurring Costs |
|---|---|---|
| **Border Crossing** | | |
| Northbound Dedicated ITS Truck Lane | $1,351,130 | $67,557 |
| Northbound ITS Equipment/System Deployment | $244,645 | $2,722 |
| Southbound Dedicated ITS Truck Lane | $1,242,000 | $62,100 |
| Southbound ITS Equipment/System Deployment | $175,442 | $1,021 |
| TCOS Software Enhancement | $170,000 | $0 |
| APL Facility AVI Reader System | $112,405 | $1,648 |
| ***Total Border Crossing Costs*** | ***$3,295,622*** | ***$135,048*** |
| **Weigh Station Facilities** | | |
| Vancouver | $1,200,000 | $30,340 |
| Everett | $1,200,000 | $30,305 |
| Stanwood Bryant | $2,500,000 | $63,093 |
| Bow Hill | $1,200,000 | $30,282 |
| Port Mann | $1,377,000 | $34,800 |
| ***Total Weigh Station Costs*** | ***$7,477,000*** | ***$188,820*** |
| **Total Public Sector Deployment Costs** | **$10,772,622** | **$323,868** |

## 5.9 PRIVATE-SECTOR DEPLOYMENT COSTS

Private-sector costs for ITS participation may include a minimal investment in computer hardware and software to access the Internet-based TCOS system and purchase of transponders for trucks. It is assumed that the majority of business enterprises currently use at least personal computers to support their back office activities and that the incremental cost of Internet access is so minimal, that costs associated with using the TCOS system for information exchange is zero. Therefore, for the purposes of this analysis, private sector ITS costs are limited to transponder purchase ($50 per transponder with a service life of 5 years). Although these costs are labeled “Private Sector”, it is recognized that many transponder-equipped Washington State-based trucks use transponders provided free of charge by Oregon State as part of the State’s Weight-Distance tax administration. This notwithstanding, the cost of all transponders is assumed to be a private sector cost for this analysis.

Unlike large public sector ITS investments that represent relatively few projects with clearly defined implementation timeframes, purchases of transponders are many and staggered over the study horizon. Therefore, transponder costs are calculated as $10 per year ($50 divided by 5 years), with the total level of transponders used related to the estimated levels of bypass events along the corridor. Based on discussions with CVISN managers at WSDOT, the current ratio of Washington State-based trucks with transponders to their corresponding bypass events is estimated at approximately 31 bypasses per transponder.[30] Using this ratio for all projected bypass events over the study horizon, ranges of private sector transponder costs were developed and are presented in Table 5-5.

Using a discount rate of 7 percent over the 10-year study horizon, total *discounted* private sector costs are estimated to be approximately $2.4, $3.9, and $5.8 million for the low, medium, and high ITS participation scenarios, respectively.

In calculating cross border costs and weigh station bypass private sector costs, it is assumed that the transponders would be used for both purposes; therefore, the preceding cost streams were allocated based on a ratio of estimated weigh station bypasses to ITS-border crossing events (i.e., 14 percent of transponder costs are allocated to the border crossing cost stream).

**Table 5-5. Project Levels of Transponders and Costs by Deployment Scenario**

| ITS DEPLOYMENT SCENARIO | Base Year Number of Transponders | Base Year Cost of Transponders | Year 10 Number of Transponders | Year 10 Cost of Transponders | Total Discounted 10- Year Transponder Costs |
|---|---|---|---|---|---|
| Low | 22,300 | $0.22 | 52,800 | $0.53 | $2.4 |
| Medium | 34,100 | $0.34 | 88,000 | $0.88 | $3.9 |
| High | 55,400 | $0.55 | 123,200 | $1.23 | $5.8 |

## 5.10 PUBLIC-SECTOR BENEFITS

The ITS deployments along the IMTC corridor can provide a variety of positive externalities associated with improved operations, security, safety, and environmental quality. Sufficient baseline and forecast data exist along with secondary sources of potential impacts to develop estimates for potential air quality and safety benefits of the ITS deployments, and are presented in Sections 5.10.1 and 5.10.2. This analysis estimates the discounted net present value of these public benefits to be approximately **$22.7**, **$35.7** and **$53.4** million for low, medium and high deployment scenarios, respectively.

Given limited or no baseline or full deployment direct operational data, attempting to monetarize the potential benefit streams of customs agency operations and enhanced levels of security could introduce unacceptable levels of variability into the cost-benefit calculations. Therefore, for the purpose of this evaluation, these potential benefits were addressed qualitatively in this section.

[30] The unique transponder identification versus weigh station bypass events are based on WSDOT data for April 2003 and is considered a consistent ratio through out a given year.

### 5.10.1 Potential Air Quality Benefits

Air quality benefits are expressed in terms of avoided heath costs associated with diesel truck exhaust. The benefits derive from reduced idling time at the border crossings and at the weigh stations along the border regional corridors. To derive the reduced health impacts, estimates of reduced truck (delay or idling) time developed in this analysis (see Sections 5.11.1 and 5.11.2) were combined with published estimates of truck diesel emission levels while at idle and published estimates of health costs related to the emissions. As a caveat, air quality impacts can be affected by a number of factors including the stop and go nature of the truck queues; composition of trucks in queue with regards to age and engine conditions; meteorological and climatologic variables; levels of other point and non-point sources of air pollution; and population demographics. Therefore, care is advised in interpreting these results.

Sources for truck idle emissions data include studies conducted by U.S. Environmental Protection Agency and the U.S. Department of Energy, academia, and private firms. Based on the literature, hourly truck idling emissions of VOCs, N2O, CO, and particulate matter (PM) were developed. Table 5-6 presents these ranges.

**Table 5-6. Baseline Truck Idling Emissions (in Grams per Hour)**

| Study | VOC | N2O | CO | PM |
|---|---|---|---|---|
| NACEC 2001[31] | 12.6 | 46.8 | 105.6 | 2.16 |
| NESCAUM[32] | 36.4 | 122.0 | 118.0 | 2.19 |
| Clean Air Technologies International[33] | 86.4 | 225.0 | 189.7 | 2.19 |

Published research that assigns actual dollar values to the health costs of emissions from trucks at idle is somewhat scarce. The CalTrans environmental impact assessment tool Cal-B/C uses cost factors developed by McCubbin and Delucchi[34] to assess the impacts of transportation projects[35]. McCubbin and Delucchi developed estimates of air pollutant costs for the Los Angeles area, urban areas as a whole, and for nationwide averages for the United States. The Cal-B/C model uses the Los Angeles costs for the Los Angeles, urban area costs for all other urban areas, and the nationwide costs for rural areas in California. This analysis assumes the average of pollution costs for the “urban” and “rural” truck emissions per ton in 2003 dollars, which are presented in Table 5-7.

[31] North American Trade and Transportation Corridors: Environmental Impacts and Mitigation Strategies, August 2001-Figures presented are estimates of truck idling pollutants for United States – Canada border crossings in 1999. Prepared by ICF Consulting for the North American Commission for Environmental Cooperation.

[32] Northeast States for Coordinated Air Use Management GHG Case Study – The Hunts Point Truck/Trailer Electrification Pilot Project. The figures used were an un-weighted average of published emissions results from EPA-Mobile5, Colorado Institute for Fuels and Environmental Research, and the University of California Davis. (2001)

[33] Clean Air Technologies International – Extended Idling Emissions Study, conducted for IdleAir Technology Corporation, 2001.

[34] McCubbin, D. and M. Delucci. “The Social Cost of the Health Effects of Motor Vehicle Air Pollution.” Report #11 in the series, “The Annualized Social Cost of Motor-Vehicle Use in the United States, based on 1990-1991 Data,” Institute of Transportation Studies, University of California Davis, August 1994.

[35] California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Technical Supplement to Users Guide, Booz Allen & Hamilton, 1999.

**Table 5-7. Health Costs of Truck Emissions (in 2003 US dollars)**

| Pollutant | Urban Cost/Ton | Rural Cost/Ton |
|---|---|---|
| VOC | $1,052 | $826 |
| N2O | $11,187 | $15,059 |
| CO | $66 | $60 |
| PM | $121,577 | $86,737 |

These emission level and cost factors[36] and the expected travel delay (idle) time reductions calculated in this evaluation, enabled the estimation of avoided negative health impacts by the following formula:

(Level of air pollutants produced per hour by trucks at idle)

**x**

(Hours of border and weigh station delays)

**x**

(Estimated health costs per ton for truck-generated pollutants)

Base Year and Year 10 health-related cost avoidance estimates are presented in Table 5-8. The discounted net public benefits of the ITS deployments are estimated to be approximately **$1.6**, **$2.1** and **$2.5** million for the low, medium, and high ITS scenarios, respectively. The border-crossing share of these benefits ranges from 65 to 80 percent (high to low deployment scenario).

[36] It is estimated that the hourly health costs associated with truck emissions during idling is $0.45 per hour. Truck emissions used in this analysis are: 44 g/hr, 136 g/hr, 130 g/hr, and 2.18 g/h for VOC, CO, N2O and PM, respectively.

**Table 5-8. Estimated Value of Negative Health Impacts of Truck Idling Emissions (In Thousands of Dollars)**

| Value of Air Pollution Related Health Costs Avoided by ITS Scenario | Location | | Total Cost Savings |
|---|---|---|---|
| | Border | Weigh Stations | |
| **Base Year** | | | |
| Low | $88.2 | $22.9 | $111.1 |
| Medium | $112.7 | $34.4 | $147.1 |
| High | $134.7 | $57.3 | $192.0 |
| **Year 10** | | | |
| Low | $299.9 | $61.2 | $361.1 |
| Medium | $369.7 | $102.0 | $471.7 |
| High | $393.1 | $142.8 | $535.9 |

### 5.10.2 Safety Benefits

The estimated safety benefits are assumed derived through a focus of enforcement activities on inspection of non-electronically screened (transponder-equipped) vehicles. Identifying and prescreening vehicles of "safe" motor carriers allows enforcement personnel to maximize inspection time on the higher risk operators. The degree to which the effectiveness of roadside inspections can be enhanced can be estimated based on the following derivations:

- Truck crash avoidance estimates developed through the intervention model developed by the John A. Volpe National Transportation Systems Center to assess the effectiveness of roadside inspection and traffic enforcement activities.[37] The results for 1999 and 2000 estimate .0038 truck crashes are avoided per roadside inspection.

- Cost estimates for large truck crashes developed by the Pacific Institute for Research and Evaluation for FMCSA.[38] The study places the average per crash cost for all trucks at $75,637 per crash in 1997. Inflated using the Consumer Price Index (CPI), this equates to $87,033 per truck crash in 2003.

- Roadside inspection activity for Washington State.[39]

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[37] FMCSA Safety Program Performance Measures, Intervention Model: Roadside Inspection and Traffic Enforcement Effectiveness Assessment, John. A. Volpe National Transportation Systems Center, September 2002.

[38] Cost of Large Truck and Bus Involved Crashes, Federal Motor Carrier Safety Administration, March 2001. The study places the average per crash cost for all trucks at $75,637 per crash. Inflated using the CPI, this equates to $87,033 per truck crash.

[39] FMCSA – Analysis and Information (A&I) Website, supported by the John A. Volpe National Transportation Systems Center. In 2001, approximately 72,000 roadside inspections were conducted in the state. According to

Taken together, the first two derivations render an average truck crash cost avoidance of $331 per roadside inspection for the base year (2003)[40]. This analysis holds the level of roadside inspections constant at 72,000 over the 10-year horizon and assumes that the effectiveness of each roadside inspection will increase proportionately to the incremental increases in level of ITS deployment. For example, a 10 percent increase in ITS deployment would render a ten percent increase in truck crash cost avoidance per inspection.

Base Year and Year 10 truck crash cost avoidance estimates are presented in Table 5-9. Over the 10-year study horizon, the net discounted safety benefits are estimated at **$21.1**, **$33.6** and **$50.9** million for the low, medium, and high deployment scenarios, respectively.

**Table 5-9. Estimated Value of Truck Crashes Avoided (In Millions of Dollars)**

| Value of Truck Crashes Avoided by ITS Scenario | Total Cost Savings |
|---|---|
| **Base Year** | |
| Low | $2.4 |
| Medium | $3.6 |
| High | $5.9 |
| **Year 10** | |
| Low | $3.7 |
| Medium | $6.2 |
| High | $8.7 |

### 5.10.3 Security Benefits

Both CBP/CCCRA sense that for their needs, the most significant benefit derived from ITS utilization is the ability to expedite the flow of timely, accurate, and thorough information to their personnel. Providing CBP/CCRA personnel with information flow containing shipment, driver, importer and exporter details as quickly as possible facilitates better assessment of possible risk posed by a shipment arriving at the international border. ITS technology permits more time to investigate shipments that seem “suspicious” or “out of the ordinary”. ITS technology allows routine transacting to apply to most shipments while alerting customs personnel that specific shipments pose a risk.

Washington State Patrol, the majority of these inspections were conducted at fixed facilities within the IMTC; therefore this analysis assigns the full number to the corridor.

[40] The base year figure of $331 is increased by 4 percent per year over the study horizon to account for inflation.

### 5.10.4 Operations Benefits

IMTC ITS technology deployments possess the ability to facilitate greater throughput of commercial motor vehicles at the Pacific Highway international border crossing. With demand expected to grow rapidly over the coming decade, the ability to move greater volumes of commercial vehicle traffic with only minimal increases in staff and moderate costing infrastructure improvements is of tremendous value. By reducing border travel times for commercial motor vehicles through a targeted ITS program, CBP/CCRA processing capacity will increase.

ITS technology will allow CBP/CCRA to adopt practices that reduce redundant paperwork still currently part of an electronic customs clearance system, which still creates much paperwork as supporting documentation. Shipment, driver, exporter, and importer information can be stored in advance of shipment arrival and retrieved in real time for customs clearance processing. By utilizing ITS technology at international border crossings, this method will eliminate the need for much of the current supporting documentation.

### 5.10.5 Free and Secure Trade

An excellent example of a current bi-national United States – Canadian program with the potential to provide substantial security and operational benefits is the Free and Secure Trade (FAST) program. Advance information via ITS technology is a vital part of the FAST program being implemented jointly by the United States and Canadian federal governments. The FAST program is adopting a common approach to risk management. This approach is accomplished by partnering with members in the trade community who have a history of compliance and are committed to the integrity of their supply chain management processes. By using compatible and advanced ITS technology, the United States and Canada are working together to interdict threats to public security, while keeping their shared border open to the free flow of low-risk, legitimate trade. Companies that make the commitment to improve their supply chain security will enjoy the benefits of a "dedicated fast ITS lane" for commercial truck traffic.

For low-risk goods being transported between the United States and Canada by a pre-authorized importer, a preauthorized carrier, and a registered driver, minimal data will be transmitted in advance of the arrival of the shipment at the border to CBP/CCRA. When the shipment arrives at the border, it will be processed through a dedicated lane where the driver will present a personal registration card and, using bar code or transponder technology, identify the shipment. Whether low-risk goods are moving into the United States or Canada, the goods will be cleared expeditiously through dedicated lanes using compatible technology.

Goods cleared using the FAST program will still remain subject to physical examinations. However, given the low-risk nature of the goods, and that the driver, carrier, and importer are known partners with the CBP/CCRA administrations who have invested in security-enhancing business practices, these goods will be examined at a significantly lower rate than other imported goods.

## 5.11 PRIVATE-SECTOR BENEFITS

For the private sector, two benefit streams were estimated for the ITS deployments along the IMTC corridor. These benefit streams include commercial vehicle travel time savings, and administrative costs savings associated with improved automation and exchange of carrier, vehicle, driver, and shipping documentation across stakeholders.

### 5.11.1 Cross Border Travel Time Savings

Given the current and projected large volumes of commercial vehicle travel through the IMTC corridor, private-sector benefits from the ITS deployments within the corridor will be realized primarily through travel time savings. These benefits will be realized through reduction in expected en-route delays at the border and at weigh stations along the corridor. Depending on the ITS deployment scenario, it is estimated that between 73 and 87 percent of these benefits (varying by ITS deployment scenario) are associated with reductions in time to cross the border. Table 5-10 presents the travel time savings estimated for traversing the border.

**Table 5-10. Estimated Travel Time Savings at the Blaine Border Crossing**

| Hours of Travel Time Saved by Trip Type and ITS Scenario | Direction | | Total Hours Saved |
|---|---|---|---|
| | SB | NB | |
| **Base Year** | | | |
| 10 | 171,000 | 24,150 | 195,150 |
| 15 | 206,154 | 43,265 | 249,420 |
| 25 | 229,342 | 68,571 | 297,914 |
| **Year 10** | | | |
| 15 | 598,211 | 65,283 | 663,494 |
| 25 | 696,451 | 121,383 | 817,834 |
| 35 | 697,991 | 171,542 | 869,533 |

Applying conservative cost factors for the time value of a truck of $36 and $45 per hour for light and heavy trucks, respectively, and a ratio of 9:1 of heavy to light trucks, values were developed for the projected time savings. The estimated travel time costs are presented in Table 5-11.[41]

[41] This is based upon an assumed value of time of in U.S. dollars ($36 and $45 per hour, respectively) for light and heavy commercial vehicles from the source "Value Travel Time for Passengers Cars and Light & Heavy Commercial Vehicles in the Vancouver Region, British Columbia Ministry of Transportation and Highways, March 1995. Factors adjusted for currency conversion to US dollars and inflated to current dollars). Ration of 9:1 heavy/light trucks based on observations during the border survey is used.

**Table 5-11. Estimated Value of Travel Time Savings at the Blaine Border Crossing (In Millions of Dollars)**

| Value of Travel Time Saved by Trip Type and ITS Scenario | Direction | | Total Cost Savings |
|---|---|---|---|
| | SB | NB | |
| **Base Year** | | | |
| Low | $7.7 | $1.1 | $8.6 |
| Medium | $9.1 | $1.9 | $11.0 |
| High | $10.1 | $3.0 | $13.1 |
| **Year 10** | | | |
| Low | $26.4 | $2.9 | $29.3 |
| Medium | $30.7 | $5.4 | $36.1 |
| High | $30.8 | $7.6 | $38.3 |

The border crossing modeling effort demonstrates significant cost savings differences between northbound and southbound ITS deployments. The primary causes for differences found between directions includes differences in overall traffic volumes; queuing characteristics; shipment characteristics; the degree of waiting time for clearance processing for non-precleared trucks; and the greater demand-sensitive nature of northbound customs operations (opening additional booths to clear peak demands).

Over the 10-year horizon of the analysis, the net present values for the benefits of the border ITS deployments (in millions of dollars) are estimated at: **$124.2**, **$154.5,** and **$169.9** million for the low, medium, and high ITS participation scenarios, respectively. Table 5-12 presents the estimated net present values by direction of travel.

**Table 5-12. Estimated Net Present Value of Travel Time Savings at the Blaine Border Crossing Over 10 Years (In Millions of Dollars)**

| Value of Travel Time Saved by Trip Type and ITS Scenario | Direction | | Total Cost Savings |
|---|---|---|---|
| | SB | NB | |
| Low | $110.9 | $13.3 | $124.2 |
| Medium | $130.4 | $24.1 | $154.5 |
| High | $134.7 | $35.2 | $169.9 |

### 5.11.2 Corridor (Bypass) Travel Time Savings

The corridor bypass time savings occur as driver/vehicle/shipment are screened initially via electronic means or through physical inspection, then are cleared from further inspections along the corridor through the passing of information to other weigh/inspection sites along the corridor, subject to verification via WIM and AVI technologies. Projected time savings associated with bypassing weigh stations were developed using weigh station statistics provided by WSDOT and the ICBC.

Projections for the potential volume bypass events were developed based on current baseline data, projected commercial vehicle travel demand, and assumed levels of ITS participation defined by the three test scenarios. A conservative average timesaving of 5 minutes per bypass is assumed based on WSDOT observations of actual truck weight inspections. Table 5-13 presents the projected volume of weigh station bypasses through the IMTC corridor and associated travel time savings.

**Table 5-13. Estimated Time and Cost Savings of Weigh Station Bypass Events (In Millions of Dollars)**

| Time Savings and Value of Travel Time Saved by Trip Type and ITS Scenario | Projected Savings | |
|---|---|---|
| | Approximate Hours Saved | Cost Savings |
| **Base Year** | | |
| Low | 50,700 | $2.3 |
| Medium | 76,000 | $3.4 |
| High | 126,700 | $5.7 |
| **Year 10** | | |
| Low | 135,400 | $6.0 |
| Medium | 225,600 | $9.9 |
| High | 315,900 | $13.9 |

The net present values for the benefits of the border ITS deployments (in millions of dollars) over the 10-year analysis horizon are**: $25.6**, **$40.7** and **$61.7** million for the low, medium, and high ITS participation scenarios, respectively. Table 5-14 presents the estimated net present values by of time and cost savings of weigh station bypass events over the 10-year period.

**Table 5-14. Estimated Net Present Value of Time and Cost Savings of Weigh Station Bypass Events Over 10 Years (In Millions of Dollars)**

| Value of Travel Time Saved by Trip Type and ITS Scenario | Total Cost Savings |
|---|---|
| Low | $25.6 |
| Medium | $40.7 |
| High | $61.7 |

### 5.11.3 Administrative Cost Savings

Though considerably less in scale than the estimated travel time benefits, potential administrative benefits of electronic information exchange are significant for stakeholders. According to the United Nations Conference on Trade and Development, the average international transaction can involve the re-keying of 60 to 70 percent of data at least once[42].

In this analysis, it is assumed that the estimated administrative benefits are to be derived from reduced data entry, paper handling, and errors via electronic data exchange among stakeholders. Estimating the potential administrative benefits is based on the expected level of customs-related transactions (releases) associated with non-empty truck border crossings; average time per transaction (shipment) by shippers, motor carriers, and customs brokers; and documented ranges of administrative savings using electronic information exchange mechanisms. Baseline estimates of time on task and potential administrative time savings were developed from observed driver time at the border crossing spent with customs brokers; interviews with customs brokers representatives; and published sources of shipping documentation preparation time, automation time savings, and wage rates for clerical occupations.

The following per-transaction average administrative processing times are used for this analysis: 3 minutes for shippers and motor carriers; 11 minutes for customs brokers. It should be noted that these represent conservative processing time estimates.

Published sources provide a range of potential savings in such paperwork time on task through the use of electronic data exchange of between 11 and 67 percent, with the majority of sources pointing towards the 50 percent level.

Using simulation, overall potential time savings of 35 to 37 percent were estimated. Using prevailing wage rates for clerical staff, the per-transaction cost savings were estimated at $0.30 for shippers, $0.28 for motor carriers, and $1.03 for customs brokers. Though these savings may seem relatively small, given projected levels of approximately 795,000 and 1,420,000 annual transactions for the Base Year and Year 10, the administrative savings become significant. The discounted administrative time savings benefits over 10 years is estimated to be **$8 million** for customs brokers, **$2.3 million** for shippers, and **$2.2 million** for motor carriers.

## 5.12 BASE BENEFIT AND COST STREAMS

The estimated cost and benefit streams detailed in the preceding sections are brought together for overall ITS deployment in the corridor for each of the three ITS participation scenarios and presented Tables 5-15 through 5-17. The estimated streams are referred to as “base” streams because they represent the simulated mean values for the factors.

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[42] Paperless Trading: Benefits to APEC; Australian Department of Foreign Affairs and Trade and the Chinese Ministry of Foreign Trade and Economic Cooperation. Published by the Commonwealth of Australia, 2001.

**Table 5-15. Estimated Mean Benefit and Cost Streams for the "Low" ITS Deployment Scenario**

| Discounted Cost Streams | Years | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Yr0 | Yr1 | Yr2 | Yr3 | Yr4 | Yr5 | Yr6 | Yr7 | Yr8 | Yr9 | Yr10 |
| Border ITS Deployment | $0.4 | $0.4 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Border Infrastructure | $3.5 | $2.6 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| TCOS (Internet Site) Modifications | $0.2 | $0.2 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Supporting Corridor ITS | $0.1 | $0.1 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **Subtotal Border Costs** | **$4.2** | **$3.3** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** |
| Weigh Stations (4 in WA, 1 in BC) | $8.8 | $7.5 | $0.2 | $0.2 | $0.2 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| Transponder Costs | $2.4 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 |
| **Subtotal Weight Inspection Costs** | **$11.2** | **$7.5** | **$0.4** | **$0.4** | **$0.4** | **$0.4** | **$0.4** | **$0.4** | **$0.4** | **$0.4** | **$0.4** | **$0.4** |
| **Total ITS Costs** | **$15.4** | **$10.8** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.4** | **$0.4** | **$0.4** |
| **Discounted Benefit Streams** | **Total** | **Yr0** | **Yr1** | **Yr2** | **Yr3** | **Yr4** | **Yr5** | **Yr6** | **Yr7** | **Yr8** | **Yr9** | **Yr10** |
| Cross Border Carrier Time Savings | $124.2 | $0.0 | $8.0 | $9.5 | $10.8 | $11.8 | $12.7 | $13.4 | $14.0 | $14.4 | $14.7 | $14.9 |
| Weigh Station Carrier Time Savings | $25.6 | $0.0 | $2.1 | $2.3 | $2.4 | $2.5 | $2.6 | $2.6 | $2.7 | $2.8 | $2.8 | $2.9 |
| **Subtotal Travel Time Savings** | **$149.8** | **$0.0** | **$10.2** | **$11.8** | **$13.1** | **$14.3** | **$15.3** | **$16.0** | **$16.7** | **$17.2** | **$17.5** | **$17.7** |
| Carrier Administrative Processing Time | $2.2 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| Customs Broker Processing Time | $8.0 | $0.0 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.7 |
| Shipper Processing Time | $2.3 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| **Subtotal Administrative Savings** | **$12.5** | **$0.0** | **$1.3** | **$1.3** | **$1.3** | **$1.3** | **$1.3** | **$1.3** | **$1.2** | **$1.2** | **$1.2** | **$1.2** |
| Cross Border Air Pollution Benefits | $1.3 | $0.0 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.2 | $0.2 | $0.2 |
| Weigh Station Air Pollution Benefits | $0.3 | $0.00 | $0.02 | $0.02 | $0.02 | $0.03 | $0.03 | $0.03 | $0.03 | $0.03 | $0.03 | $0.03 |
| **Subtotal Air Pollution Benefits** | **$1.6** | **$0.0** | **$0.1** | **$0.1** | **$0.1** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** |
| **Safety Inspection Benefits** | **$21.1** | **$0.0** | **$2.2** | **$2.3** | **$2.2** | **$2.2** | **$2.2** | **$2.1** | **$2.1** | **$2.0** | **$1.9** | **$1.9** |
| **Total ITS Benefits** | **$185.0** | **$0.0** | **$13.8** | **$15.5** | **$16.8** | **$18.0** | **$18.9** | **$19.6** | **$20.2** | **$20.6** | **$20.8** | **$21.0** |

**Table 5-16. Estimated Mean Benefit and Cost Streams for the "Medium" ITS Deployment Scenario**

| Discounted Cost Streams | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Yr0 | Yr1 | Yr2 | Yr3 | Yr4 | Yr5 | Yr6 | Yr7 | Yr8 | Yr9 | Yr10 |
| Border ITS Deployment | $0.4 | $0.4 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Border Infrastructure | $3.5 | $2.6 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| TCOS (Internet Site) Modifications | $0.2 | $0.2 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Supporting Corridor ITS | $0.1 | $0.1 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **Subtotal Border Costs** | **$4.2** | **$3.3** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** |
| Weigh Stations (4 in WA, 1 in BC) | $8.8 | $7.5 | $0.2 | $0.2 | $0.2 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| Transponder Costs | $3.9 | $0.0 | $0.3 | $0.3 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 |
| **Subtotal Weight Inspection Costs** | **$12.7** | **$7.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** | **$0.5** |
| **Total ITS Costs** | **$16.9** | **$10.8** | **$0.6** | **$0.6** | **$0.6** | **$0.6** | **$0.6** | **$0.6** | **$0.6** | **$0.6** | **$0.6** | **$0.6** |
| **Discounted Benefit Streams** | **Total** | **Yr0** | **Yr1** | **Yr2** | **Yr3** | **Yr4** | **Yr5** | **Yr6** | **Yr7** | **Yr8** | **Yr9** | **Yr10** |
| Cross Border Carrier Time Savings | $154.5 | $0.0 | $10.3 | $12.0 | $13.5 | $14.8 | $15.8 | $16.6 | $17.3 | $17.8 | $18.1 | $18.3 |
| Weigh Station Carrier Time Savings | $40.7 | $0.0 | $3.2 | $3.4 | $3.7 | $3.9 | $4.1 | $4.2 | $4.4 | $4.5 | $4.6 | $4.7 |
| **Subtotal Travel Time Savings** | **$195.3** | **$0.0** | **$13.5** | **$15.5** | **$17.2** | **$18.7** | **$19.9** | **$20.8** | **$21.7** | **$22.3** | **$22.8** | **$23.1** |
| Carrier Administrative Processing Time | $2.2 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| Customs Broker Processing Time | $8.0 | $0.0 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.7 |
| Shipper Processing Time | $2.3 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| **Subtotal Administrative Savings** | **$12.5** | **$0.0** | **$1.3** | **$1.3** | **$1.3** | **$1.3** | **$1.3** | **$1.3** | **$1.2** | **$1.2** | **$1.2** | **$1.2** |
| Cross Border Air Pollution Benefits | $1.6 | $0.0 | $0.1 | $0.1 | $0.1 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| Weigh Station Air Pollution Benefits | 0.43 | 0.00 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Subtotal Air Pollution Benefits** | **$2.1** | **$0.0** | **$0.1** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** | **$0.2** |
| **Safety Inspection Benefits** | **$33.6** | **$0.0** | **$3.3** | **$3.5** | **$3.5** | **$3.5** | **$3.4** | **$3.4** | **$3.3** | **$3.3** | **$3.2** | **$3.1** |
| **Total ITS Benefits** | **$243.4** | **$0.0** | **$18.2** | **$20.4** | **$22.2** | **$23.6** | **$24.8** | **$25.7** | **$26.5** | **$27.0** | **$27.4** | **$27.6** |

**Table 5-17. Estimated Mean Benefit and Cost Streams for the "High" ITS Deployment Scenario**

| Discounted Cost Streams | Years | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Yr0 | Yr1 | Yr2 | Yr3 | Yr4 | Yr5 | Yr6 | Yr7 | Yr8 | Yr9 | Yr10 |
| Border ITS Deployment | $0.4 | $0.4 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Border Infrastructure | $3.5 | $2.6 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| TCOS (Internet Site) Modifications | $0.2 | $0.2 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Supporting Corridor ITS | $0.1 | $0.1 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| **Subtotal Border Costs** | **$4.2** | **$3.3** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** | **$0.1** |
| Weigh Stations (4 in WA, 1 in BC) | $8.8 | $7.5 | $0.2 | $0.2 | $0.2 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| Transponder Costs | $5.8 | $0.0 | $0.5 | $0.5 | $0.6 | $0.6 | $0.6 | $0.6 | $0.6 | $0.6 | $0.6 | $0.6 |
| **Subtotal Weight Inspection Costs** | **$14.6** | **$7.5** | **$0.7** | **$0.7** | **$0.7** | **$0.7** | **$0.7** | **$0.7** | **$0.7** | **$0.7** | **$0.7** | **$0.7** |
| **Total ITS Costs** | **$18.8** | **$10.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** | **$0.8** |
| **Discounted Benefit Streams** | **Total** | **Yr0** | **Yr1** | **Yr2** | **Yr3** | **Yr4** | **Yr5** | **Yr6** | **Yr7** | **Yr8** | **Yr9** | **Yr10** |
| Cross Border Carrier Time Savings | $169.9 | $0.0 | $12.2 | $13.9 | $15.3 | $16.4 | $17.3 | $18.1 | $18.7 | $19.1 | $19.3 | $19.5 |
| Weigh Station Carrier Time Savings | $61.7 | $0.0 | $5.3 | $5.6 | $5.8 | $6.0 | $6.2 | $6.3 | $6.5 | $6.6 | $6.7 | $6.7 |
| **Subtotal Travel Time Savings** | **$231.6** | **$0.0** | **$17.6** | **$19.5** | **$21.1** | **$22.4** | **$23.5** | **$24.5** | **$25.1** | **$25.7** | **$26.0** | **$26.2** |
| Carrier Administrative Processing Time | $2.2 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| Customs Broker Processing Time | $8.0 | $0.0 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.8 | $0.7 |
| Shipper Processing Time | $2.3 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| Subtotal Administrative Savings | $12.5 | $0.0 | $1.3 | $1.3 | $1.3 | $1.3 | $1.3 | $1.3 | $1.2 | $1.2 | $1.2 | $1.2 |
| Cross Border Air Pollution Benefits | $1.8 | $0.0 | $0.1 | $0.1 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 |
| Weigh Station Air Pollution Benefits | 0.64 | 0.00 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| **Subtotal Air Pollution Benefits** | $2.5 | $0.0 | $0.2 | $0.2 | $0.2 | $0.2 | $0.2 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 |
| Safety Inspection Benefits | $50.9 | $0.0 | $5.6 | $5.7 | $5.5 | $5.4 | $5.2 | $5.0 | $4.9 | $4.7 | $4.6 | $4.4 |
| **Total ITS Benefits** | $297.5 | $0.0 | $24.6 | $26.7 | $28.1 | $29.3 | $30.2 | $31.0 | $31.5 | $31.9 | $32.0 | $32.1 |

## 5.13 RANGES OF BENEFITS, COSTS, NET PRESENT VALUES, AND BENEFIT-COST RATIOS

The “base” values presented in Section 5.12 were calculated using mean estimates for the costs and benefits. The “real world” rarely provides for such precision; therefore, through the use of Monte Carlo simulation, variance in component cost and benefit streams are weighed and used to develop probability functions for the derived total costs and benefits. Using estimates of costs and benefits with a ±1 standard deviation from the estimated means allows one to create ranges of costs and benefits with a high degree of confidence.

The ranges of benefit and cost streams were used to develop NPVs and benefit-cost ratios for the ITS deployment scenarios. The NPVs represent the discounted net payback (benefits less costs) for the deployment scenarios. The benefit-cost ratios are, as the name suggests, simple ratios of the two factors.

### 5.13.1 Corridor and Component Values

Using the upper bound of costs and the lower bound of benefits, conservative benefit-cost ratios and NPVs were developed. Conversely, using lower bound costs and upper bound estimates yield more robust benefit-cost ratios and NPVs. The ranges of benefits and costs, and the associated NPVs and benefit-cost ratios are presented in Tables 5-18 through 5-20.

The analysis demonstrates positive benefit-cost ratios and strong NPVs for ITS deployments for the entire corridor and each of the component deployment segments (i.e., border crossing and weigh station ITS deployments) for all three ITS deployment scenarios over the 10-year study horizon. The range of benefit-cost ratios for corridor-wide ITS deployment is from 11.1:1 to 16.8:1, increasing directly proportional to the level of ITS participation. Corridor-wide NPVs are estimated at approximately $164 to $175 million; $220 to $233 million; and, $270 to $$285 million, respectively, for the low, medium, and high ITS deployment scenarios.

It is seen that the ratios are the most robust for the border crossing ITS deployments, ranging from approximately 29.1:1 to 42.2:1 (depending on level of ITS deployment). This is due to relatively low deployment costs, coupled with very large time savings for both transponder-equipped trucks as well as those without transponders – especially in the southbound direction, as noted in the TSi modeling effort. The border crossing deployments show NPVs ranging from approximately $129 to $185 million, moving from low to high ITS scenarios.

Weigh station ITS deployments (for five ITS-equipped weigh stations) show lower overall returns and higher investment costs than the border crossing ITS deployments. It should be noted that the technical, procedural, and ITS deployment cost effectiveness for the border crossing is enabled by the corridor-wide data exchange – a key element for the weigh station ITS deployments. This notwithstanding, the weigh station ITS deployments do show positive benefit-cost ratios ranging from 4.0:1 to 8.5:1, again positively related to the overall level of ITS participation. The NPVs for the weigh station ITS deployments range from approximately $35 to $102 million, moving from low to high ITS scenarios.

**Table 5-18. "Low" ITS Deployment Scenario Estimated Ranges of Cost-Benefit Elements and Net Present Value by Deployment Type (In Millions of Dollars)**

| Cost-Benefit Element | Border ITS | Weigh Station ITS | Total Corridor ITS |
|---|---|---|---|
| Total Costs | $4.4 to $4.6 | $10.8 to $11.5 | $15.2 to $16.1 |
| Total Benefits | $133.9 to $142.7 | $45.6 to $$48.4 | $179.5 to $191.1 |
| Benefit-Cost Ratios | 29.1:1 to 32.4:1 | 4.0:1 to 4.5:1 | 11.1:1 to 12.6:1 |
| Net Present Value | $129.3 to $138.3 | $34.8 to $36.9 | $164.3 to $175.0 |

**Table 5-19. "Medium" ITS Deployment Scenario Estimated Ranges of Cost-Benefit Elements and Net Present Value by Deployment Type (In Millions of Dollars)**

| Cost-Benefit Element | Border ITS | Weigh Station ITS | Total Corridor ITS |
|---|---|---|---|
| Total Costs | $4.3 to $5.1 | $12.3 to $13.1 | $16.6 to $18.2 |
| Total Benefits | $163.6 to $173.8 | $72.6 to $77.0 | $236.2 to $250.8 |
| Benefit-Cost Ratios | 32.1:1 to 40.4:1 | 5.9:1 to 6.2:1 | 12.9:1 to 15.1:1 |
| Net Present Value | $158.2 to $169.5 | $60.3 to $63.9 | $219.6 to $232.6 |

**Table 5-20. "High" ITS Deployment Scenario Estimated Ranges of Cost-Benefit Elements and Net Present Value by Deployment Type (In Millions of Dollars)**

| Cost-Benefit Element | Border ITS | Weigh Station ITS | Total Corridor ITS |
|---|---|---|---|
| Total Costs | $4.5 to $5.5 | $13.7 to $15.0 | $18.2 to $20.5 |
| Total Benefits | $178.7 to $189.7 | $109.9 to $116.7 | $288.6 to $306.4 |
| Benefit-Cost Ratios | 32.5:1 to 42.2:1 | 5.9:1 to 8.5:1 | 14.1:1 to 16.8:1 |
| Net Present Value | $173.2 to $185.2 | $96.2 to $101.7 | $270.4 to $285.9 |

### 5.13.2 Distribution of Public- and Private- Sector Benefits and Costs

The previous sections detailed the public- and private-sector benefit and cost streams for individual factors. As previously noted, public-sector costs involve ITS deployment infrastructure at the border crossing and weigh stations, while benefits accrue to the public sector through enhanced motor carrier safety enforcement and improved air quality impacts. The estimated public-sector benefit-cost ratios range from 1.6:1 to 4.4:1 and NPVs are estimated to range from $9.4 to $41.6 million, moving from low to high ITS deployment scenarios.

Private-sector costs are limited to equipping trucks with transponders, and benefits accrue to the private sector through reduced travel delays and administrative cost savings. The private-sector benefit-cost ratios are extremely robust, estimated to range from 39.8:1 to 72.6:1, moving from high to low deployment scenarios. This inverse relationship results largely to travel time savings accruing to non-transponder-equipped trucks as the transponder-equipped trucks are removed from queue during border crossing. NPVs for the private sector are estimated to range from $157.2 to $243.4 million, moving from low to high deployment scenarios. Tables 5-21 through 5-23 summarizes these benefit and cost streams allowing the reader to compare the relative distributions of benefits and costs between the public and private sectors.

**Table 5-21. "Low" ITS Deployment Scenario Estimated Ranges of Cost-Benefit Elements and Net Present Value by Stakeholder (In Millions of Dollars)**

| Cost-Benefit Element | Public Sector | Private Sector |
|---|---|---|
| Total Costs | $12.6 to $13.4 | $2.3 to $2.5 |
| Total Benefits | $22.0 to $23.4 | $157.2 to $167.0 |
| Benefit-Cost Ratios | 1.6:1 to 1.9:1 | 62.9:1 to 72.6:1 |
| Net Present Value | $9.4 to $10.0 | $154.7 to $164.7 |

**Table 5-22. "Medium" ITS Deployment Scenario Estimated Ranges of Cost-Benefit Elements and Net Present Value by Stakeholder (In Millions of Dollars)**

| Cost-Benefit Element | Public Sector | Private Sector |
|---|---|---|
| Total Costs | $12.6 to $13.4 | $3.7 to $4.1 |
| Total Benefits | $35.0 to $36.4 | $203.6 to $212.0 |
| Benefit-Cost Ratios | 2.6:1 to 2.9:1 | 49.6:1 to 57.3:1 |
| Net Present Value | $22.4 to $23.0 | $199.5 to $208.3 |

**Table 5-23. "High" ITS Deployment Scenario Estimated Ranges of Cost-Benefit and Net Present Value by Stakeholder (In Millions of Dollars) (In Millions of Dollars)**

| Cost-Benefit Element | Public Sector | Private Sector |
|---|---|---|
| Total Costs | $12.6 to $13.4 | $5.6 to $6.0 |
| Total Benefits | $51.8 to 55.0 | $239.0 to $249.0 |
| Benefit-Cost Ratios | 3.9:1 to 4.4:1 | 39.8:1 to 44.5:1 |
| Net Present Value | $39.2 to $41.6 | $233.0 to $243.4 |

Tables 5-24 and 5-25 summarize the estimated mean discounted benefits by stakeholder and ITS deployment scenario.

**Table 5-24. Estimated Mean Discounted Benefits by Stakeholder and ITS Deployment Scenario (In Millions of Dollars)**

| Discounted Benefit Streams | Stakeholder | Low Benefits | Medium Benefits | High Benefits |
|---|---|---|---|---|
| Cross Border Carrier Time Savings | Private Sector | $124.2 | $154.5 | $169.9 |
| Weigh Station Carrier Time Savings | Private Sector | $25.6 | $40.7 | $61.7 |
| Carrier Administrative Processing Time | Private Sector | $2.2 | $2.2 | $2.2 |
| Customs Broker Processing Time | Private Sector | $8.0 | $8.0 | $8.0 |
| Shipper Processing Time | Private Sector | $2.3 | $2.3 | $2.3 |
| Cross Border Air Pollution Benefits | Public Sector | $1.3 | $1.6 | $1.8 |
| Weigh Station Air Pollution Benefits | Public Sector | $0.3 | 0.43 | 0.64 |
| **Safety Inspection Benefits** | Public Sector | **$21.1** | **$33.6** | $50.9 |
| | **Total ITS Benefits** | **$185.0** | **$243.4** | $297.5 |

**Table 5-25. Estimated Mean Discounted Benefits by Stakeholder and ITS Deployment Scenario (In Millions of Dollars)**

| Discounted Benefit Streams | Stakeholder | Low Benefits | Medium Benefits | High Benefits |
|---|---|---|---|---|
| **Subtotal Travel Time Savings** | Private Sector | $149.8 | $195.3 | $231.6 |
| Subtotal Administrative Savings | Private Sector | $12.5 | $12.5 | $12.5 |
| **Subtotal Air Pollution Benefits** | Public Sector | $1.6 | $2.1 | $2.5 |
| Safety Inspection Benefits | Public Sector | $21.1 | $33.6 | $50.9 |
| | **Total ITS Benefits** | $185.0 | $243.4 | $297.5 |

### 5.13.3 Impacts to Trucking Companies

Section 5.13.2 described the distribution of benefits and costs of ITS deployments between public and private sector stakeholders. While the macro level analyses are useful to public sector decision makers, motor carriers represent a key stakeholder in the realization of potential ITS program benefits through their participation in programs. An owner of a trucking company will base the decision on whether and to what degree to participate in ITS programs, not on macro analyses, but on how participation will affect the bottom line. Therefore, this section examines how the IMTC ITS deployments may impact trucking companies' costs of operation.

This analysis recognizes that no two trucking companies are the same, so costs and benefits are first presented on a per trip basis, then for a mid-sized “model” trucking company conducting cross-border drayage operations between Vancouver, British Columbia, and the Ports of Tacoma or Seattle. Table 5-26 presents the per-trip potential cost savings for the ITS deployment scenarios. In this analysis it is assumed that a transponder-equipped truck would save time at the border crossings by the use of dedicated ITS lanes, and the same truck would save time via weigh station bypasses. It is assumed that a truck will be stopped at the first of four weigh/inspection stations on the route, then cleared to bypass the remaining three for each leg of the round trip (i.e., six bypasses per round trip).

As shown in Table 5-26, an ITS-supported truck would save approximately $49 per round trip in the base year through time and administrative cost savings. This is 98 percent of the full cost of a transponder. **This equates to a financial breakeven to a motor carrier by the second round trip**. By 2013, the benefits are estimated to increase approximately 28, 25, and 10 percent for the low, medium, and high ITS deployment scenarios, respectively.[43] This analysis concludes that motor carriers will realize net positive returns on ITS participation almost immediately.

The following illustrates the bottom line impacts to a mid-sized drayage company:

- Company has 11 trucks.
- Each truck makes one cross-border round-trip drayage haul between Vancouver, British Columbia, and the Ports of Tacoma or Seattle per day, 5 days per week.
- The net cost to the drayage company is **$550**, or 11 x $50 per transponder.
- The net benefit (base year) is:

  ($49 savings per trip) x (55 round trips per week) x (52 weeks)

  = **$140,140** per year, or **$12,740** per truck per year

[43] Diminishing marginal benefit of ITS is exhibited due to increasing benefits of reduced border queues to non-transponder equipped trucks.

**Table 5-26. Average Per Trip ITS Savings for Motor Carriers**

| ITS Scenario | Average Value of Time Savings at the Border Crossing | | Total Average Value of R/T Border Crossing Time Savings | Average Value of R/T Weigh Station Bypass Time Savings | Total Average Value of R/T Time Savings | Total Value of Administrative Savings[44] | Total Average R/T Savings |
|---|---|---|---|---|---|---|---|
| | SB[45] | NB | | | | | |
| **Base Year** | | | | | | | |
| Low | $21.34 | $4.13 | ***$25.47*** | ***$22.05*** | **$47.52** | ***0.56*** | **$48.08** |
| Medium | $21.89 | $5.51 | ***$27.40*** | ***$22.05*** | **$49.45** | ***0.56*** | **$50.01** |
| High | $21.82 | $4.95 | ***$26.77*** | ***$22.05*** | **$48.82** | ***0.56*** | **$49.38** |
| **Year 10** | | | | | | | |
| Low | $35.05 | $3.87 | ***$38.92*** | ***$22.05*** | **$60.97** | ***0.56*** | **$61.53** |
| Medium | $36.25 | $3.71 | ***$39.96*** | ***$22.05*** | **$62.01** | ***0.56*** | **$62.57** |
| High | $28.82 | $2.65 | ***$31.47*** | ***$22.05*** | **$53.52** | ***0.56*** | **$54.08** |

[44] Two electronic transactions (one for each direction of round trip is assumed).
[45] Average of time savings for ITS conversion from pre-cleared and non pre-cleared border crossings.

## 5.14 ESTIMATED PAYBACK PERIODS

For each successive each year of the study horizon, the discounted "net" streams (benefits less costs) were added to the previous year's project-to-date returns to yield discounted accrued net returns for the scenarios. The point in time when the discounted "net" streams exceed zero represents the payback or break-even point in time. Section 5.14.1 presents the net streams and payback periods for the IMTC corridor and its component deployments. Section 5.14.2 presents the net streams and payback periods by stakeholder (public versus private sector).

### 5.14.1 Net Streams and Payback Periods for IMTC Corridor and Component Deployments

As illustrated in Figures 5-1 through 5-3, the ITS – CVO border crossing deployments realize a payback on investment the first year of deployment for each of the three scenarios. Again, the time savings for transponder-equipped trucks, as well as those without transponders (due to reduced queue times by taking the ITS trucks out of the general stream), are large in comparison to the deployment costs.

The payback of investment for the weigh station ITS deployments requires longer time periods and are more ITS participation rate-sensitive than for the border crossing ITS deployments. This is because of the greater first cost requirements for the weigh stations and a benefit stream dependent only upon time savings realized by transponder-equipped trucks. The estimated payback periods for the weigh station ITS deployments are 2 years for the low and medium ITS scenarios, and 1 year for the high ITS scenario.

Due to the overwhelming proportion of total benefits realized through the border crossing ITS deployments, the corridor-wide combined payback period is 1 year for all three ITS participation scenarios.

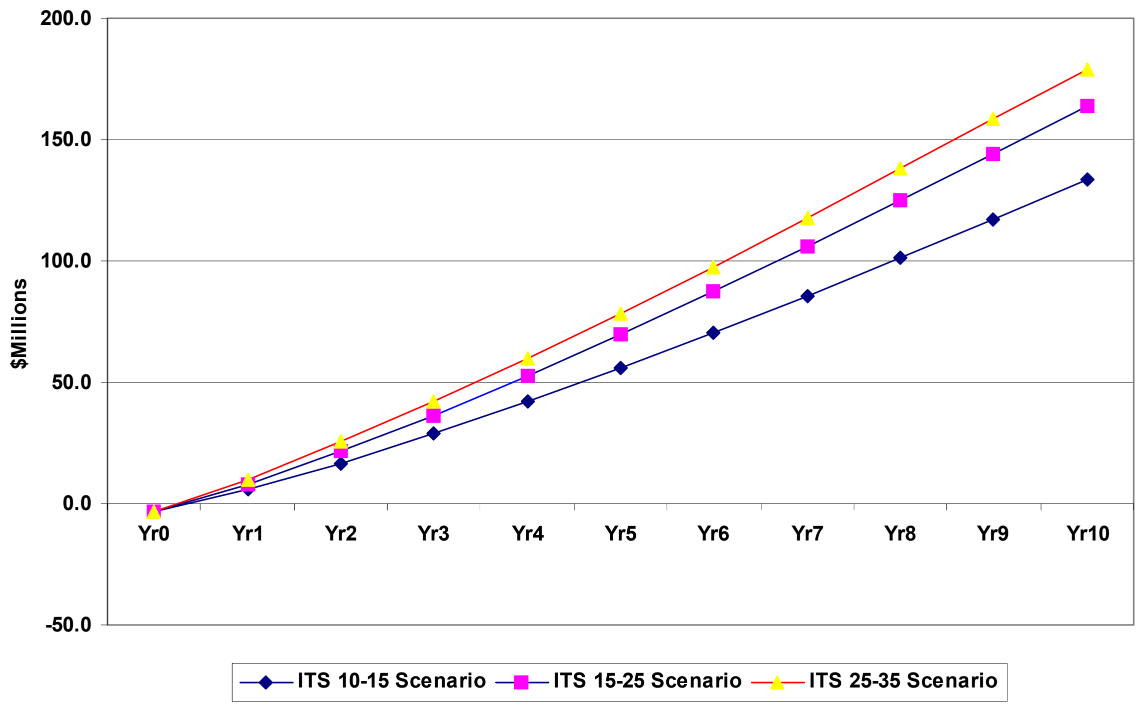


**Figure 5-1. Border Crossing ITS Discounted Accrued Net Returns.**

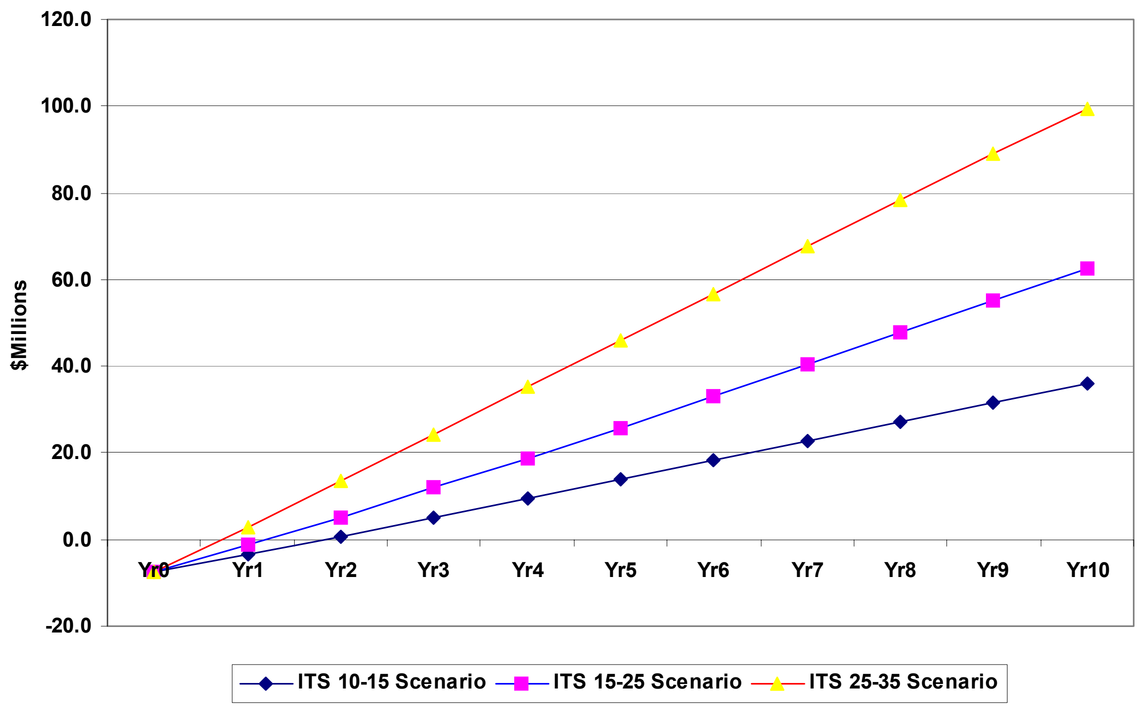


**Figure 5-2. Weigh Station ITS Discounted Accrued Net Returns.**

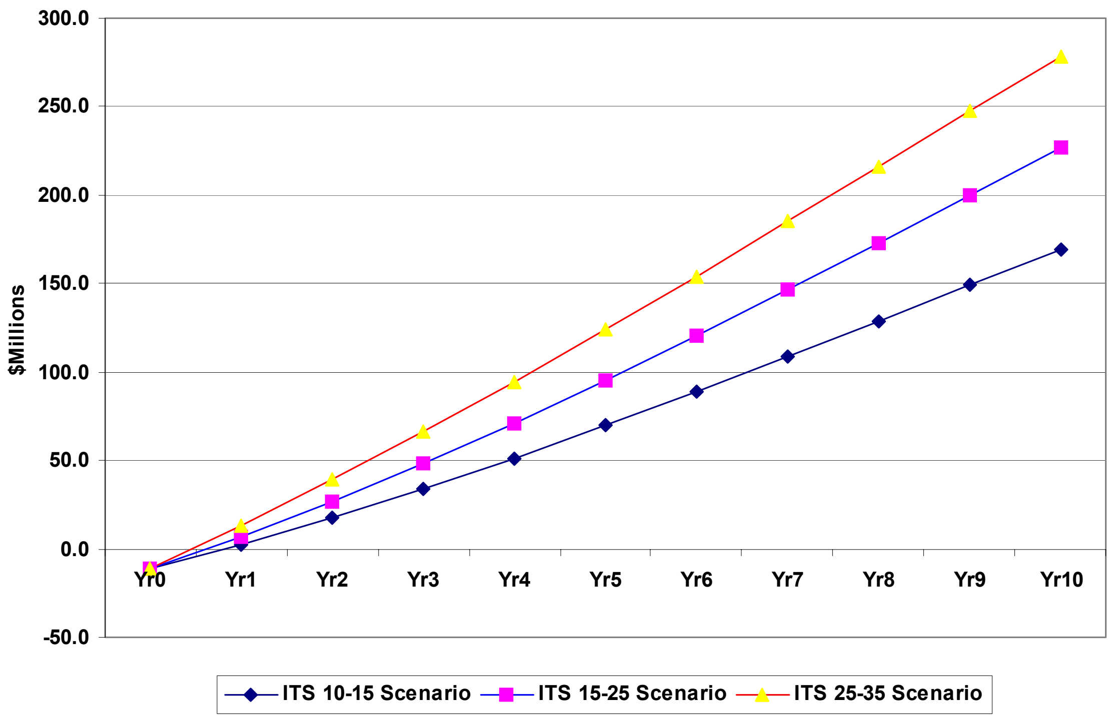


**Figure 5-3. Total Corridor ITS Discounted Accrued Net Returns.**

### 5.14.2 Net Streams and Payback Periods for Public and Private Sectors

As presented in Figures 5-4 and 5-5, both public and private sectors can expect payback within the 10-year horizon of this study. The private sector net discounted benefits accrue concurrent with the costs of ITS deployment and given the relatively small costs of participation with the large travel time benefits, it is seen that throughout the study horizon, benefits exceed costs. Therefore, private sector breakeven is immediate for all ITS deployment scenarios.

The public sector expends a relatively large proportion of deployment costs initially, with benefits accruing (primarily through truck crash avoidance due to ITS-enhanced commercial vehicle enforcement) modestly over the study horizon. The level of public ITS benefits accrued over time is directly proportional to the private sector ITS participation rates. It is estimated that public sector payback periods are 6 years, 5 years, and 3 years, respectively, for the low, medium, and high ITS deployment scenarios.

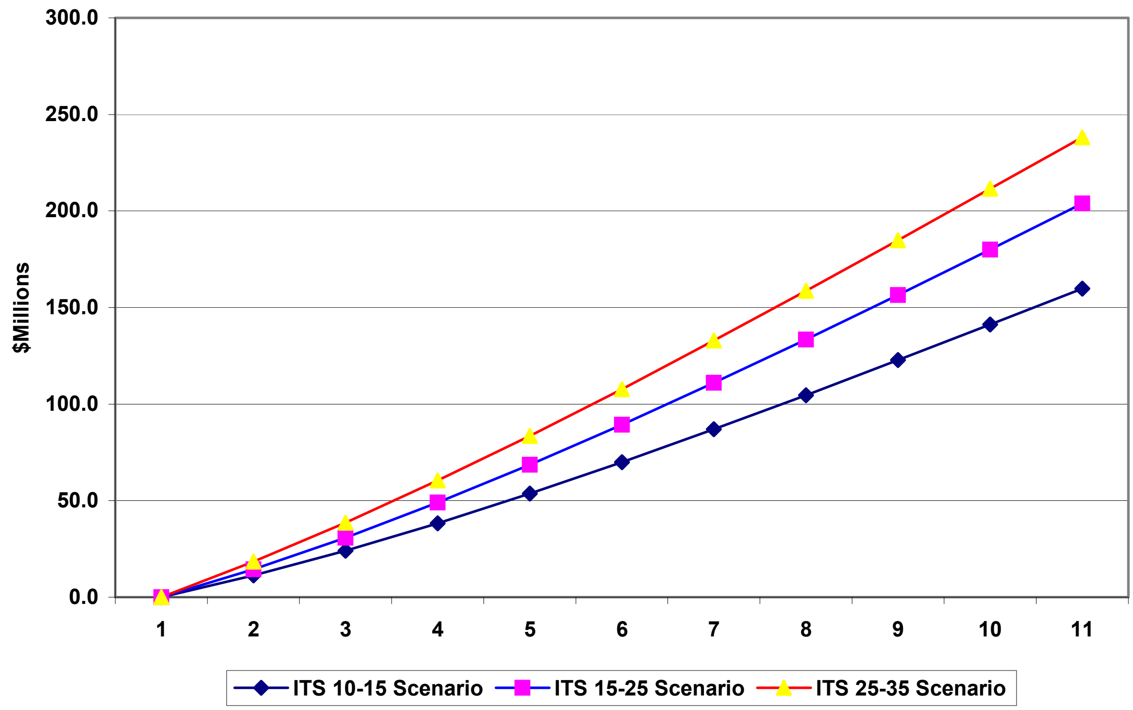


**Figure 5-4. Private Sector ITS Discounted Accrued Net Returns.**

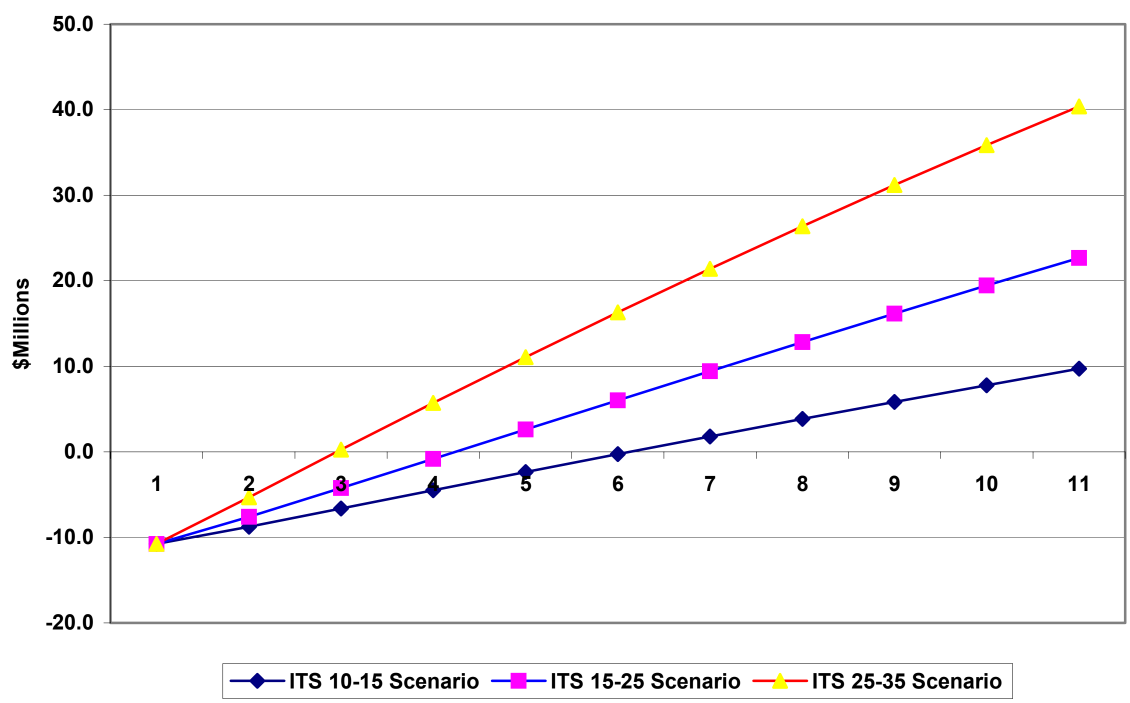


**Figure 5-5. Public Sector ITS Discounted Accrued Net Returns.**

## 5.15 BENEFIT-COST ANALYSIS CONCLUSIONS

The financial analysis of the ITS deployments in the IMTC show positive benefit-cost ratios and net returns for all deployment level and composition scenarios and for the two stakeholder groups examined – public and private sectors. The greatest benefits are accrued through travel time savings at the border crossing and weigh stations due to automated identification and screening of compliant drivers/loads/vehicles/carriers through the ITS Dedicated Truck Lanes deployment.

As detailed in this section, the benefit cost-analysis developed a range of estimates so that the assessment could develop conservative benefits cost ratios based on the upper bound of costs and the lower bound of benefits. Additionally, the benefit-cost model employed Monte Carlo simulation to develop more statistically valid ranges for the cost-benefit estimates.

The major findings of this benefit-cost analysis are summarized as follows:

- The discounted benefits of the travel time savings due to the border ITS deployments, including the Dedicated ITS Truck Lane and the reductions in stops at the brokerage houses, are estimated to be between at: $124.2 and $169.9 million over the next 10 years, and represent by far, the most significant benefits considered in this analysis. These benefits are estimated directly from the border crossing modeling effort outlined in Section 4.

- Private sector benefits were overwhelmingly positive! This analysis concludes that motor carriers will realize net positive returns on ITS participation almost immediately. For a typical mid-size trucking company involved in daily drayage moves across the border, the cost-benefit analysis showed conclusively that for an initial investment of $550 for transponders to equip a fleet of 11 trucks, the benefit-cost analysis showed that a benefit of over $12,000 per year in travel time savings could be expected due to the use of the dedicated ITS truck lanes at the border and through weigh station bypass events. Here, this trucking company would *reach a financial breakeven point for its fleet in less than a week*!

- Public sector benefits were estimated to be greater than costs. Public-sector costs involve ITS deployment infrastructure at the border crossing and weigh stations, while benefits accrue to the public sector through enhanced motor carrier safety enforcement and improved air quality impacts. The estimated public-sector benefit-cost ratios range from 1.6:1 to 4.4:1, moving from low to high ITS deployment scenarios. The public sector will absorb the most of the ITS deployment and operational costs (predominantly at the outset of deployment), and accrue benefits at a comparatively modest rate compared to the private sector. The level of public ITS benefits accrued over time is directly proportional to the private sector ITS participation rates. It is estimated that public sector payback periods are 6 years, 5 years, and 3 years, respectively, for the low, medium, and high ITS deployment scenarios.

- While estimation was not possible in this analysis, additional public sector benefits should be considered. Potential public-sector benefits not quantitatively assessed in this analysis could yield additional benefits in terms of improved regulatory (customs) processes, enhanced freight security, and overall regional economic competitiveness enabled by more efficient freight operations.

- The analysis demonstrates positive benefit-cost ratios and strong discounted benefit streams for ITS deployments for the entire corridor and in each of the component deployment segments (i.e., border crossing and weigh station ITS deployments) for all three ITS deployment scenarios over the 10-year study horizon. The range of benefit-cost ratios for corridor-wide ITS deployment is from 11.1:1 to 16.8:1. Corridor-wide discounted benefits are estimated at approximately $164 to $175 million; $220 to $233 million; and, $270 to $$285 million, respectively, for the low, medium, and high ITS deployment scenarios.

- It is seen that the ratios are the most robust for the border crossing ITS deployments, ranging from approximately 29.1:1 to 42.2:1 (depending on level of ITS deployment). This is due to relatively low deployment costs, coupled with very large time savings for both transponder-equipped trucks as well as those without transponders – especially in the southbound direction, as noted in the modeling effort detailed in Section 4. The border crossing deployments show NPVs ranging from approximately $129 to $185 million, moving from low to high ITS scenarios.

- Weigh station ITS deployments (for five ITS-equipped weigh stations) show lower overall returns and higher investment costs than the border crossing ITS deployments. It should be noted that the technical, procedural, and ITS deployment cost effectiveness for the border crossing is enabled by the corridor-wide data exchange – a key element for the weigh station ITS deployments. This notwithstanding, the weigh station ITS deployments do show positive benefit-cost ratios ranging from 4.0:1 to 8.5:1, again positively related to the overall level of ITS participation. The NPVs for the weigh station ITS deployments range from approximately $35 to $102 million, moving from low to high ITS scenarios.

- The Total Deployment Cost for the Border ITS System and the Dedicated ITS Truck lanes on both sides of border are estimated at approximately $10.8 million in current year dollars. Of this amount, $3.3 million represents ITS deployment at the north/southbound border crossing at Blaine and supporting ITS deployment at the APL intermodal facility. Of this $3.3 million, approximately $2.6 million are estimated costs for construction of dedicated ITS truck lanes in the north- and south-bound directions. Of the remaining $0.7 million, approximately $532K represents the costs of: site-specific systems engineering and system installation; AVI readers and supporting hardware; communications links; and computer system hardware and software. Transcore software enhancements account for the remaining $170K. Additionally, ITS deployments at four weigh/inspection stations in Washington State, and one in British Columbia are estimated to cost $7.5 million to deploy. Recurring costs are estimated to be $.14 million per year at the border facilities, and $0.19 million per year at the weigh stations.

- The discounted air quality public benefits of the ITS deployments are estimated to be between $1.6 and $2.5 million over the next 10 years. The border-crossing share of these benefits ranges from 65 to 80 percent (high to low deployment scenario). Here, air quality benefits from reductions in truck idling times at the border crossings and the weigh stations were expressed in terms of avoided heath costs associated with diesel truck exhaust.

- The discounted safety benefits of the ITS deployments are estimated to be between $21.1 and $50.9 million over the next 10 years. The benefits are due to an expected re-focus of enforcement activities on inspection of non-electronically screened (transponder-equipped) vehicles. Identifying and prescreening vehicles of “safe” motor carriers allows enforcement personnel to maximize inspection time on the higher risk operators. The benefits were estimated using three key inputs from federal and state sources.

- The discounted travel time savings associated with bypassing weigh stations are estimated to be between $25.6 and $61.7 million over the next 10 years. The corridor bypass time savings occur as driver/vehicle/shipment are screened initially via electronic means or through physical inspection, then are cleared from further inspections along the corridor through the passing of information to other weigh/inspection sites along the corridor (including bi-national WIM data sharing between Washington and British Columbia), subject to verification via WIM and AVI technologies. Projected time savings associated with bypassing weigh stations were developed using weigh station statistics provided by WSDOT and the ICBC.

- The discounted administrative time savings benefits over 10 years is estimated to be $8 million for customs brokers, $2.3 million for shippers, and $2.2 million for motor carriers, respectively. Using simulation, overall potential time savings of 35 to 37 percent were estimated. Using prevailing wage rates for clerical staff, the per-transaction cost savings were estimated at $0.30 for shippers, $0.28 for motor carriers, and $1.03 for customs brokers. Though these savings may seem relatively small, given projected levels of approximately 795,000 and 1,420,000 annual transactions for the Base Year and Year 10, the administrative savings become significant.

# 6. IMTC CASE STUDY

## 6.1 INTRODUCTION

This section describes the IMTC Case Study performed by the Evaluation Team. This study is comprised of three components:

1. A description of the IMTC purpose participants and objectives is provided.
2. An overview of the IMTC's ongoing ITS program is presented – the IMTC has provided oversight and innovative solutions for freight ITS projects that can be used as a guidance vehicle by other border region coalitions with similar needs.
3. A discussion is provided concerning the potential institutional challenges concerning IMTC region's ITS border system deployment, bi-national transponder operations and electronic exchange of credentialing information.

The remainder of this section is organized as follows:

- 6.2 The International Mobility and Trade Corridor (IMTC
- 6.3 IMTC Freight ITS Program Overview
- 6.4 IMTC Institutional Challenges
- 6.5 Summary: IMTC Case Study Findings

## 6.2 THE INTERNATIONAL MOBILITY AND TRADE CORRIDOR

Cross-border commercial truck traffic has increased over 80 percent through the Washington State – British Columbia border region since the implementation of NAFTA in 1993. The Blaine Border Crossing is now the third busiest passenger vehicle crossing, and the fourth busiest commercial motor vehicle crossing along the United States – Canadian border. Add to these transportation demands the recent population growth surge in the area, both sides of the international border are facing challenges in maintaining cross border mobility through the Cascade Gateway.

The International Mobility and Trade Corridor – the IMTC – is a joint United States – Canadian business and government coalition. Formed in 1997, the primary purpose of the IMTC is to identify and promote cross border mobility and security for the primary land border crossings linking the British Columbia and Washington State Cascade Gateway: the Peace Arch Bridge and Pacific Highway in Blaine, Washington/Surrey, British Columbia; Sumas, Washington/Abbotsford, British Columbia; and Lynden, Washington/Aldergrove, British Columbia.

The IMTC brings together local, state/provincial, and regional agencies from both sides of the international border, along with business and trade associations to discuss pertinent cross border issues, identify creative solutions to these issues, and seek out a variety of funding mechanisms to implement IMTC solutions. The IMTC is composed of over 60 public and private organizations that share concerns with business and traffic mobility issues surrounding the international border crossing between Washington State and British Columbia. The Whatcom Council of Governments (WCOG) in Washington State is the lead organization for the IMTC.

The IMTC serves as an information clearinghouse. The IMTC Website (www.wcog.org/imtc) provides users access to all IMTC committee meeting materials, regional transportation data, and a calendar of border-related events. Users also can view a Cascade Gateway regional project inventory that includes planning studies, construction, and other changes in the IMTC region. A regularly scheduled electronic newsletter keeps participants informed of the progress of IMTC-sponsored projects, meetings, and developments.

By definition, the IMTC is[46]:

- A forum that facilitates collaboration between border stakeholders from business, government, transportation, and inspection agencies.

- A bi-national coalition that identifies and prioritizes needs that transportation and border management agencies can act on from both sides of the border.

- A successful response to the United States' Federal Highway Administration's Coordinated Border Infrastructure Program, positioning both Washington State and British Columbia for financial partnerships aimed at mobility improvements.

The WCOG arranges IMTC steering committee meetings every month, Core Group meetings every quarter, and General Assembly meetings twice a year. These meetings are designed to encourage candid discussion of pertinent issues and provide a forum for facilitating decision making between the numerous agencies and organizations represented in the IMTC. Meeting agendas focus on providing participants information pertaining to research studies, infrastructure implementation efforts, and bi-national coordination of planning on both sides of the border.

[46] Source: Whatcom Council of Governments.

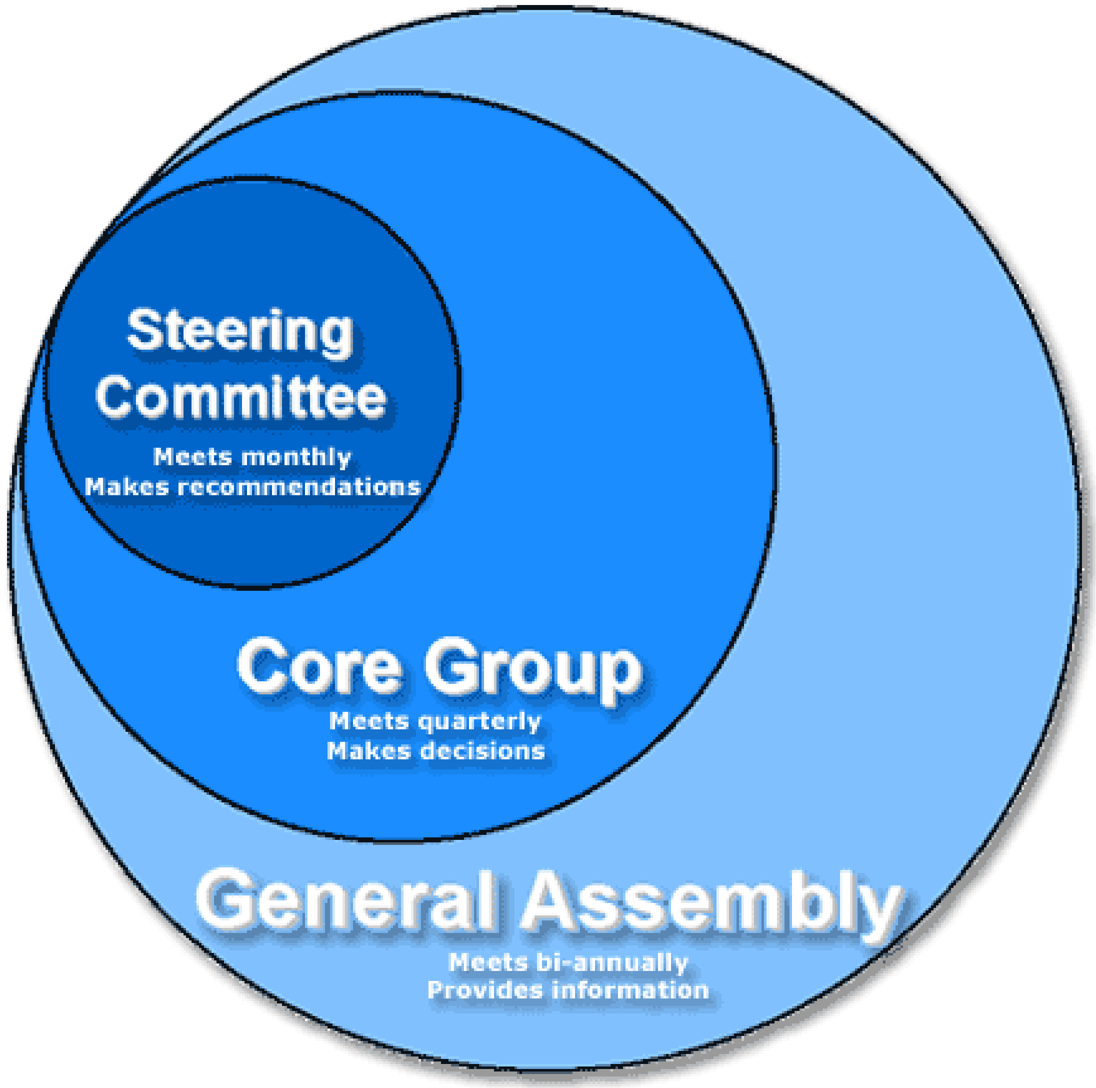


**Figure 6-1. IMTC Committee Structure.**

The IMTC bi-national participants come from both the public and private sectors, and represent a wide variety of constituent interests. Table 6-1 provides a listing of some of the IMTC participants[47] who regularly attend meetings and participate in IMTC activities. It should be noted here that during the course of this evaluation, the Evaluation Team has been presented at numerous ITMC Steering Committee meetings, and has worked closely with IMTC leadership over the past 2 years to inform them of project activities and involve them in the this evaluation.

[47] Source: Whatcom Council of Governments.

**Table 6-1. IMTC Participants**

| **Transportation Agencies** | |
|---|---|
| B.C. Ministry of Transportation | Port of Bellingham |
| B.C. TransLink | B.C. Transportation Financing Authority |
| U.S. Federal Railroad Administration | U.S. Federal Transit Administration |
| U.S. Maritime Administration | U.S. Federal Highways Administration |
| Transport Canada | Vancouver International Airport |
| Vancouver Port Corporation | WA State Department of Transportation |
| Whatcom Council of Governments | Whatcom Transportation Authority |
| **Inspection Agencies** | |
| Canada Customs & Revenue Agency | Citizenship & Immigration Canada |
| U.S. Bureau of Customs and Border Protection | U.S. Immigration & Naturalization Service |
| **Border Municipalities** | |
| Abbotsford, BC | Bellingham, WA |
| Blaine, WA | Langley, BC |
| Lynden, WA | Sumas, WA |
| Surrey, BC | Whatcom County, WA |
| White Rock, BC | |
| **Non Government Organizations** | |
| B.C.-WA Corridor Task Force | Bellingham/Whatcom Convention & Visitors |
| Bellingham/Whatcom Chamber of Commerce | Bellingham/Whatcom Economic Development |
| Better Borders Northwest | Cascadia Institute |
| Cascadia Project/Discovery Institute | Greater Vancouver Gateway Council |
| Pacific Corridor Enterprise Council | Vancouver Board of Trade |
| **Other Governmental Agencies** | |
| B.C. Ministry of Employment & Investment | Consul General of Canada, Seattle |
| U.S. General Services Administration | U.S. Consulate, Vancouver |
| WA Dept. of Trade & Economic Development | |
| **Private Industry** | |
| Amtrak | B.C. Trucking Association |
| BNSF Railroad | Northwest Motorcoach Association |
| US & Canadian customs brokerages | US & Canadian duty free stores |
| US & Canadian retail stores | WA Trucking Association |

The overall goal of the IMTC program is to improve mobility and safety in the Cascade Gateway region, which includes the broader regions that surround the primary Blaine/Surrey border crossing, as well as other border crossings in Northwestern Washington/Southern British Columbia. Following is a list of the objectives targeted by the IMTC for project consideration, grouped under the three IMTC primary goals of facilitating cross-border transportation, improving border data and planning, and promoting infrastructure improvements[48]:

### 6.2.1 Facilitate Cross-Border Transportation

- Integrate ITS solutions.
- Promote Improvements to operations, policy and staffing.
- Harmonize cross-border policies and operations in accordance with the goals of the Canada - U.S. Partnership agreement (CUSP).
- Increase resources and staffing levels at border inspection facilities.
- Improve commercial traffic management at all ports of entry.
- Ensure ongoing sustainability of pre-approved travel programs.
- Promote consolidated administration of pre-approved travel programs.
- Pursue shared United States – Canadian border inspection facilities, including the creation of accord-processing zones.
- Consider off-border inspection functions.

### 6.2.2 Improve Border Data and Planning

- Improve traffic information and data.
- Promote management of the Cascade Gateway as a system.
- Determine feasibility of rail, transit, and marine options.

### 6.2.3 Promote Infrastructure Improvements

- Improve border crossing approach roads.
- Improve rail crossings and connections.
- Improve corridor connections of trade and travel routes.

[48] “2000 IMTC Report Card”, International Mobility and Trade Corridor Project, Whatcom Council of Governments, 2000.

Based on numerous discussions the Evaluation Team has had with IMTC stakeholders, the IMTC is regarded in the region as a successful champion for obtaining funding and implementing border ITS projects based on the goals highlighted above. Additionally, the IMTC is also moving forward in promoting United States – Canada joint efforts to increase roadway capacity, improve safety, and more effectively utilize rail and marine transportation to alleviate commercial motor vehicle congestion. In this regard, a major bi-national regional transportation travel demand modeling effort is currently underway, which will build on the previous IMTC border trade and travel survey effort, which was completed in 2001.

As demonstrated in Section 5, benefits that may arise from the IMTC public - private partnership include more efficient enforcement, reduction of border wait times, and reduced transportation maintenance and operating costs. These benefits can aid in reducing the costs of international cross-border business and improve the competitiveness of the regional economy.

## 6.3 IMTC FREIGHT ITS PROGRAM OVERVIEW

The IMTC acts as a mechanism through which cross border regional mobility improvement projects are identified, prioritized, and then proposed for funding. The WCOG submits annual funding applications to USDOT's Borders and Corridors Program based on IMTC recommendations. The IMTC is also actively involved in working with political bodies in Washington State and British Columbia to identify additional sources of funding, encompassing local, state/province and regional sources. This effort recently included working with Washington State on an ITS Earmarks funding application for a border Advanced Traveler Information System, as well as working with the province of British Columbia to secure infrastructure funding for a truck staging lot on the southbound approach to the United States border at Surrey. The truck staging lot will support the future goal of Transport Canada of funding a dedicated ITS truck lane at this border crossing.

At the 2002 EURA Conference on Urban and Spatial European Policies held in Turin, Italy, guest speaker Susan Clarke defined the role of the IMTC project, which "…stands out as a public-private partnership of diverse, bi-national interests, lead by a public agency, responding to local congestion concerns by going after national funds for bi-national transportation funding."[49] A significant portion of IMTC project funding is generated for the United States from the Transportation Equity Act for the 21$^{st}$ century (TEA-21) legislation enacted in 1998. FHWA funding has been matched by regional funding sources such as the Washington State Department of Transportation, the Province of British Columbia, Transport Canada, and border municipalities.

Provided below are a selection of IMTC project descriptions that represent some of the most critical IMTC projects that may relate or support the ITMC CVO border ITS system detailed in this report.[50]

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[49] "Spatial Concepts and Cross-Border Governance Strategies: Comparing North American and Northern European Experiences", presented by Susan Clarke at the EURA Conference on Urban and Spatial European Policies, Turin, Italy, April 18-20, 2002.

[50] IMTC project descriptions are synopses of project descriptions from the Whatcom Council of Governments.

- **PACE and CANPASS Pre-Approved Travel Promotion.** The Peace Arch Crossing Entry (PACE) program for expedited border clearance of cross-border travelers was initiated by the U.S. Immigration and Naturalization Service (INS) in 1992, along with CCRA's analogous CANPASS program. These programs provide a dedicated commuter lane for enrolled regular cross-border travelers. These ITS projects provides for expedited clearance of passenger vehicles and their operators through the use of on-vehicle transponders and pre-registered users whose photos and other information are available to the customs booth operator in real time when the car approaches the booth.

  This PACE project was completed in August 2001, and a major focus since then has been aimed at promoting these two programs to the traveling public. Market research and surveys have been completed, as well as reports detailing recommended operational improvements. The getPACE.com Website started in 2000 and is widely used to provide applications to each program. Advertising efforts included broad distribution of rack cards and regional newspaper advertisements and mailings.

- **Abbotsford, BC – Sumas, WA Border Improvement Project.** The Abbotsford-Sumas Border Improvement Project is a bi-nationally funded effort to identify constraints and develop solutions for the border crossing between Abbotsford, British Columbia and Sumas, Washington. This study is the first of its kind to integrate local, regional, and national funding partners from both Canada and the United States to address the issues facing a bi-national border environment. All planning efforts were coordinated and overseen by an IMTC project subcommittee.

- **Cross-Border Travel Demand Study.** The IMTC Cross-Border Trade and Travel Study was completed in 2001 as a response to the need identified by IMTC participants for better data regarding the four ports-of-entry which make up the Cascade Gateway between Whatcom County, Washington State and British Columbia. Previous data collected on the Cascade Gateway revealed little about commodity flow, intermodal opportunities, or the potential sustainability of new transportation options. To close these gaps, updated and detailed information was collected in the summer and fall of 2000 to analyze cross-border traffic volumes; origin and destination of trips; commercial commodity flow; and passenger trip purpose. The Cross-Border Trade and Travel Study is the most comprehensive analysis of British Columbia – Washington State cross-border travel data ever completed.

- **The Cascade Gateway Bi-National/Regional Transportation Demand Model.** The WCOG is developing a cross-border transportation demand model that will estimate the demand for the movement of people or goods by mode and time period. The information generated can be used to assess policy initiatives and support economic analysis of infrastructure alternatives and infrastructure design. This model will be the first of its kind in North America to be capable of cross-border, bi-national modeling. It will also serve as a regional model for Whatcom County and its cities.

- **Advanced Traveler Information System.** This Advanced Traveler Information System (ATIS) project will provide advance travel information to southbound cross-border motorists. An analogous system is currently being installed northbound by WSDOT. Using license-plate readers, closed-circuit cameras, and variable message signs, the system will determine wait times at the Peace Arch and Pacific Highway border crossings between Blaine, Washington, and Douglas, British Columbia. The signs will allow motorists to choose between the two border crossings based on relative wait times at each port-of-entry. In addition to the signs, wait-time information will also be made available on a Website. An additional project benefit will be the collection of historical wait-time data for these ports of entry.

- **Cross-Border Transit Study.** The Cross-Border Transit Study is assessing current and future demand for regional, cross-border transit in the Cascade Gateway. The IMTC coalition has identified numerous benefits that a cross-border transit system would provide for the Cascade Gateway bi-national region:

  - Reduction in cross-border personal vehicle trips and related congestion.
  - Environmental and efficiency improvements for cross-border work commuting.
  - Enhanced travel links for regional shopping, recreation, and tourism.
  - Enhanced regional intermodal connections.
  - Creation of a transportation system reflective of the degree to which the people of this bi-national region cross the border as part of daily life.

- **Cascade Gateway Rail Study.** As roadway congestion worsens on the travel corridor between Seattle, Washington, and Vancouver, British Columbia, interest has grown in improving the corridor's rail systems so that rail can increasingly serve significant shares of passenger and freight travel demand.

  The Cascade Gateway Rail Study's purpose was to identify the freight and passenger rail traffic that could be attracted to the Burlington Northern Santa Fe (BNSF) rail line over the next 10 years. The study then determined the minimum capacity of improvements needed to handle this traffic. As these improvements may require public sector participation, the study quantifies the economic and societal benefits of diversions to rail. There were two secondary purposes of the study: to assess the potential of a cross-border commuter rail service running between Bellingham, Washington, and downtown Vancouver, British Columbia. The other was to assess the potential of a Scott Road Amtrak Station in Surrey, British Columbia.

## 6.4 IMTC INSTITUTIONAL CHALLENGES

This discussion documents institutional issues related to the IMTC region’s ITS border system deployment and bi-national transponder operations and electronic exchange of credentialing information. Frequently, the most complex issues confronting a deployment are not only technical hurdles, but are also the institutional challenges that accompany the deployment. It is crucial for any stakeholder involved to communicate effectively and to reach agreements early in the operational process so that obstacles can be detected quickly, solutions successfully proposed and ultimately administered. The issues the Evaluation Team examined were: Stakeholder Data Privacy;

CBP/CCRA Information Exchange; Transponder Interoperability; Transportation Infrastructure; Security Requirements and Business Impacts. The following presents a summary of each of these areas.

### 6.4.1 Stakeholder Data Privacy

Data privacy is always an issue when information is transmitted between stakeholders, especially when it involves public-private information transfers. Private-sector stakeholders are wary of either private sector competitors or government agencies having access to their sensitive or proprietary information. It is necessary to ensure that only authorized system users have access to information and those users only have access to relevant information pertaining to their involvement with a particular shipment. Obviously, certain stakeholders such as CBP/CCRA personnel have a necessary need to access a wide range of information pertaining to a shipment, but only in as much detail as to enforce national laws and regulations.

A system such as TCOS handles the needed functionality, and provides security while being an intermediary to the public and private IMTC stakeholders. The TCOS registers commercial carriers, shippers, brokers, importers, exporters, and regulatory agencies as trade corridor users. These users go to a single Website to collect information defined by their user role. Users must provide a password to gain secure access to the user’s specified authorized trade corridor information. The key feature here is that users can only access and view the data for which they are authorized. Only U.S. Customs, WSDOT and the system administrator (TransCore) have access to a global view containing container/truck information for each company participating in the system.

### 6.4.2 CBP/CCRA Information Exchange

Based on recent discussions between the United States and Canada, there is expected to be limited exchange of information between CBP and CCRA in the near future. Some of this information will clearly focus on specific trade information exchange. This information could include exchange of NAFTA-based information including audit plans, audit reports, results of advance rulings, and origin determinations. CBP/CCRA have an ongoing relationship to explore other bi-national information-sharing opportunities as well to promote both improved freight and commuter efficiency and security at the border.

As an example of this new bi-national coordination, Free and Secure Trade (FAST) is a joint United States – Canada program that is involving exchange of some information concerning motor carriers, drivers, and importers/exporters between the two countries customs systems which is expected to allow for some marginal level of expedited truck clearance through the booths of both customs agencies at the border. This program is being administered bi-nationally, and can be considered a first small step towards the developing an ITS dedicated truck lane-based system that is highlighted in this report.

The above discussion notwithstanding, there are currently no plans to directly integrate any vital parts of the information systems between CBP and CCRA at this time or in the near future. CBP and CCRA each enforce laws and regulations unique to their nation. Sensitive internal information will not typically be shared between agencies through automated systems.

The United States and Canada are pursuing development of joint facilities along the border. While developing joint facilities has proven difficult due to legal and policy differences between the two nations, the potential benefits to both nations may be significant. Co-location of inspection agencies would allow economies of scale, greater coordination of inspection efforts, and direct on site communication between CBP and CCRA. Moreover, co-location of inspection booths at the border could eliminate the “double stops” that currently occur for trucks in each direction as they have to stop at both countries customs booths when traveling across the border. This would be expected to result in some small amount of travel time delay reduction for trucks carrying freight across the border.

### 6.4.3 Transponder Interoperability

While there is uniformity in transponders for bi-national WIM communication based on the CVISN system, there are still four different variants of the 915-Mhz DSRC-standard transponder protocols in use in the IMTC region.[51] While these systems can typically all read each other’s transponder serial numbers (the hardware is standardized), since they are not identifiable on each other’s systems, the read is meaningless. One of the major problems here is exemplified by the two primary competing national standards for DSRC WIM/CVISN systems – the PrePass pre-clearance system developed by Lockheed Martin and launched in California in 1995[52] and North American Pre-Clearance and Safety System (NORPASS) transponder systems and registration regimes.

PrePass is an open-system that state enforcement agencies can build on their own to operate DSRC technology for WIM and CVISN. However, PrePass is an industry-based system that is sold as a service to states to provide WIM and CVISN functionality for state enforcement agencies. Since PrePass’ business model will not allow it to share data with NORPASS, a truck moving between a PrePass state and a NORPASS state would effectively have to have two transponders installed in the cab if the driver wanted to qualify for a weigh station bypass. Moreover, the two states would not be sharing the WIM information, so the truck would likely have to proceed to the WIM in the second state rather then getting a complete bypass of the weigh station. This creates major inefficiencies in the goal of a national 915-MHz DRSC standard for CVISN/WIM, and effectively makes the overall goal of having industry invest in in-vehicle transponders for trucks (and register them) significantly more difficult.

At the national level, USDOT has been promoting the development of a uniform, national 915-MHz DSRC standard for a number of years. However, even in this case, another portion of the ITS industry is clouding matters further by proposing a completely new and incompatible 5.9-GHz DSRC standard. While this standard would provide telematics-like functionality for transponder-to-roadside communications far in advance of the current 915-MHz DSRC capability, it is viewed by many states as unwelcome at this point in time. This lack of ratification may be based on the understanding that the current 915-MHz DSRC systems are still only partially deployed

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[51] “Puget Sound Regional Intelligent Transportation Systems Integration Strategy”, Puget Sound Regional Council, April 2001.

[52] “PrePass Benefits Carriers, States, “ Modern Bulk Transporter, July 1, 1998.

across the country, and also due to the lack of data exchange between NORPASS, PrePass, and other systems, including some toll roads.

Based on the preceding discussion, while a single national DSRC standard is ideal and should be an ultimate goal, it appears that its integration is unlikely for some time. Again, the primary issue is the need for more uniformity in transponder interoperability to preclude motor carriers from having to equip their vehicles with several transponders, especially as transponder-based services expand in the IMTC.

Once it is viable and accepted bi-nationally, interoperability would allow for the State of Washington, the Insurance Corporation of British Columbia, and other states down the I-5 corridor to California, and eventually to Mexico, to successfully administer large numbers of transponders to the regional trucking fleets. This action will result in improving truck safety by sharing credentialing information electronically, and could eventually provide a whole range of additional value-added services such as travel time estimation and mobile purchasing of fuel and food for the truck driver.

### 6.4.4 Transportation Infrastructure

There is a need for greater resources for transportation infrastructure around United States – Canadian international border crossings. Major international border crossings are decades old and were not designed to handle the current “heavy” volumes of traffic. Border crossings have been largely ignored despite near gridlock occurrences caused by increased traffic. United States and Canadian authorities must work in conjunction with local border municipalities and regional stakeholder organizations on future plans to improve international border crossings and obtain the necessary money to fund those improvements.

Recent efforts by both the United States and Canada focused on garnering more funding directly on targeted international border crossings. In the United States, the TEA-21 Corridor and Borders Program provides funding for the coordinated planning, design, and construction of corridors of national importance, economic growth, and international or interregional trade. This program grants the USDOT with the authority to allocate funding to states and metropolitan planning organizations to spend on corridor transportation improvement projects. IMTC has had success in utilizing TEA-21 funding in a number of the corridor improvement initiatives.

Until recently in Canada, there was very limited funding for highway maintenance and upkeep of border crossings. There are two major funding programs now underway that should aid in long overdue improvements to Canadian transportation infrastructure at and near international border crossings. The Strategic Highway Infrastructure Program (SHIP) instituted by Transport Canada is spending is $100 million across Canada on Border Crossing Transportation Initiatives (BCTI) and ITS deployments with another $500 in supporting highway upgrades.[53] The Border Infrastructure Fund (BIF) is committing $600 million towards infrastructure and ITS technology at the major border crossings between the United States and Canada.[54]

[53] “Border and Access Security Update”, published by the Vancouver Board of Trade, March 12, 2003.
[54] Ibid.

### 6.4.5 Security Requirements and Business Impacts

Following the terrorist attacks of September 11, 2001, all freight shipments coming into the United States have been under dramatically increased scrutiny to ensure national security. In moving towards enhanced security, the CBP has promulgated the need for increased levels of detail of information and longer lead times for private sector entities to provide the information. This is ostensibly to allow more critical cargo screening and earlier intervention. Though the goals of national security need to be met, care must be taken to minimize negative impacts on businesses. An example of the potential impacts to businesses of greater customs requirements can be demonstrated by private sector reaction the proposed “strawman” proposed rule generated by CBP.

Under the Trade Act of 2002, Congress directed U.S. Customs to develop a final rule by September 15, 2003 that would define the parameters for carriers’ transmittal of foreign cargo manifests to CBP electronically before cargo entry into the United States. In response, CBP promulgated a “strawman” proposal requiring the manifests to be transmitted to CBP 4 hours in advance of cargo lading. Industry reaction to the proposal was strongly negative, focusing on the business impacts of disruption in just-in-time logistics and the potential for additional security exposures.

Shippers, consignees, and transportation providers responded that the 4-hour rule does not integrate with business production cycles and operating windows and would create delays and added costs in the shipment of goods. Additionally, the level of detail of information required by CBP is seen as a potential source of leaks of confidential shipment information that can encourage pilferage and security breaches. The proposal also drew strong criticism from motor carriers who invested considerable resources to comply with expedited clearance programs such as the Customs-Trade Partnership Against Terrorism (C-TPAT) and FAST. Under the proposal, the requirements for these carriers would be the same as for carriers not enrolled in the programs.

Due to such widespread criticism, on February 14, 2003, CBP announced that it retracted the proposal. Instead of a tight comment period, followed by closed-door decision-making, it was planned that a new proposal will be drafted with the assistance of an Advisory Committee on Commercial Operations – a group of 20 private-sector business representatives. Critics of the effort are concerned that a reasonable proposal may not be drafted, subjected to review, and finalized by the 15 September 2003 congressional deadline.

Despite the demonstrated tensions between U.S. Customs and industry over the proposed 4-hour rule, in general, industry in Canada has responded well to the C-TPAT program. C-TPAT is a joint government-business initiative to build cooperative relationships that strengthen overall supply chain and border security. C-TPAT requires businesses to ensure the integrity of their security practices and communicate their security guidelines to their business partners within their supply chains. In October 2002, Canadian National (CN) railroad became the first North American railroad to gain membership in C-TPAT.

With regards to land border crossings, Customs will offer potential benefits to C-TPAT members, including:

- A reduced number of inspections (reduced border travel times).
- An assigned account manager.
- Access to the C-TPAT membership list.
- Eligibility for account-based processes (e.g., monthly payments).
- An emphasis on self-policing, not Customs verifications.

In another related program, the U.S. Customs Container Security Initiative (CSI), launched by the CBP in January of 2002, may have an effect on border operations involving intermodal container shipments by truck between the Port of Vancouver and destinations in the United States via the Blaine crossing. The element of CSI relevant to this involves the recent placing of CBP inspectors at the Port of Vancouver to target and pre-screen United States-bound cargo containers before they are shipped by truck to the United States. This can be expected to have the following two effects on operations in the southbound direction at Blaine:

- Allow for improved efficiencies in CBP inspections for trucks carrying intermodal containers that were pre-screened by CBP personnel at the Port of Vancouver.
- Due to pre-screening of the container they are carrying, the potential exists for a truck to get an expedited clearance at the CBP booth at Blaine, thereby reducing travel time.

In addition to the above, the following other security measures have been taken in the past year by CBP and CCRA:

- There are two mobile Vehicle and Cargo Inspection System (VACIS™) (truck-mounted, non-intrusive gamma detection systems) inspection units in operation for Blaine and other regional crossings. An additional unit for rail inspections was recently ordered.
- CBP personnel are being issued personal radiation detectors for use while inspecting vehicles. During the week of June 23, 2003, site surveys are being completed at all four regional ports-of-entry to install portal radiation detectors to scan vehicles for radiation.
- CBP and the INS are now under the Department of Homeland Security. Major changes to what the public sees and experiences are not envisioned.
- Staffing has been a continual problem for both CBP and CCRA. Although CBP did recently open 15 new positions for the region, more manpower is needed. There has been no additional funding set aside for increased staffing at CCRA, although inspection functions have increased.
- CCRA has developed a program similar to CBP' C-TPAT, called the Partnership Information Program (PIP).

- CCRA is consideration the acquisition of a regional SCAN Trader device, similar to the United States' VACIS™ machine. This mobile x-ray machine will be used across the border region in British Columbia as needed.

- CCRA is developing the Integrated Primary Inspection Lane (IPIL), which will link Customs databases, and scan documents into the system.

## 6.5 SUMMARY: IMTC CASE STUDY FINDINGS

The results of this case study case serve as an input or point of discussion to other bi-national stakeholder communities in border regions with significant freight flows along U.S. Canadian border, as well as perhaps analogous stakeholder communities along the U.S.-Mexican border. The major findings of this case study are summarized as follows:

- **The IMTC is a Unique Public-Private Partnership that was Developed as a Direct Response to Regional Border Transportation and Trade Issues.** Formed in 1997, this joint United States – Canadian business and government coalition was created to identify and promote cross border mobility and security for the primary land border crossings linking the British Columbia and Washington State region. The IMTC is composed of over 60 public and private organizations that share concerns with business and traffic mobility issues surrounding the international border crossing between Washington State and British Columbia. The IMTC has also sponsored an number of critical studies in the past five years related to transportation, trade and ITS.

- **The IMTC Provides a Template for the Successful Development of Bi-National Freight ITS Solutions.** The IMTC stands out as a public-private partnership of diverse, bi-national interests, lead by a public agency, responding to local congestion concerns by going after national funds for bi-national transportation funding The IMTC model involves successful interactions with federal, provincial, state and local governments from two countries to fund and deploy major border ITS solutions. The IMTC is regarded in the region as a successful champion for obtaining funding and implementing border ITS projects in response to a broad range of border transportation goals that the ITMC has set for the region.

- **The IMTC is Currently Leading the Development of a First of Its Kind Bi-National Transportation Demand Model.** The "Cascade Gateway Bi-National/Regional Transportation Demand Model" will estimate the demand for the movement of people or goods by mode and time period across the border region. The information generated will be used to assess policy initiatives and support economic analysis of infrastructure alternatives and infrastructure design. This model will be capable of cross-border modeling. This model will represent a unique bi-national approach to assessing border transportation issues, and it builds upon a previous IMTC analysis in 2001 that assessed regional bi-national trade flows.

- **The "TCOS" Border Freight ITS System Has Successfully Responded to Freight Data Privacy Issues.** TCOS provides security while being an intermediary to the public and private IMTC stakeholders. Users must provide a password to gain secure access to the user's specified authorized trade corridor information.

The key feature here is that users can only access and view the data for which they are authorized. Only Customs, WSDOT and TransCore have access to a global view containing freight information for each company using the system; no competitive information can be seen by companies accessing the site.

- **Joint Facilities along the Border May Become a Reality in the Near Future**. While developing joint facilities has proven difficult due to legal and policy differences between the two nations, the potential benefits to both nations may be significant. Co-location of inspection agencies would allow economies of scale, greater coordination of inspection efforts, and direct on site communication between CBP and CCRA. Moreover, co-location of inspection booths at the border could eliminate the “double stops” that currently occur for trucks in each direction as they have to stop at both countries customs booths when traveling across the border.

- **Use of Transponders in the Region Illustrates the National Problem of the Lack of DSRC Standards.** While a single national 915 MHz DSRC standard is ideal and should be an ultimate goal, it appears that not only is integration or NORPASS and PREPASS unlikely in the near-future, but some in industry are moving forward with a proposal for a completely incompatible 5.9 GHz DSRC standard even though the current systems are 915 MHz systems are now just being deployed at a national level for some time. The primary issue as use of transponders expand in the IMTC region is the need for more uniformity in transponder interoperability to preclude motor carriers from having to equip their vehicles with several transponders.

- **911 Has Lead to Development of New Security Systems and Practices for Freight on the Washington State – British Columbia Border.** Following the terrorist attacks of September 11, 2001, all freight shipments coming into the United States have been under dramatically increased scrutiny to ensure national security. In support of this, U.S. Customs, supported by Canada Customs and industry, proceeded with the development a number of new systems and practices, including the C-TPAT program, the Container Security Initiative (CSI), and the FAST program. However, a proposal last Spring that would have required that manifests to be transmitted to CBP 4 hours in advance of cargo lading, created an Industry uproar, as many companies were concerned about the rule’s potentially disruptive impacts to just-in-time logistics regarding regional business-to-business deliveries.

# 7. CONCLUSIONS AND RECOMMENDATIONS

This section presents the conclusions and recommendations developed by the Evaluation Team based on data analyzed and the findings developed over the course of this modeling and analysis evaluation effort. The conclusions highlight "lessons learned" from the presented analyses, and the recommendations provide suggestions to be considered in other relevant border ITS efforts and across other applicable border regions.

Please note that the conclusions presented below in 7.1 are the "major conclusions" of this report. Given the breadth and detail provided in this report, the reader is encouraged to visit the more detailed "findings" of this report, which are presented comprehensively at the conclusions of Sections 3, 4, 5 and 6 of this report.

## 7.1 MAJOR CONCLUSIONS

Following are the conclusions that were developed by the Evaluation Team, organized across the following five categories:

- 7.1.1 Conclusions – Utility of Dedicated ITS Truck Lanes at the Border
- 7.1.2 Conclusions – Utility of Bi-National Virtual Weight Stations
- 7.1.3 Conclusions – Private Sector Benefits
- 7.1.4 Conclusions – Public Sector Benefits
- 7.1.5 Conclusions – Lessons Learned from the IMTC Partnership

### 7.1.1 Conclusions – Utility of Dedicated ITS Truck Lanes at the Border

While the ITS systems necessary for the ***Dedicated ITS truck Lanes*** described in this report are already deployed, the physical infrastructure (i.e., additional lanes and revamped customs booth areas) on both sides that would allow for expedited clearance and travel time reductions to occur are still unfunded by WSDOT and Transport Canada. In response to this, with the support of FHWA, the ITS-JPO and a bi-national consensus of stakeholders involved in this study, it was determined in early 2002 that this evaluation should focus primarily on modeling the corridor benefits associated with future ITS dedicated truck lanes on both sides of the border.

To implement this approach, the Evaluation Team fielded a team of surveyors and collected on-site border operations data for a two-week period in June 2002. Following this, a previously built and validated border travel demand model, SLM-49, was significantly augmented, and then used to model and compare future "with" and "without" Dedicated ITS Truck Lane cases for both directions at the border. These results, along with other corridor ITS inputs, were then applied to a 10-year benefit-cost model, which resulted in a series of findings which lead to a unequivocal conclusion finding regarding the utility of Dedicated ITS Truck Lanes at the border.

This key conclusion, is that even under the most conservative modeling scenario (only 10 percent of trucks with transponders in 2003 growing to 15 percent in 2013), the

Evaluation Team estimated that over the next 10 years, the deployed Dedicated ITS Truck Lanes (including reduced broker stops) would result in a demonstratively impressive benefits stream to the regional economy (through motor carrier travel and operations savings), with discounted benefits growing from $8.6 million in 2003 to $29.3 million in 2013. The primary source for these benefits will be on the southbound approach to the U.S. Customs booths for both ITS and non-ITS-equipped trucks. Benefits for non-ITS commercial vehicles were actually higher then those for ITS commercial vehicles, as non-ITS vehicles benefit significantly from the reduced queues due to the ITS trucks using the Dedicated ITS Truck Lanes – in short, both ITS and non-ITS equipped trucks will see substantial time savings under a deployed Dedicated ITS Truck Lane system at the border.

When compared to the detailed cost estimates that were developed for this report, the Evaluation Team estimated that benefit-cost ratios here for the Dedicated ITS Truck Lanes ranged from approximately 29.1:1 to 42.2:1 (depending on level of ITS market penetration). This is due to relatively low deployment costs, coupled with the very large time savings for both transponder-equipped trucks as well as those without transponders – especially in the southbound direction, as noted above.

Covering the range of the conservative to robust modeling scenarios, the discounted benefits of the Dedicated ITS Truck Lane and the reductions in stops at the brokerage houses, are estimated to be between at: $124.2 and $169.9 million over the next 10 years, and represent by far, the most significant benefits considered in this analysis. Due to the overwhelming proportion of total benefits realized through the border crossing ITS deployments, the corridor-wide combined payback period is 1 year for all three ITS market penetration scenarios.

Based on the significant benefits estimated here, the primary conclusion of this evaluation effort is that the deployment of Dedicated ITS Truck Lanes at the Blaine/ Surrey international border crossing, particularly in the southbound direction through U.S. Customs, is more than justified. With benefit-cost ratios of at least 29 to 1, and payback periods to the regions economy of less than a year, the deployment of this ITS system and operational concept can be defended.

This conclusion is so dramatic that the Evaluation Team believes that it may serve as an input to United States and Canadian efforts to fund the infrastructure portions of the Dedicated ITS Truck Lanes concept in the near future. With the system already up and running, the investment in the infrastructure (additional lanes and new customs booth configurations) on both sides of the border is all that would be required to begin realizing the benefits that have been outlined here.

### 7.1.2 Conclusions– Utility of Bi-National Virtual Weight Stations

In addition to Dedicated ITS Truck Lanes goal, the IMTC has supported the development of a network for assimilating and exchanging information between British Columbia and Washington State motor vehicle enforcement agencies to enable bi-national weigh-in-motion information exchange – referred to here as the ***Bi-National Virtual Weight Station*** operational concept. This bi-national communication sharing permits timely, accurate electronic motor carrier information transfer between the Insurance Corporation of British Columbia (ICBC) and the Washington State Patrol. With this CVISN-based system, both northbound and southbound trucks operating in the IMTC will be monitored for safe and legal compliance, allowing eligible carriers to bypass IMTC corridor weigh stations on both sides of the border. It should be noted that at the time this report is going to publication, the deployment of this operational concept is imminent.

Significant time savings for motor carriers and resource savings for enforcement personnel were estimated in the Evaluation Team's benefit-cost analysis, which was based on statistical weigh station usage data provided by the WSDOT and the ICBC, and focused on 5 weight stations along the IMTC corridor. The analysis showed that discounted travel time savings for motor carriers associated with bypassing weigh stations are expected to be between be between $25.6 and $61.7 million over the next 10 years. The corridor bypass time savings occur as driver/vehicle/shipment are screened initially via electronic means or through physical inspection, then are cleared from further inspections along the corridor through the passing of information to other weigh/inspection sites along the corridor (including bi-national WIM data sharing between Washington and British Columbia), subject to verification via WIM and AVI transponder technologies.

Additionally, for the enforcement agencies, safety benefits were also estimated by the based on the expected refocusing of enforcement activities on the inspection of non-electronically screened (transponder-equipped) vehicles – this would be expected since resource efficiencies to the agencies would be realized through the elimination of "double weigh-ins" of "safe and legal" trucks along the IMTC corridor, allowing additional resources to be focused on non-ITS trucks, and especially carriers considered "high risk." Based on this, the discounted safety benefits associated with this operational concept are estimated to be between $21.1 and $50.9 million over the next 10 years. These benefits were estimated using three key inputs from federal and state sources.

Overall, the weigh station ITS deployments showed lower overall returns and higher investment costs than for Dedicated ITS Truck Lanes. Nevertheless, the weigh station ITS deployments still showed significantly positive benefit-cost ratios ranging from 4.0:1 to 8.5:1, again related to the overall level of ITS participation. The discounted benefits for the weigh station ITS deployments range from approximately $35 to $102 million, moving from low to high ITS scenarios.

The payback of investment for the weigh station ITS deployments requires longer time periods and are more ITS participation rate-sensitive than for the border crossing ITS deployments. This is because of the greater first cost requirements for the weigh stations and a benefit stream dependent only upon time savings realized by transponder-equipped trucks. The estimated payback periods for the weigh station ITS deployments are 2 years for the low and medium ITS scenarios, and 1 year for the high ITS scenario.

The preceding discussion highlights the benefits of employment of a ***Virtual Weigh Station*** operational concept in a bi-national border region. With conservative benefit-cost ratios above 4 to 1, payback periods of less than 2 years, and safety benefits to the traveling public, the conclusion of the Evaluation Team is that this operational concept will provide significant utility to motor carriers, enforcement agencies and the traveling public in U.S. Canadian border regions. As this technology is currently just being deployed, it will be interesting to examine how this concept is actually deployed in the field, and if the benefits estimated in this evaluation study can be validated.

### 7.1.3 Conclusions – Private Sector Benefits

Private sector benefits were overwhelmingly positive for the corridor ITS freight deployments modeled in this effort! This analysis concludes that motor carriers will realize net positive returns on ITS participation almost immediately. The private-sector net discounted benefits accrue concurrent with the costs of ITS deployment and given the relatively small costs of participation with the large travel time benefits, it is seen that throughout the study horizon, benefits exceed costs. Therefore, private sector breakeven is immediate for all ITS deployment scenarios.

To illustrate this better, the Evaluation Team examined the case for a typical mid-size trucking company involved in daily drayage moves across the border. For this company, with an initial investment of $550 for transponders to equip a fleet of 11 trucks, the benefit-cost analysis showed that for a benefit of over $12,000 per year in travel time savings could be expected due to the use of the dedicated ITS truck lanes at the border and through weigh station bypass events. Here, this trucking company *would reach a financial breakeven point for its fleet in less than a week*!

Administrative benefits to the private sector were also estimated by the Evaluation Team. The discounted administrative time savings benefits over 10 years is estimated to be $8 million for customs brokers, $2.3 million for shippers, and $2.2 million for motor carriers. Using simulation, overall potential time savings of 35 to 37 percent were estimated. Using prevailing wage rates for clerical staff, the per-transaction cost savings were estimated at $0.30 for shippers, $0.28 for motor carriers, and $1.03 for customs brokers. Though these savings may seem relatively small, given projected levels of approximately 795,000 and 1,420,000 annual transactions for the Base Year and Year 10, the administrative savings become significant.

Based on the preceding, it is the conclusion of the Evaluation Team that the benefits to deploying the Dedicated ITS Truck Lanes and the Virtual Weigh-in-Motion systems will result in almost immediate savings to the private sector, particularly motor carriers. The benefit-cost estimates for industry are so overwhelmingly positive, that the Team believes that the results highlighted here may be instrumental in assisting the IMTC public and private partners in administering increasing numbers of transponders to motor carriers in the region. Furthermore, the results here also point the way for other United States – Canadian border regions to move forward with analogous systems to improve the economic competitiveness of their freight industries.

### 7.1.4 Conclusions – Public Sector Benefits

While not providing the dramatic results seen for the private sector above, public sector benefits were estimated by the Evaluation Team to be greater than costs, even in the most conservative modeling scenarios. Public-sector costs involve ITS deployment infrastructure at the border crossing and weigh stations, while benefits accrue to the public sector through enhanced motor carrier safety enforcement and improved air quality impacts. The estimated public-sector benefit-cost ratios range from 1.6:1 to 4.4:1, moving from low to high ITS deployment scenarios.

Overall, the public sector will expend a relatively large proportion of deployment costs initially, with benefits accruing modestly over the study horizon. The level of public ITS benefits accrued over time is directly proportional to the private sector ITS participation rates. It is estimated that public sector payback periods are 6 years, 5 years, and 3 years, respectively, for the low, medium, and high ITS deployment scenarios.

The costs burden for the public sector for the Dedicated ITS Truck lanes (and associated systems) on both sides of border are estimated at approximately $10.8 million in current year dollars. Of this amount, $3.3 million represents ITS deployment at the north/southbound border crossing at Blaine and supporting ITS deployment at the APL intermodal facility. Of this $3.3 million, approximately $2.6 million are estimated costs for construction of dedicated ITS truck lanes in the north- and south-bound directions. Of the remaining $0.7 million, approximately $532K represents the costs of: site-specific systems engineering and system installation; AVI readers and supporting hardware; communications links; and computer system hardware and software. Transcore software enhancements account for the remaining $170K. Additionally, ITS deployments at four weigh/inspection stations in Washington State, and one in British Columbia are estimated to cost $7.5 million to deploy. Recurring costs are estimated to be $.14 million per year at the border facilities, and $0.19 million per year at the weigh stations.

In addition to the public sector safety benefits associated with the Virtual Weigh Station operational concept detailed above in Section 7.1.2, benefits associated with air quality improvements for the public sector associated with the ITS systems were also estimated by the Evaluation Team. Here, air quality benefits arise from reductions in truck idling times at the border crossings and the weigh stations were expressed in terms of avoided heath costs associated with diesel truck exhaust. Based on this, the discounted air quality public benefits of the ITS deployments are estimated to be between $1.6 and $2.5 million over the next 10 years. The border-crossing share of these benefits ranges from 65 to 80 percent (high to low deployment scenario).

Given the results shown above, even in the absence of the overwhelmingly positive results for the private sector detailed above, the deployments of these freight ITS technologies can still be justified given the most conservative modeling scenario estimate which showed a *public investment break-even point of 6 years*. However, when the public sector does examines the significant private sector benefits that would result from these deployments in combination with their own benefits, a very compelling case can be made for the public sector to move forward with the deployment of the Dedicated ITS Truck Lanes and Bi-National Virtual Weigh Station operational concepts.

### 7.1.5 Conclusions – Lessons Learned from the IMTC Partnership

The Evaluation Team has concluded that the IMTC public-private partnership provides an international model for development of freight border ITS projects across international borders. The IMTC structure, functions, processes and real-world ITS deployment results to date can serve as an input or point of discussion to other bi-national stakeholder communities in border regions with significant freight flows along United States - Canadian border, as well as perhaps analogous stakeholder communities along the United States - Mexican border. The IMTC stands out as a public-private partnership of diverse, bi-national interests, lead by a public agency, responding to local congestion concerns by going after national funds for bi-national transportation funding. The IMTC model involves successful interactions with federal, provincial, state, and local governments from two countries to fund and deploy major border ITS solutions. The IMTC is regarded in the region as a successful champion for obtaining funding and implementing border ITS projects in response to a broad range of border transportation goals that the ITMC has set for the region.

For the IMTC Phase II deployment assessed in this report, the IMTC and project stakeholders successfully addressed a concern related to the freight data privacy of this system. The "TCOS" Border Freight ITS System provides security while being an intermediary to the public and private IMTC stakeholders. Users must provide a password to gain secure access to the user's specified authorized trade corridor information. The key feature here is that users can only access and view the data for which they are authorized. Only Customs, WSDOT, and TransCore have access to a global view containing freight information for each company using the system; no competitive information can be seen by companies accessing the site.

The IMTC partnership has also facilitated open discussions between the customs agencies of the United States and Canada at the Blaine/Surrey international crossing. These discussions, as well as discussions at the national-level of both countries, may lead to joint facilities being deployed at the border in the near future. Co-location of inspection agencies would allow economies of scale, greater coordination of inspection efforts, and direct on site communication between CBP and CCRA. Moreover, co-location of inspection booths at the border could eliminate the "double stops" that currently occur for trucks in each direction as they have to stop at both countries customs booths when traveling across the border.

A number of the IMTC public and private partners have been involved and have supported the new security focus on border freight movements since 9-11. Following the terrorist attacks of September 11, 2001, all freight shipments coming into the United States have been under dramatically increased scrutiny to ensure national security. In support of this, U.S. Customs, supported by Canada Customs and industry, proceeded with the development a number of new systems and practices, including the C-TPAT program, the Container Security Initiative (CSI), and the FAST program. However, a proposal last Spring that would have required that manifests to be transmitted to CBP 4 hours in advance of cargo lading, created an Industry uproar, as many companies were concerned about the rule's potentially disruptive impacts to just-in-time logistics regarding regional business-to-business deliveries.

Finally, one area in the IMTC region, as well as in North America, where progress is not being made involves the lack of DSRC transponder standards. While a single national 915-MHz DSRC standard is ideal and should be an ultimate goal, it appears that not only is integration or NORPASS and PREPASS (both CVISN-compliant systems) unlikely in the near-future, but some in industry are moving forward with a proposal for a completely incompatible 5.9-GHz DSRC standard, even as current 915-MHz systems are now just being deployed fully at a national level. The primary issue as use of transponders expand in the IMTC region is the need for more uniformity in transponder interoperability to preclude motor carriers from having to equip their vehicles with several transponders.

## 7.3 RECOMMENDATIONS

Shown below are the five primary recommendations that the SAIC Evaluation Team is offering to USDOT, Transport Canada, WSDOT, British Columbia, the IMTC partnership, and others in government and industry to consider based on the conclusions obtained in conducting this evaluation.

1) **The United States and Canadian Federal and State/Provincial Governments Should Move Forward with the Deployment of Dedicated ITS Truck Lanes at the Blaine/Surrey International Border Crossing.** The benefit-cost analysis for this system conducted by the Evaluation Team provided overwhelming justification for the deployment of this system. While private sector benefits far outstripped public sector benefits, the payback time for public benefits only for public investment was still only 6 years even under the most conservative benefit-cost modeling scenario. Given these results, WSDOT, FHWA, and Transport Canada, may want to consider partnering to fund and construct the physical infrastructure (i.e., additional lanes and revamped customs booth areas) on both sides that would allow for expedited clearance and travel time reductions to occur. ***The ITS border systems to make this operational concept a reality are already deployed – it is now up to government bodies to complete the job and build the infrastructure which will allow the benefits developed in this report to be realized by both the private and public sectors***.

2) **The United States and Canadian Federal and State/Provincial Governments Should Move Forward with the Deployment of Bi-National Virtual Weight Stations.** The benefit-cost analysis for this system conducted by the Evaluation Team provided sound justification for the deployment of these systems. With conservative benefit-cost ratios above 4 to 1, payback periods of less than 2 years, and safety benefits to the traveling public, deployment of these technologies will provide significant utility to motor carriers, enforcement agencies, and the traveling public in the IMTC border region.

3) **The IMTC, WSDOT, and British Columbia Should Consider Developing a Marketing Program to Demonstrate the Potential Benefits Here to the Private Sector to Encourage Increased Usage of These ITS Technologies.** The benefits estimated by the Evaluation Team in this report of adopting these ITS systems for the private sector are enormous. The investment required for motor carriers to participate is almost negligible given the near immediate benefits they will receive. And all stakeholders in the supply chain will benefit from travel time savings and administrative efficiencies enabled directly or indirectly from ITS. The private sector must be made aware of these benefits through educational outreach directly through government channels or from organizations such as the IMTC. ***As the private sector at the Blaine/Surrey crossing embraces border freight ITS technology, this will help to spur on private sector interest and participation in freight ITS border systems in other U.S. border regions with both Canada and Mexico.***

4) **Apply the Benefit-Cost Analysis Methodology Developed Here to Additional International Border Crossings and Trade Corridors Where Border Freight ITS Solutions have been Proposed.** Where freight ITS solutions are being proposed, the benefit-cost methodology and the border transportation demand

model developed in this effort for the IMTC Blaine/Surrey international border crossing should be applied at other major international border crossings and adjacent trade corridors on both the United States – Canadian and United States – Mexican borders. Individual benefit-cost studies at other border crossing sites and trade corridors should be used to validate future freight ITS and supporting infrastructure deployment, while tailoring planning efforts to regional transportation and economic demands.

5) **Within the Current E-Seal Phase II Evaluation, Expand the Evaluation Results Developed Here to a Larger Corridor Benefits Assessment to Include International Container Movement through Supply Chains.** The E-seal Phase II Evaluation, which recently began, will be evaluating technologies similar to those tested in the initial electronic seal deployment, and also incorporating the border ITS systems detailed in this report. This FOT will explore international end-to-end container flows, oriented toward the development of an integrated security system, of which the E-seal is just one element. The overall objective will be to evaluate the ability of a technology to both increase the security of container movements and improve the documentation and processing of intermodal freight. As such, the SAIC Evaluation Team involved in that project should consider using the benefits estimation tools and results from this project as a major input, with a potential goal being the expansion of this benefits assessment approach to incorporate international container movements from points of origin overseas.

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# APPENDIX:

# Evaluation Modeling Report

This report, which provides the details of the border transportation modeling effort, was performed by TSi Consultants for SAIC in support of this evaluation effort. It has been provided as a separate stand-alone document.

# Washington State – British Columbia
# International Mobility and Trade Corridor (IMTC)
# ITS – CVO Border Crossing Deployment
# Evaluation Final Report

## APPENDIX
## EVALUATION MODELING REPORT:
### Pacific Highway Crossing – ITS Deployment Evaluation

## (TSi Consultants Final Report)

*Final Report*
*July*
*2003*


*Prepared for:*

SAIC

*Prepared by:*

TSi consultants

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## Table of Contents

## LIST OF EXHIBITS

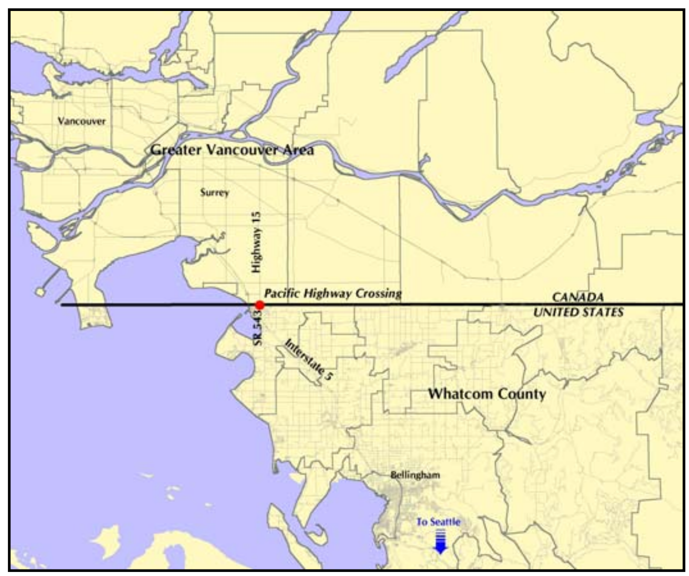
# 1.0 Introduction

## 1.1 Context

The United States Pacific Northwest economy is becoming increasingly engaged with trading partners within Canada/British Columbia. Ports of Entry between Washington and British Columbia and en-route truck inspection sites are important points in the gateway logistics chain that serves the movement of commodities between these trading partners. The ability to efficiently and reliably handle commodities at these points, and in particular the U.S/Canada border, is critical to sustaining and enhancingthe reinforcement of the Pacific Northwest's position in an increasingly increasingly global logistics and competitive international marketplace.


Over 1.2 million commercial vehicles crossed the international border between Whatcom County (Washington State) and the Greater Vancouver area (British Columbia) in 1999 and 2000. This constitutes an increase of almost 100% since 1991, and converts to an annual growth rate of approximately 8%year. Close to 75% of the commercial vehicle demand at the border are processed at the Pacific Highway Crossing located at Blaine, Washington and Surrey, British Columbia **(Exhibit 1.1).** This border crossing carried close to one million commercial vehicles in the year 2000, and is the fourth busiest commercial vehicle crossing along the U.S./Canada border.

**Exhibit 1.1 – Study Area**




## 1.2 Logistics Supply Chain Costs

Commercial vehicle demand at the border decreased from year 2000 levels in the wake of the incidents of September 11, 2001. However, commercial vehicle operations at Pacific Highway Crossing are still characterized by long waits. Congestion experienced by these commercial vehicles increases transportation costs and the price of goods. Unpredictable travel times affect the ability to meet 'time critical' or 'time definite' deadlines, and incur additional lost opportunity costs for suppliers and manufacturers throughout the logistics chain.

United States and Canadian government authorities are investigating methods to improve the level of service for commercial vehicle clearance operations at Pacific Highway Crossing and truck inspection sites. One solution being proposed is the introduction of ITS measures and complementary dedicated traffic lanes that would enable commercial vehicles carrying electronically pre-approved commodities and/or commercial vehicle drivers expedited access through the border and by truck inspection sites.

### 1.3 Scope of Work and Methodology

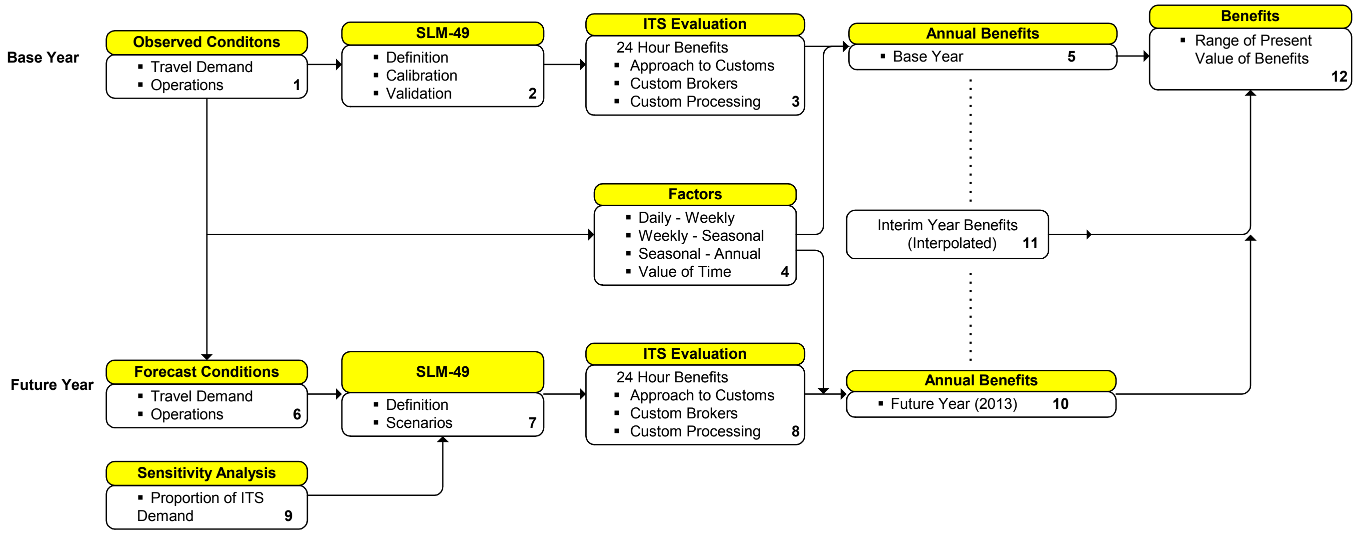
This report provides an analysis of the commercial vehicle border operations benefits of such ITS deployment at Pacific Highway Crossing. The evaluation is based upon an empirical analysis of border operations as observed during a border operations survey, and application of a sketch planning Strategic Logistics Model (SLM-49) that was developed specifically for this study. SLM-49 was developed such that it isolated three primary components of border operations travel time cost including the time on the approach to the customs booth, customs broker related time and customs booth related time. This evaluation is part of a larger comprehensive evaluation of the proposed ITS deployment.

Looking southbound at Pacific Highway Border Crossing (prior to new gravel parking lot).

This component of the ITS evaluation methodology is presented in **Exhibit 1.2.** In summary, the travel time benefits of ITS deployment were estimated using SLM-49 which was developed and validated using empirical observations from the border operations survey conducted in June, 2002. This model was developed for the base year and, as benefits of ITS deployment and infrastructure can be expected to accrue into the future towards a reasonable life of the project, for future year 2013.

Daily benefits for the base and future year were estimated through application of SLM-49, factored to annual benefits based upon relationships derived from observed data and converted to a monetary value using assumed values of time. The benefits for the present and future years were converted to present value, and served as input into the overall study benefit/cost analysis. The sensitivity of the commercial vehicle border operations benefits to realistic ITS demand scenarios was evaluated, thus presenting a range of estimated benefits.

## Exhibit 1.2 – ITS Evaluation Methodology




## 1.4 Report Organization

**Section 2** of this report provides an overview of commercial vehicle clearance operations at Pacific Highway Crossing, and summarizes the border operations survey. **Section 3** describes the development of border operations models within SLM-49, and provides an estimate of base year border operations costs. Forecast year 2013 demand and commensurate border operations and costs are given in **Section 4.** Estimated commercial vehicle border operations benefits related to ITS deployment are provided in **Section 5.** Finally, **Section 6** contains salient study conclusions.

Northbound at Pacific Highway Border Crossing. Top: I-5. Bottom: CCRA Booths

# 2.0 Pacific Highway Commercial Vehicle Border Operations Survey

In support of the benefits analysis of ITS deployment, a detailed survey of border operations at the Pacific Highway Crossing was conducted in June, 2002. The primary purposes of the survey were to acquire a comprehensive understanding of operating conditions, and to gather data required to develop and validate the Strategic Logistics Model (SLM-49). This section presents the salient features of commercial vehicle clearance operations, and to summarize relevant survey results.

The first part of this section describes commercial vehicle operations in both the southbound and northbound direction at the Pacific Highway Crossing. The second part of this section provides an overview of the border operations survey and data collection efforts. The final parts of this section present summary results from the border operations survey by direction.

## 2.1 Commercial Vehicle Clearance Operations

The existing operations for southbound and northbound commercial vehicles at the Pacific Highway Crossing are described in **Exhibits 2.1 and 2.2.** Please note that these exhibits show border facilities prior to reconstruction of the U.S. Customs operations and the introduction of a new holding area in the southbound direction. The new gravel parking lot has provided some relief to southbound congestion as commercial vehicles that require customs broker processing no longer park directly on Highway 15. Consequently, trucks now line up in only the outside lane.

Southbound at Pacific Highway Border Crossing (prior to new gravel parking lot). Top: U.S. Customs. Middle: Duty Free Shop

It is noteworthy that the clearance operations differ between U.S. and Canadian Customs approaches. In the southbound direction, commercial vehicles that have shipments pre-approved (i.e. precleared commercial vehicles) are separated from those that require processing with customs brokers prior to proceeding to the customs booths (non-precleared commercial vehicles). Three commercial vehicle staging areas, including a relatively new gravel staging area, are identified as Staging Areas A–C in **Exhibit 2.1.** Commercial vehicles that are parked in Staging Area C, the duty free commercial vehicle parking lot, can be parked there in order to shop at the duty free, visit the customs brokers, or both. Commercial vehicle drivers walk from the staging areas to customs brokers located on the south side of the border.

In the northbound direction, all commercial vehicles wait in the queue on the approach to the Canada Customs and Revenue Agency (CCRA) booths. Commercial vehicles that require processing by customs brokers or are referred for a secondary inspection are directed to a holding area after passing through the Canada Customs. They exit the holding area via an automated customs booth.

## Southbound Commercial Vehicle Operations

1) Commercial vehicles enter survey area – one dedicated truck lane. The northern limit of the study area was defined by 8th Avenue, approximately 1mile (1.6 kilometres) north of the border.

2) Commercial Vehicles have option to:

   i) If pre-cleared, continue to U.S. Customs booth. If an extensive queue exists, truck passengers have been known to walk from point 1 (or north) to customs brokers, thereby precluding the requirement to park in a staging area, and permitting the truck to stay in the through lane.

   ii) Use Duty Free parking entrance for access to: a) Duty Free commercial vehicle parking area (C); or b) new gravel staging area (A).

*Note: Commercial vehicles are required to wait in the truck lane until the Duty Free entrance. Those that try to jump the queue (using a passenger vehicle lane) in order to gain access to the Duty Free are waived through by a Duty Free attendant, and may have difficulty accessing Staging Area B.*

3) Access to Staging Area A or B – From this point truck drivers walk across the border to have shipments processed by customs brokers. Trucks with pre-approved cargo continue in one lane towards U.S. Customs booths.

4) Commercial vehicles that used the staging area re-enter queue on approach to booth. A second lane (right hand lane - RHL) begins at the egress of staging area B.

*Note: A) Queues build up into the staging area. Commercial vehicles park and re-enter traffic stream at various places.*

*B) If pre-cleared commercial vehicles are present, the trucks leaving the staging area are generally confined to the RHL on the approach to booths.*

5) Customs Booths – Generally two of three booths are open after 8:00 AM. If sufficient demand is present, line-release trucks use LHL; In other words, trucks that use Staging Areas A – C use RHL unless capacity is available in the LHL.

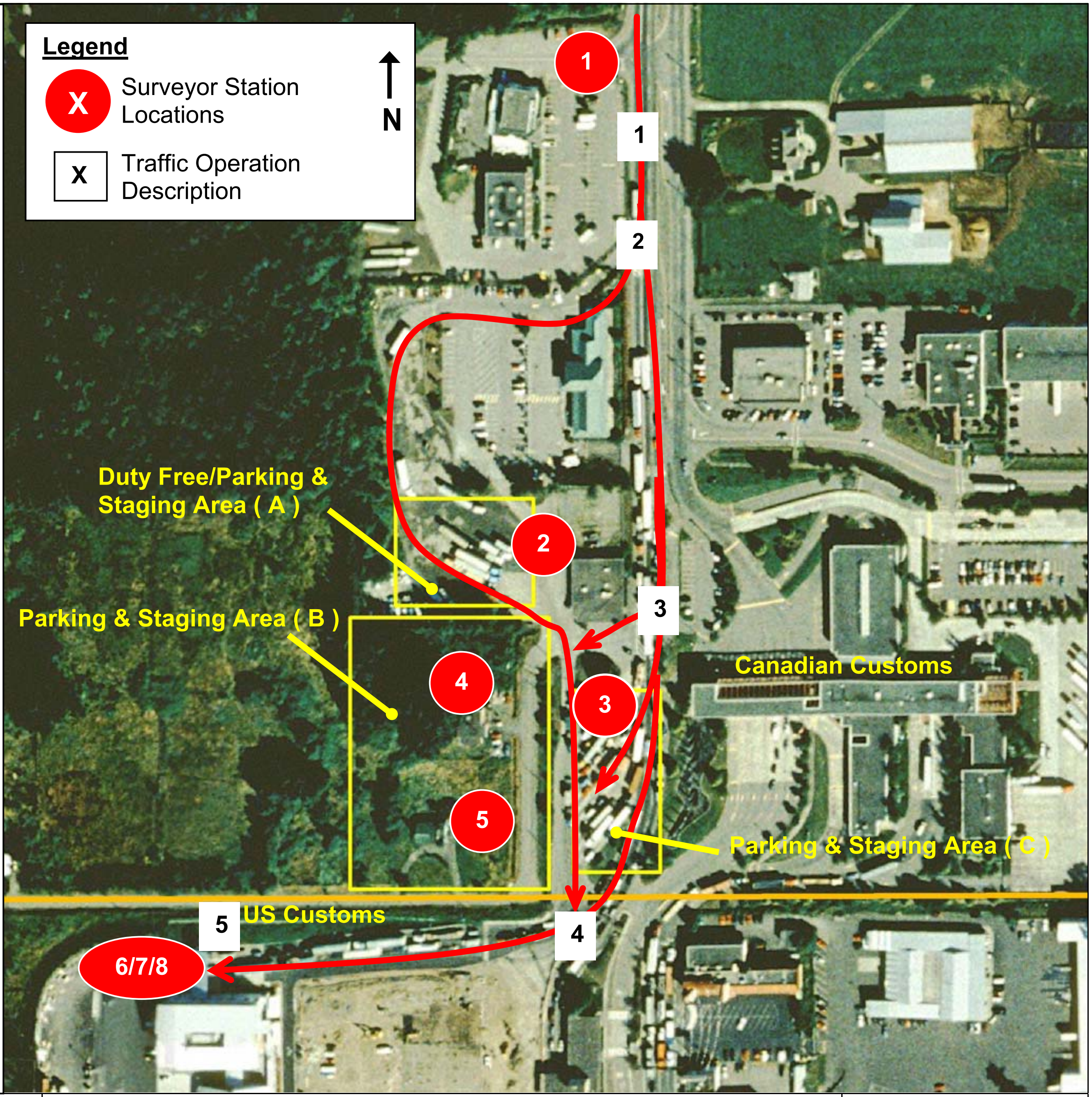





**Exhibit 2.1 – Existing Southbound Commercial Vehicle Operations – Pacific Highway Crossing**

**Northbound Commercial Vehicle Operations**

1) Commercial vehicles enter survey area – The RHL is dedicated lane for commercial vehicles on SR 543. Passenger vehicles have dedicated LHL. The southern limit of the study area was defined by Boblett Street (Near I-5).

2) Commercial vehicles have option to:

   i) Continue NB to booth.

   ii) Pullout to truck parking lot approx. 300 – 600 m south of NB Duty Free.

3) Pre-cleared and non-precleared commercial vehicles continue in towards booths on the east side of the Canada Customs building.

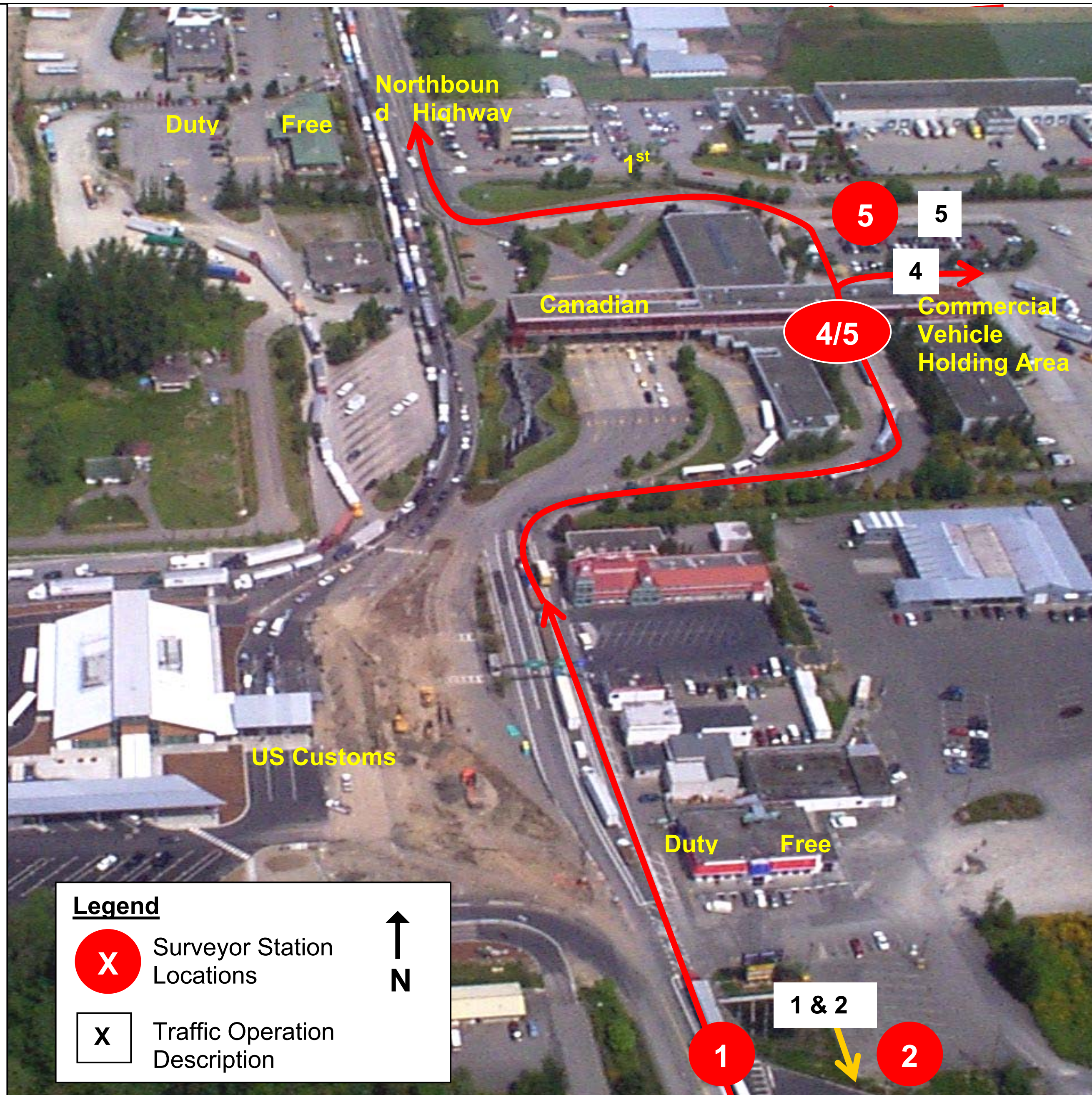
4) Commercial vehicles have two options at Canada Customs booths:

   i) Pre-cleared vehicles continue northbound on Highway 15.

   ii) Non-precleared commercial vehicles or those referred for a secondary inspection access CCRA holding area.

*Note: the number of open CCRA booths varies by demand and time of day.*

5) Commercial vehicles exit Canada Customs holding area via an automated customs booth.



## 2.2 Survey Methodology

The survey methodology was primarily developed to capture travel time by major segment from the moment a commercial vehicle entered the study area to the completion of primary inspection at a customs booth. Please note that detail survey methodology is located in **Appendix A**. The surveyor station locations are identified by red circles in **Exhibits 2.1** and **2.2.** In order to ensure a precise timestamp for every recorded vehicle at each station, reduce recording errors and produce timely databases and results, data was collected using a personal digital assistant (PDA). All PDA's were synchronized to ensure data consistency. Data was collected over a four day period in each direction.

Essential survey tools.

The primary items of data collected at all stations included the license plate and a timestamp for each observation. This enabled tracking each commercial vehicle through the border operations process at major decision points from the time it entered a queue to its departure from the primary inspection booth.

In addition to license plate data, the following data were also collected:

- Vehicle classification collected at the customs booths. These included passenger vehicles (that proceeded through the commercial vehicle clearance operations), light trucks and various combinations of heavy trucks;
- Empty trucks could be identified at the US Customs booths as they generally were expected to pull forward for a brief inspection at the booth prior to release. These trucks were recorded using the PDAs. In the northbound direction, CCRA officials recorded the number of empty trucks using a tally sheet on a 30 minute basis; and,
- Length of queue along Pacific Highway and SR 543.

TSi staff train surveyors on surveyor roles and use of PDA.

After a series of data and logic checks, the records at each individual station were aggregated into a master table. The number of commercial vehicles processed at the Customs booth served as a control for the master table, and the 'hit rate' for aggregation of individual station tables to the master table was between 90 to 95 percent.

## 2.3 Southbound Survey Results

The southbound direction was surveyed between Monday June 10$^{th}$ and Thursday June 14$^{th}$, 2002. Note that anecdotal discussions with customs staff and truckers during this time indicated that travel time and queueing on the final two days of the survey were unusually light.

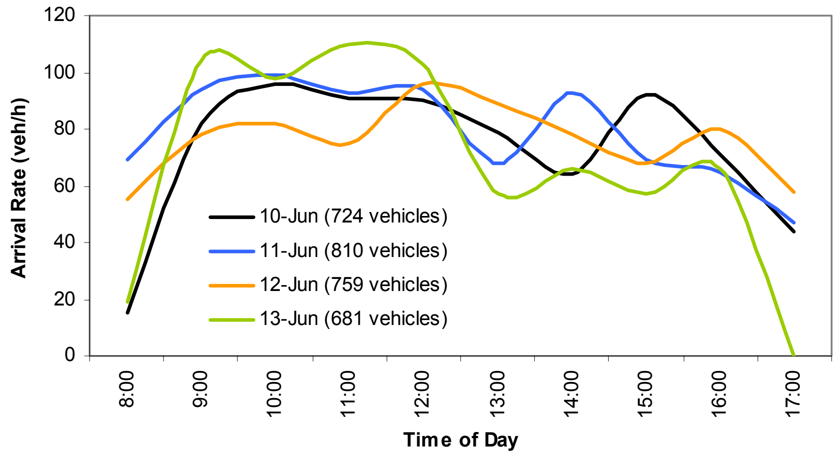
*Commercial Vehicle Arrival Rates*

Southbound commercial vehicle arrival rates observed during the survey are illustrated in **Exhibit 2.3.** The variation in demand, not only in total but also in distribution profile throughout the day is noteworthy. During this survey period, it appears that demand per hour peaked during the morning period. However, there does not seem to be a pattern of arrivals between days.

Southbound on Highway 15, Pacific Highway Crossing.

Surveyors at morning meeting place just north of the southbound duty free store.

### Exhibit 2.3 – Southbound Commercial Vehicle Arrival Rates (8:00 AM to 5:00 PM)




*Fleet Composition*

The total number of southbound vehicles surveyed and their vehicle type composition are provided in **Exhibit 2.4.** The average volume during the survey period was 744 commercial vehicles, where the heaviest volume was experienced on Tuesday and Wednesday, June 12$^{th}$ and 13$^{th}$.

### Exhibit 2.4 – Southbound Fleet Composition

| Date | VEHICLE TYPE | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | HEAVY TRUCKS | | | | | |
| | Passenger Vehicles | Light Trucks | Single Unit | Truck / Trailer Combo | Tractor | Tractor/Trailer Combo | Tractor / Container Combo | |
| **10-Jun-02** | 16% | 10% | 1% | 0% | 3% | 59% | 9% | 724 |
| **11-Jun-02** | 18% | 13% | 2% | 4% | 1% | 56% | 7% | 810 |
| **12-Jun-02** | 14% | 13% | 2% | 7% | 1% | 55% | 7% | 759 |
| **13-Jun-02** | 18% | 11% | 1% | 7% | 2% | 51% | 8% | 681 |
| **Average** | 17% | 12% | 2% | 5% | 2% | 55% | 8% | 744 |

The fleet composition was fairly consistent between the surveyed days[1]. Notable statistics include:

- Approximately 17 percent of vehicles processed through the commercial vehicle clearance operations are passenger vehicles. Some of these vehicles may be related to export activities;
- Approximatley 12 percent of commercial vehicles are light trucks;
- The remaining 72% of commercial vehicles are heavy trucks;

[1] *Passenger vehicles were not surveyed as they entered the study area. Unless otherwise noted, further statistics regarding the commercial vehicle fleet and clearance travel time do not include passenger vehicle records.*

- Approximately 2% of commercial vehicles are tractors without a trailer or container. These vehicles likely originate south of the border, and are 'bobtailing' after delivering a trailer or container in Canada; and,
- Approximately 8% of total vehicles carry a container. This percentage is approximately half of northbound percentage.

Looking southbound on Highway 15 from 8th Avenue. The U.S. – Canada border is approximately 1 mile. On a typical summer weekday truck traffic can be expected to backup to this point.

*Vehicle Operating Characteristics*

**Exhibit 2.5** provides the southbound vehicle operating characteristics. Approximately 10 percent of commercial vehicles were empty, and approximately 45 percent were carrying a commodity and pre-cleared. Non-precleared vehicles were defined as those that stopped at holding areas A–C, and also comprised of approximately 45 percent of demand. This is considerably higher than the northbound direction (18 percent).

**Exhibit 2.5 – Southbound Vehicle Operating Characteristics**

| Date | Empty | Precleared | Non-precleared |
|---|---|---|---|
| 10-Jun | 15% | 41% | 44% |
| 11-Jun | 7% | 44% | 49% |
| 12-Jun | 5% | 48% | 47% |
| 13-Jun | 13% | 47% | 40% |
| Avg. | 10% | 45% | 45% |

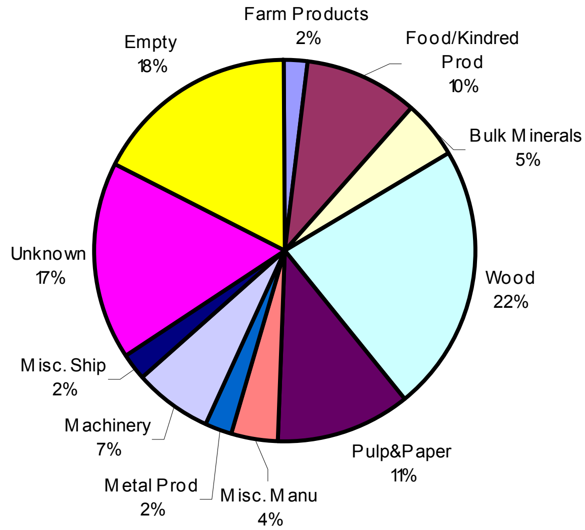
**Exhibit 2.6** presents commodity flow information captured from the IMTC Cross-border Trade and Trade Survey (2000). **Exhibit 2.6** illustrates the types of industries on the logistics supply chain that are influenced by congestion at the Pacific Highway border crossing. The predominant industry were related to wood, pulp and paper. During this survey approximately 18 percent of southbound commercial vehicles were empty. This percent approaches that experienced on the first day of the June 2002 border operations survey.



Southbound Duty Free Commercial Vehicle Staging Area (A) Entrance.

Rover records a southbound commercial vehicle.

**Exhibit 2.6 – Summer Pacific Highway Southbound AADT Commodity Flow Characteristics**




*Customs Broker Related Time*

As noted earlier, commercial vehicle drivers required to personally visit a customs broker generally park in any of the three holding areas, and walk across the border to the customs broker offices. This time was explicitly recorded during the survey, and average travel statistics over the four days are presented in **Exhibit 2.7.**

Looking southbound at staging areas C (left) and B (center). U.S. Customs in center background.

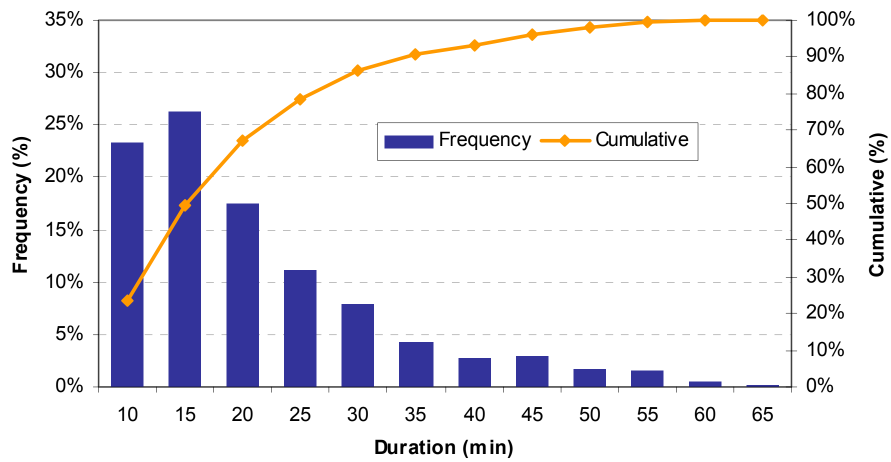
**Exhibit 2.7 – Average Customs Broker Related Time**

| Date | Average Time (min) |
|---|---|
| 10-Jun | 17 |
| 11-Jun | 20 |
| 12-Jun | 18 |
| 13-Jun | 18 |
| Average | 18 |

The average customs broker related time was relatively consistent between the two days, and did not show a pattern by time of day. A frequency histogram of the customs broker related time constructed from all four days of data is given in **Exhibit 2.8.**

Recording entries in staging area C.

**Exhibit 2.8 – Frequency Histogram of Customs Broker Related Time**



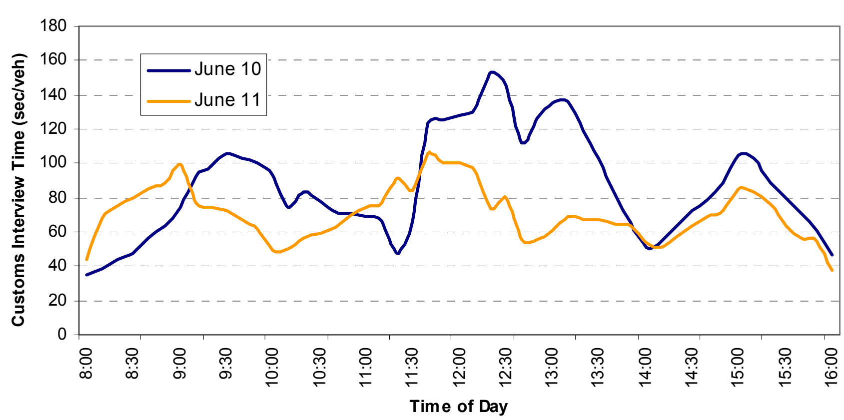

### *Customs Booth Related Time*

Customs booth related time consists of interview time with the customs official, and vehicle transit time from the stop position to the to the customs booth. On these days, customs booth interview time generally ranged between 50 to 100 seconds per vehicle (36 to 72 vehicles per hour per booth). **Exhibit 2.9** illustrates the observed processing time throughout the first two days of the survey. This demonstrates that there does not appear to be a regular pattern throughout or between days. The other two days are consistent with this conclusion, but have not been included as they may make the graph more difficult to follow.

The random pattern of customs booth related time is amplified by occasional interviews which can take over 5 minutes (one incident on June 10$^{th}$ at noon); and more frequently others that consume approximately 3 minutes. These interviews can influence queue length approaching to the customs booths.

U.S Customs commercial vehicle primary inspection booths at Pacific Highway Crossing.

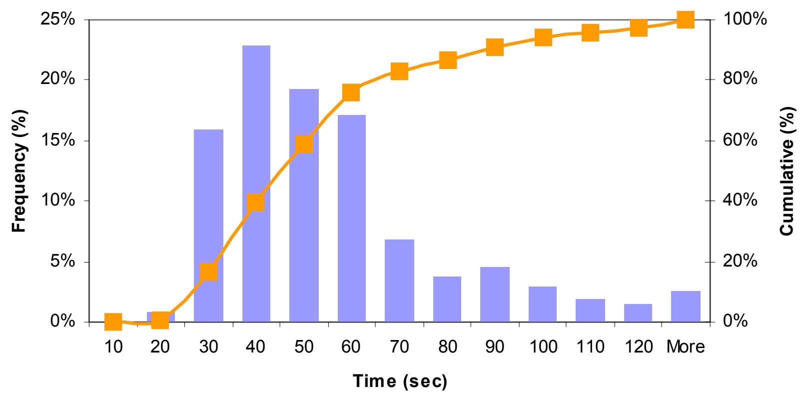
**Exhibit 2.9 – Southbound Customs Booth Interview Time on June 10$^{th}$ and June 11$^{th}$ (8:00 AM to 4:00 PM)**



U.S Customs commercial vehicle primary inspection booths at Pacific Highway Crossing.

A frequency distribution of the customs booth interview time complied over the four days is given in **Exhibit 2.10.** Over the four days, customs booth interview time generally ranged between 30 to 70 seconds per vehicle, and the average customs booth interview time was 57 seconds per vehicle. Approximately 3 percent of customs booth interviews exceeded 2 minutes. The maximum observed during the four day survey period was 510 seconds, or 8.5 minutes.

**Exhibit 2.10 – Frequency Distribution of Customs Booth Interview Time**




The average customs booth interview time for the survey period during four days is provided in **Exhibit 2.11.** It is noted that average interview time ranged between 49 to 66 seconds per vehicle over the four day period. The difference in interview time also has a significant impact on border operations. The average vehicle transit time, as derived from the survey results, was 16 seconds per vehicle.

Recording an entry at a U.S Customs commercial vehicle primary inspection booth.

**Exhibit 2.11 – Average Customs Booth Interview Time**

| Date | Average Interview Time (sec/veh) |
|---|---|
| **10-Jun** | 66 |
| **11-Jun** | 63 |
| **12-Jun** | 51 |
| **13-Jun** | 49 |
| **Average** | 57 |

The sensitivity of border operations to variation in customs booth related time can be illustrated in the following simple example. Given the additional vehicle transit time, the customs booth related time for June 10th would be 82 seconds per vehicle, or a service rate of 44 vehicles per hour per booth. Similarly, customs booth related time for June 13th would be 65 seconds per vehicle, or 55 vehicles per hour per booth. Assuming one open booth and an average commercial vehicle length and gap of 80 feet this may be converted to, for that *one hour period*, a difference in queue of close to 1,000 feet.

*Commercial Vehicle Clearance Operations Travel Characteristics*

The preceding discussion described the primary variables that influence operating conditions. These variables vary within and between days, producing a set of operating conditions that are unique. The border operating conditions that are produced through the convergence of these variables are most often described in terms of travel time and queue length.

A summary of average daily commercial vehicle travel time is provided in **Exhibit 2.12.** Over the four survey days, the average time from the moment of a truck entering the survey area to clearance from primary inspection was approximately 40 minutes per vehicle. However, it is notable that the average time ranged between 23 to 60 minutes during the four days.

**Exhibit 2.12 – Southbound Average Travel Time During Survey Period**

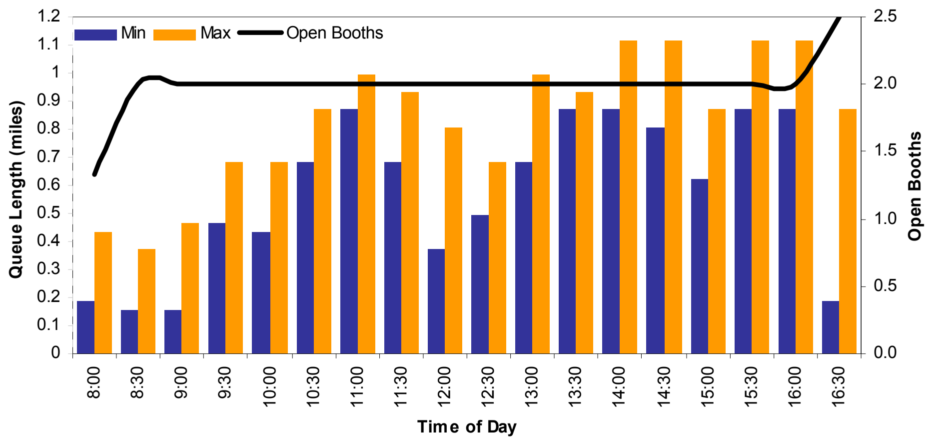
| | Travel Time (min) | | |
|---|---|---|---|
| Date | All Trucks | Empty or Precleared | Non-precleared |
| 10-Jun | 60 | 51 | 70 |
| 11-Jun | 49 | 41 | 56 |
| 12-Jun | 30 | 22 | 38 |
| 13-Jun | 23 | 15 | 35 |
| Avg. | 40 | 32 | 50 |

The travel time for the average empty or pre-cleared truck was approximately 32 minutes, or about 15 to 20 minutes less than the average non-precleared truck. This additional time is consistent with the observed customs broker related time.

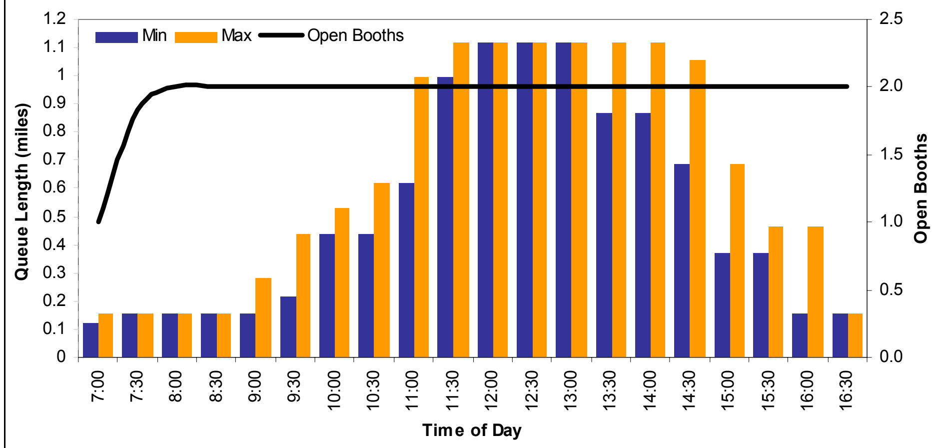
The maximum and minimum queue length distribution during each half hour period for each of the southbound survey days is provided in **Exhibit 2.13.** The minimum recorded length in the survey was 1/8$^{th}$ of a mile (200 m). **Exhibit 2.13** also shows the distribution of open booths by half hour period throughout the day. In general, there were two booths open throughout the survey period. Of note:

- Days 1 and 2 exhibit dramatically different queuing patterns than days 3 and 4. This can in part be attributed in large part to the higher customs booth related time discussed in the previous section;
- Days 1 and 2 experienced periods of sustained queuing beyond the maximum surveyed point of 1.1 miles (1770 m). On these days the queue extended westward on 8$^{th}$ Avenue towards 172$^{nd}$ Street (and at times beyond);

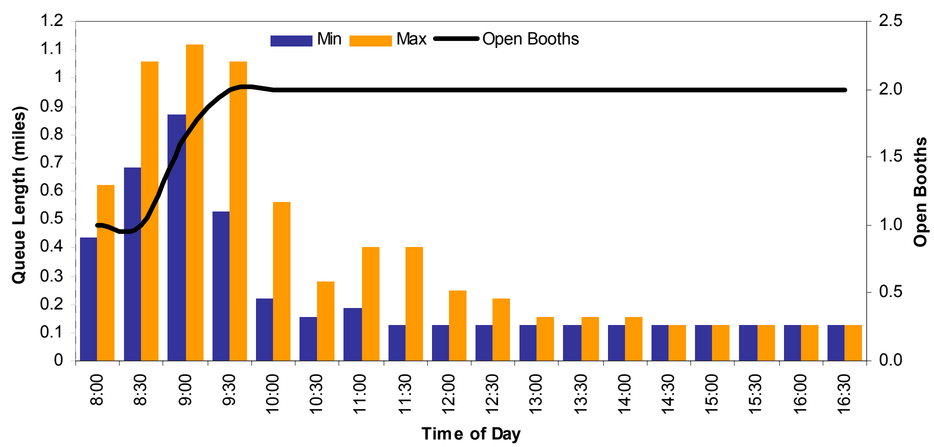
## Day 1 – June 10, 2002




## Day 2 – June 11, 2002




## Day 3 – June 12, 2002




## Day 4 – June 13, 2002

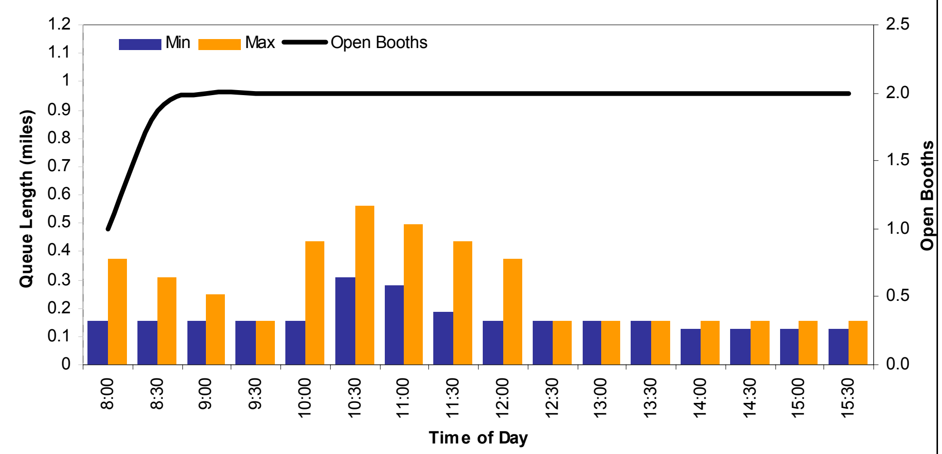





**Exhibit 2.13 – Southbound Maximum and Minimum Queue Length and Number of Operating Booths**

- The final time period beginning at 4:00 PM on day 1 is noteworthy. The maximum queue during that period was over one mile (1600 m). This was reduced to *no queue* in a period of just over 20 minutes after a third U.S. Customs booth was opened; and,
- The morning queue on day 3 may have been precipitated by later than normal opening of the second booth.

**Exhibits 2.12** and **2.13** demonstrate the daily variance of operating conditions. For example, the total number of arrivals over the survey period on June $12^{th}$ exceeded June $10^{th}$. However, the average travel time and queue profile on June $12^{th}$ is considerably lower in magnitude than June $10^{th}$. This is likely related to the difference in arrival profile *and* customs booth related processing time. This difference between the two days would have been aggravated had the second booth opened at 8:00 on June $12^{th}$. This conclusion is consistent with an earlier travel time study conducted on behalf of the FHWA[2].

June $13^{th}$ and $14^{th}$ (days 3 and 4) experienced similar customs booth processing rates. However, the average travel time on day 4 was approximately 7 minutes of 20% less. This may be attributed in large part to a difference in demand over the survey period in terms of both profile and total demand.

In summary, the combination of commercial vehicle arrival rates, customs broker travel time and customs booth related processing time produces a set of volatile operating conditions that are unique to each day. Border travel time and queue are sensitive to changes in these variables such as opening of an additional booth, reduction in processing time or a reduction in demand.

## 2.4 Northbound Survey Results

Northbound on SR-543, Pacific Highway Crossing.
Sign: Canadian Customs – ½ mile.

The northbound direction was surveyed between Monday June $17^{th}$ and Thursday June $20^{th}$, 2002. Similar to the final two days in the southbound direction, anecdotal discussions with truckers and customs staff indicated that, overall, travel conditions were lighter than normal.

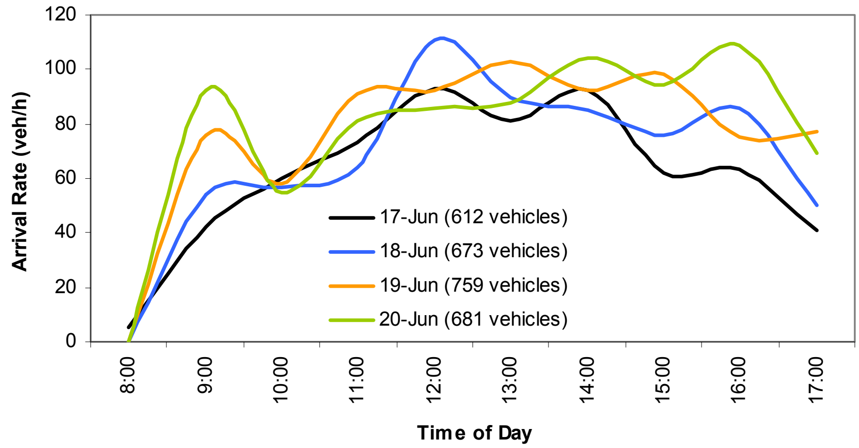
*Commercial Vehicle Arrival Rates*

Northbound commercial vehicle arrival rates observed during the survey are illustrated in **Exhibit 2.14.** As in the southbound direction, the variation in demand, not only in total but also in distribution throughout the day is noteworthy and, in part, influence the variation in travel conditions between days. During this survey period, demand started to build from approximately 8:00 AM, and generally peaked during the afternoon period. However, there does not seem to be a pattern of arrivals between days.

2 Conditions and Performance Report – Measurement of Commercial Motor Vehicle Travel Time and Delay at U.S. International Border Stations, R. Davis (Draft).

Recording a northbound entry using a PDA.

**Exhibit 2.14 – Northbound Commercial Vehicle Arrival Rates (8:00 AM to 5:00 PM)**




The total number of northbound vehicles surveyed and their vehicle type composition are provided in **Exhibit 2.15.** The average volume during the survey period was 706 commercial vehicles, where the heaviest volume was experienced on Wednesday and Thursday, June 19 and 20$^{th}$.

**Exhibit 2.15 – Northbound Fleet Composition**

| DATE | VEHICLE TYPE | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | | HEAVY TRUCKS | | | | | |
| | Passenger Vehicles | Light Trucks | Single Unit | Truck / Trailer Combo | Tractor | Tractor / Trailer Combo | Tractor / Container Combo | |
| **17-Jun-02** | 11% | 11% | 0% | 2% | 2% | 56% | 17% | 612 |
| **18-Jun-02** | 8% | 12% | 2% | 7% | 1% | 52% | 17% | 673 |
| **19-Jun-02** | 11% | 9% | 1% | 2% | 2% | 60% | 15% | 762 |
| **20-Jun-02** | 8% | 12% | 2% | 5% | 2% | 59% | 12% | 778 |
| **Average** | 10% | 11% | 1% | 4% | 2% | 57% | 15% | 706 |

Northbound Commercial Vehicles Along State Route 543 South of Canada Customs.

Similar to the southbound direction, the fleet composition was consistent over the surveyed days. Notable statistics include[3]:

- Approximately 10 percent of vehicles processed through the commercial vehicle clearance operations are passenger vehicles. This is comparable to 17 percent in the southbound direction;
- Just over 10% of commercial vehicles are light trucks;
- The remaining 80% of commercial vehicles are heavy trucks. The comparable value in the southbound direction was 72%;

[3] Passenger vehicles were not surveyed as they entered the study area. Unless otherwise noted, further statistics regarding the commercial vehicle fleet and clearance travel time do not include passenger vehicle records.

- Approximately 2 percent of commercial vehicles are tractors without a trailer or container. These vehicles likely originated north of the border, and are 'bobtailing' after delivering a trailer or container in the United States or may be related to cabotage; and,
- Approximately 15 percent of total commercial vehicles carry a container. This may be compared to 8 percent in the southbound direction.

Northbound Queue – Approximately 1/3 mile.

*Vehicle Operating Characteristics*

**Exhibit 2.16** provides the northbound vehicle operating characteristics. It is noteworthy that 37 percent of commercial vehicles were recorded as empty by CCRA officers. This is significantly higher than the 10 percent recorded in the southbound direction. Approximately 45 percent carried a commodity and were pre-cleared. Approximately18 percent carried a commodity and were not pre-cleared. Note that the CCRA targets approximately 3 percent of total daily commercial vehicles for secondary inspections. For the purpose of this analysis, these vehicles are treated as precleared.

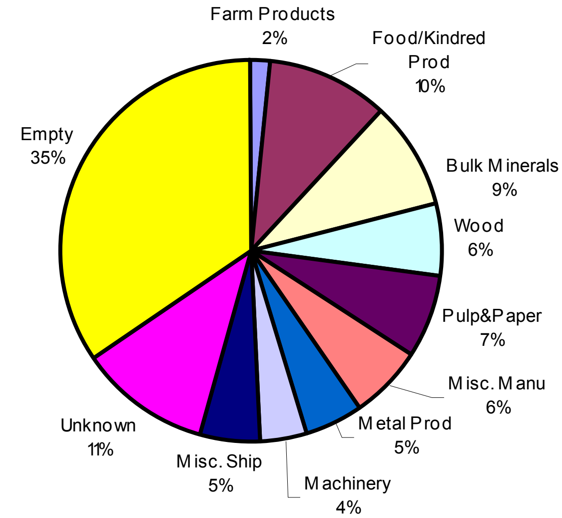
**Exhibit 2.16 – Northbound Vehicle Operating Characteristics**

| Date | Empty | Precleared | Non-precleared |
|---|---|---|---|
| **17-Jun-02** | 38% | 42% | 19% |
| **18-Jun-02** | 36% | 44% | 20% |
| **19-Jun-02** | 40% | 43% | 17% |
| **20-Jun-02** | 35% | 48% | 17% |
| **Average** | 37% | 45% | 18% |

Looking northbound from the north end of the parking lot. U.S. passenger vehicle primary inspection booths at center left.

**Exhibit 2.17** presents northbound commodity flow information captured from the IMTC Cross-border Trade and Trade Survey. **Exhibit 2.17** illustrates the types of industries on the logistics supply chain that are influenced by travel time at the Pacific Highway border crossing. Similar to the border operations survey **(Exhibit 2.16)** the IMTC survey also reported a high percent of empty commercial vehicles in the northbound direction (35 percent). This suggests that an expedited clearance system for empty commercial vehicles that may potentially include techniques such as ITS and/or an 'empty truck lane' warrants consideration. Approximately 10 percent of known commodities being shipped were food/kindred products and bulk minerals. However, the commodities being shipped were not dominated by one particular industry.

**Exhibit 2.17 – Summer Pacific Highway Northbound AADT Commodity Flow Characteristics**




Rover records northbound at north end of northbound parking lot.

### *Customs Broker Related Time*

There are two holding areas that may be used for customs broker visits in the northbound direction. The primary staging area for customs broker related activity is located north of the border. Non-precleared commercial vehicles, as well as those referred for secondary inspection, are directed to this holding area after primary inspection at the CCRA booths. CCRA generally targets approximately 3 percent of total vehicles per day for secondary inspection. Note that time related to secondary inspections has been extracted from the survey database, based upon a profile of typical secondary inspection times provided by the CCRA. This time consists of two components: i) visiting the customs broker; ii) subsequent approval of documentation by CCRA.

Recording an entry using a PDA.

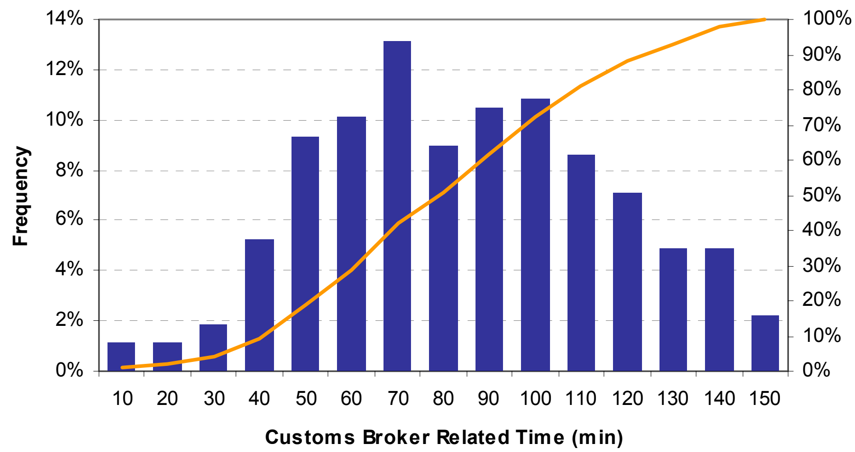
The other potential holding area is approximately ½ mile (800 m) from the CCRA booths, and saw limited use during the survey. Besides potentially providing parking for customs brokers *north* of the border, this parking lot also is also used: for the duty free stores; as a driver rest area; and as a mechanical check area. The border operations survey did not capture the proportion of commercial vehicles that used this area to attend customs brokers. However, given the limited use of the lot overall and its distance from the customs brokers this lot was not considered in the analysis of customs broker related time.

The average northbound customs broker related time over the four survey days was 79 minutes per vehicle and was relatively consistent between days.

A frequency distribution of customs broker related time complied from all four days of data is given in **Exhibit 2.18**. Customs broker related time generally follows a normal distribution, where 2 percent of commercial vehicles experience the maximum time of 150 minutes (2.5 hours). The mode and median were 70 and 80 minutes per vehicle, respectively.

Northbound commercial vehicle compound.

**Exhibit 2.18 – Frequency Histogram of Northbound Customs Broker Related Time**

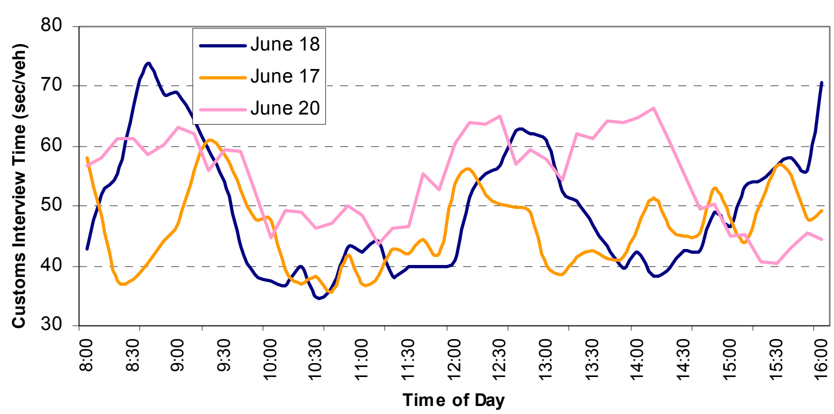



*Customs Booth Related Time*

Customs booth related time generally ranged between 50 to 80 seconds per vehicle. **Exhibit 2.19** illustrates the observed processing time throughout the first three days of the survey. Overall, the northbound customs booth interview time showed variation similar to the southbound direction in the range of 30 to 70 seconds per vehicle.

**Exhibit 2.19 – Northbound Customs Booth Interview Time on June 17th,18th and 20th (8:00 AM to 5:00 PM)**

CCRA booths.




However, the northbound direction showed fewer periods than the southbound direction where the customs booth related time

Recording an entry at the CCRA booth.

exceeded 70 seconds per vehicle. However, similar to the southbound direction, there does not appear to be a defined pattern throughout a single day or between days. The other day is consistent with this conclusion, but has not been included as they may make the graph more difficult to follow.

The average customs booth interview time for the survey period during four days is provided in **Exhibit 2.20.** It is noted that average interview time ranged between 43 to 54 seconds per vehicle over the four day period. Part of the variation in the final two days may be related to customs officer training.

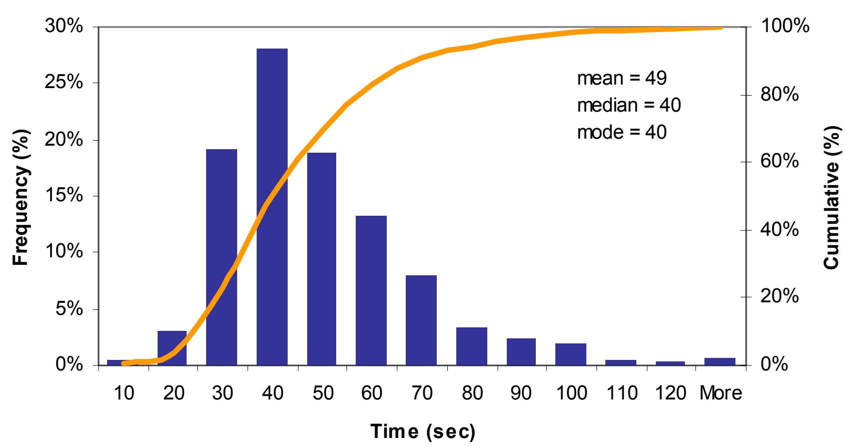
**Exhibit 2.20 – Average Customs Booth Interview Time (sec)**

| Date | Average Interview Time (sec/veh) |
|---|---|
| **17-Jun** | 45 |
| **18-Jun** | 43 |
| **19-Jun** | 54 |
| **20-Jun** | 54 |
| **Average** | 49 |

A frequency distribution of customs booth interview time in 10 second intervals, as compiled from the four days of survey data is provided in **Exhibit 2.21.** Northbound customs booth processing time is fairly tightly distributed between 30 to 60 seconds per vehicle, where the median and mode are both 40 seconds per vehicle.

**Exhibit 2.21 – Frequency Distribution of Northbound Customs Booth Related Rate**

Recording an entry at the CCRA booth.




Due to the configuration of border operations and sustained periods without a queue, vehicle transit time in the southbound direction was also applied to the northbound direction.

In the southbound direction, two customs booths are open between throughout the survey period. In the northbound

Northbound automated exit.

direction, the number of open booths is directly related to demand and queue length. For example, depending upon the situation, the second booth is opened if the queue ranges from 1,500 to 4,500 feet. This influences operating conditions, and the average number of open booths over the four surveyed days is provided in **Exhibit 2.22.** Again, it is important to note that the average number of open booths on June 19th and 20th approached two, due to staff training throughout the afternoon of both days.

**Exhibit 2.22 – Northbound Average Number of Operating Booths During Survey Period**

| Date | Average Booths Open |
|---|---|
| **17-Jun** | 1.31 |
| **18-Jun** | 1.50 |
| **19-Jun** | 1.81 |
| **20-Jun** | 1.75 |
| **Average** | 1.59 |

As noted, the number of open booths has a direct affect on the service rate at the border crossing, and, in combination with arrival rates, helps explain daily variation in travel time and queue length.

*Commercial Vehicle Clearance Operations Travel Characteristics*

A summary of average daily commercial vehicle travel time is provided in **Exhibit 2.23.** The average time from the moment a trucks enters the survey area to clearance from a primary customs booth was approximately 26 minutes per vehicle. The average border operations time for precleared commercial vehicles in the northbound direction (13 minutes) is considerably less than the southbound direction is considerably less in the southbound direction (32 minutes). This conclusion is consistent with an earlier draft travel time study conducted on behalf of the FHWA[4].

**Exhibit 2.23 – Northbound Average Travel Time During Survey Period**

| Date | Travel Time (min) | | |
|---|---|---|---|
| | All Trucks | Empty or Precleared | Non-precleared |
| **17-Jun** | 30 | 15 | 104 |
| **18-Jun** | 24 | 12 | 88 |
| **19-Jun** | 22 | 12 | 84 |
| **20-Jun** | 26 | 15 | 91 |
| **Average** | 26 | 13 | 92 |

[4] Conditions and Performance Report – Measurement of Commercial Motor Vehicle Travel Time and Delay at U.S. International Border Stations, R. Davis (Draft).

The non-precleared vehicles experienced an average travel time of approximately 92 minutes, or approximately 80 minutes more than pre-cleared vehicles. Note that vehicles which exceeded the mean stay in the northbound holding area by more than one standard deviation were removed from the data set for this analysis. It is anticipated that the drivers of these vehicles could be using the opportunity to rest and/or visit dining/entertainment establishments in the area.

Some of the northbound trucks stopped at the northbound holding area to rest, conduct a mechanical check or visit brokerage offices and/or commercial-retail outlets. This time was recorded as part of the trip, and attributed to 'precleared' or 'non-precleared', depending upon their status at the CCRA booths.

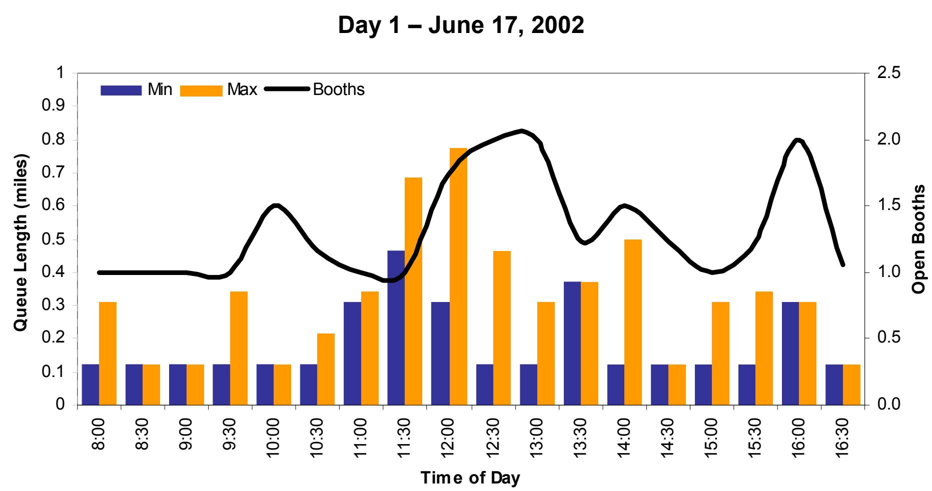
The maximum and minimum queue length distribution during each half hour period for each of the northbound survey days is provided in **Exhibit 2.24.** Due to the curve in the road on the approach to the CCRA booths, the minimum recorded length in the survey was 1/8$^{th}$ of a mile. **Exhibit 2.24** also shows the distribution of operating booths by half hour period throughout the day. Of note:

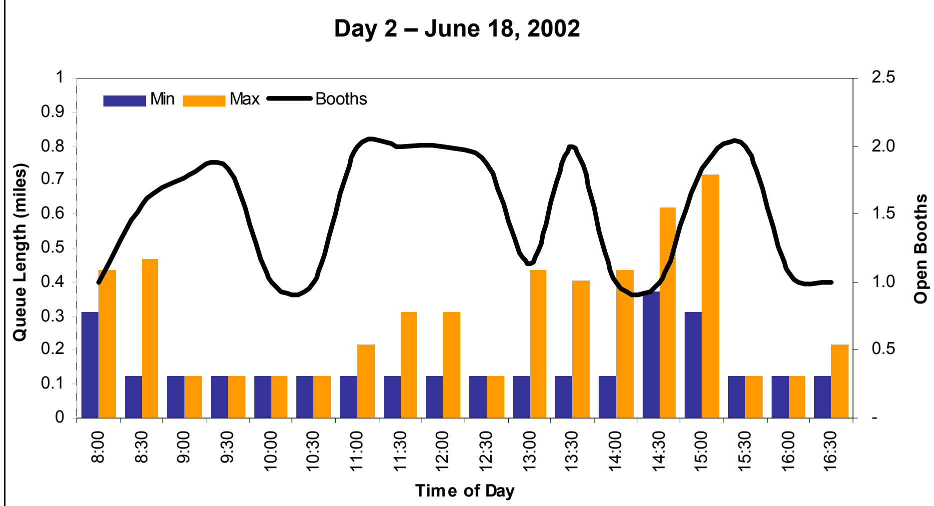
- Periods of sustained queuing of over ½ mile were not experienced;
- The maximum queue length experienced was close to one mile early in day 4;
- The shape of the queue length distribution varies from day to day and does not show a consistent pattern;
- The queue length distribution is related to, in part, the distribution of operating booths. This also varied significantly between days e.g. two booths were open for most of the afternoon on days 3 and 4. This may be due to training of new officers on days 3 and 4; and,
- The number of operating booths varied within days and, especially on day 1, appeared to be directly responsive to demand.

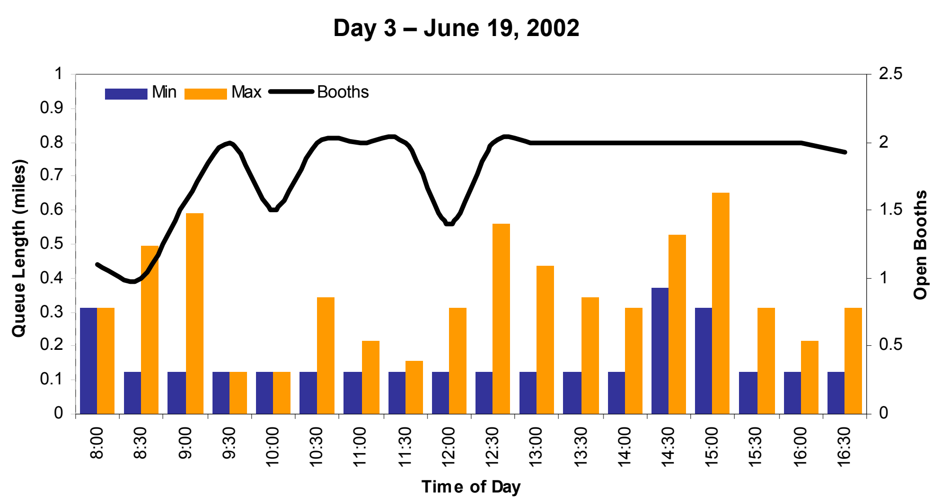
**Exhibits 2.23** and **2.24** demonstrate the variation of operating conditions from day to day. For example, the total number of arrivals over the survey period on June 19$^{th}$ and 20$^{th}$ exceeded June 17$^{th}$ and 18$^{th}$. However, the average travel time and queue profile on the final two days is considerably lower in magnitude than the first two days. This is likely related to the difference number of open booths (office training).

In summary, the combination of commercial vehicle arrival rates, customs booth related processing time, number of open booths converge to produce a set of operating conditions that are unique to each day. Operating conditions are also very sensitive to changes in these variables such as opening of an additional booth, reduction in processing time or a reduction in demand.

The methodology developed for the border operations survey was designed to capture the important components of commercial vehicle clearance operations at the Pacific Highway POE. The survey results maybe used to inform border operations planning and policy, and for the development of border operations models such as SLM-49.



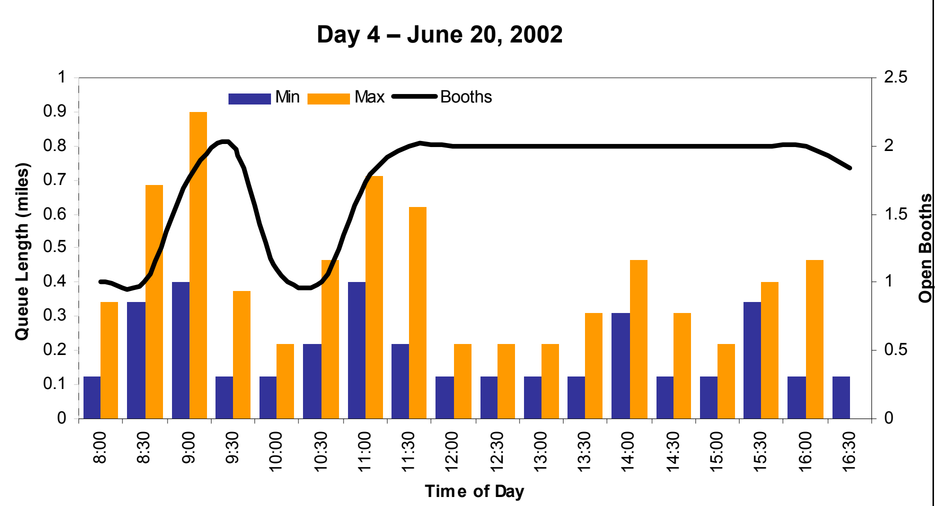






**Exhibit 2.24 – Northbound Maximum and Minimum Queue Length and Number of Operating Booths**

# 3.0 SLM-49 Validation and Representative Base Year Conditions

The previous section described commercial vehicle border operations at the Pacific Highway Crossing, and characterized border operating conditions for the four days that were surveyed. This information provides an important baseline, and also enabled the development of the sketch planning Strategic Logistics Model (SLM-49) that is able to estimate queue length and travel time for commercial vehicles in both directions at the Pacific Highway Crossing. Upon completion of model development, SLM-49 was used to estimate operating conditions for "representative" days for the base and a selected future year (2013), and evaluate the benefits of ITS deployment with respect to commercial vehicle operations.

The purpose of this section is to describe the development and validation of SLM-49, and to estimate the base year "representative day" operating conditions (weekday and weekend day for summer and winter) that served as part of the basis for the ITS evaluation. The **first** part of this section describes the overall model structure and specifications. The **second** part of this section provides the results of the model validation. The **third** part of this section describes the "representative days", and provides an estimate of the annual cost border operations to commercial vehicles.

## 3.1 Model Structure and Specifications

SLM-49 combines the unique dynamics experienced at points on the logistics chain, such as border operations, with queuing theory. The following was considered in model structure and specifications:

1. The cost of border operations is primarily attributed to travel time on the approach to the POE, at the customs broker (if required) and at the customs booth. The potential benefits to commercial vehicles for conversion to ITS would depend upon their former status as precleared or non-precleared. SLM-49 was designed to explicitly separate these two streams of traffic and isolate the three primary components of travel time.
2. The survey represented four weekdays in both directions during June, 2002. The variance in queue length, travel time and delay, customs booth processing time, number of operating customs booths etc. between days was presented in the previous section. SLM-49 was designed such that, upon calibration and validation, it could simulate "representative" or "typical" conditions such as average daily commercial vehicle demand and processing assumptions. This enabled development of four models that are representative of the following periods:

- Summer weekday;
- Summer weekend day;
- Winter weekday; and
- Winter weekend day.

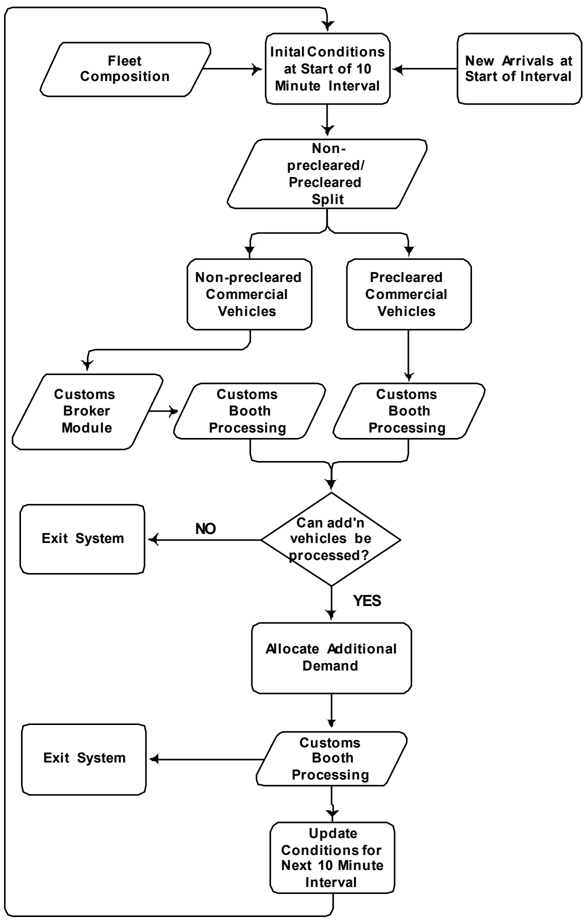
3. SLM-49 was used to estimate the benefits of ITS deployment for the base year and a selected horizon year (2013), where the benefits for the interim years could be interpolated. The application of the model in any given horizon year would require the following key assumptions: the forecast number of commercial vehicles, use of ITS technology among commercial vehicles, the arrival pattern of commercial vehicles over a 24 hour period, and customs service rates/number of operating booths over a 24 hour period. As there is some uncertainty with respect to these future year assumptions, the SLM-49 was designed to represent a level of detail compatible with planning level benefit/cost analysis.
4. Although SLM-49 was developed for the Pacific Highway Border Crossing, it was designed to be flexible and portable. The model structure and calibrated parameters may be:
   - transferred to other border crossing Ports of Entry;
   - extended to include other nodes on the logistics supply chain such as port container terminals and truck inspection sites (weigh scales);
   - expanded to include passenger vehicle border crossings; and,
   - incorporated into cross-border travel demand forecasting models.

Given the preceding considerations, SLM-49 is a sketch planning queue model that simulates border operations over a 24 hour period, in 10 minute increments. Major components of the model are the following:

- commercial vehicle composition (light, heavy, tractor, passenger car);
- commercial vehicle demand over a 24 hour period;
- customs broker related processing time;
- customs booth processing time / vehicle transition time;
- queue length; and
- travel time for pre-cleared and non-precleared commercial vehicles.

A general schematic of SLM-49 for the southbound direction at the Pacific Highway Crossing is illustrated in **Exhibit 3.1.**

**Exhibit 3.1 – General Schematic of SLM-49 for a Time Interval in the Southbound Pacific Highway Crossing**




The general process illustrated in **Exhibit 3.1** is followed for 144 ten minute time intervals within the 24 hour period:

- **New arrivals** are assigned the model in 10 minute intervals;
- The **initial conditions** at the start of the interval take into account the conditions at the end of the previous time interval, and the new arrivals within the current time interval;
- Given assumptions regarding vehicle length by vehicle type, the observed **vehicle composition**, in combination with the number of vehicles, are used to estimate queue length;
- The **pre-cleared/non-precleared** split is used to separate precleared and non-precleared commercial vehicles;
- Non-precleared commercial vehicles are assigned to the **'customs broker'** module. A time distribution (see

Section 2) is used to assign the interval in which these vehicles re-enter the traffic stream and proceed to the customs booth;

- The number of vehicles processed in each interval depends upon customs booth processing and vehicle transition time;
- Dependent upon the number of **vehicles that may be processed** during a time interval, and the available vehicles in the precleared and non-precleared traffic streams, vehicles may be re-allocated between booths;
- **Conditions** (number of commercial vehicles and queue length) are updated in preparation for the next time interval.

## 3.2 SLM-49 Validation

The model validation was conducted in two steps:

- Validate the model to each surveyed day. The purpose of this step was to ensure that the mechanics of the model were reasonably comprehensive and robust;
- Establish the requisite representative days. A set of "average" conditions were defined for summer and winter weekdays and weekend days. These were used to develop "representative day" models for these periods.

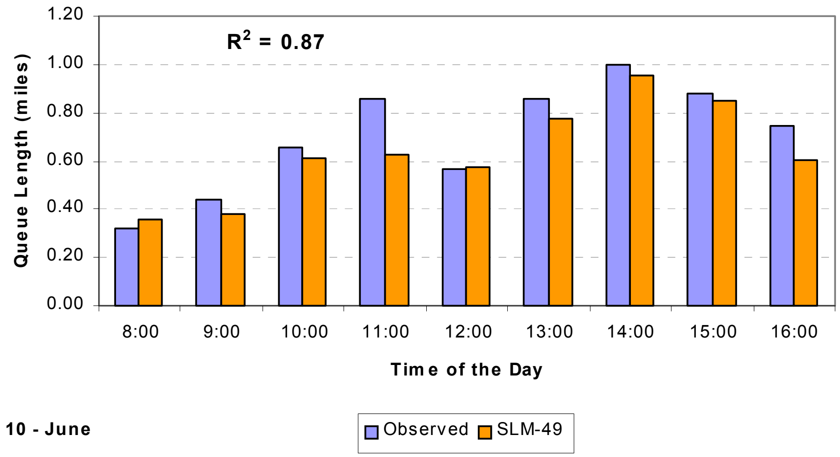
*Southbound Model Validation*

A sample result of the model calibration to queue length for each day in the southbound direction is illustrated in **Exhibit 3.2.** The root mean square error ($R^2$) for average queue length is also given, where a value of 1.0 would represent a perfect fit to observed conditions. The $R^2$ for queue length throughout the four days ranges from 0.83 to 0.97, which is considered to be within the acceptable range.

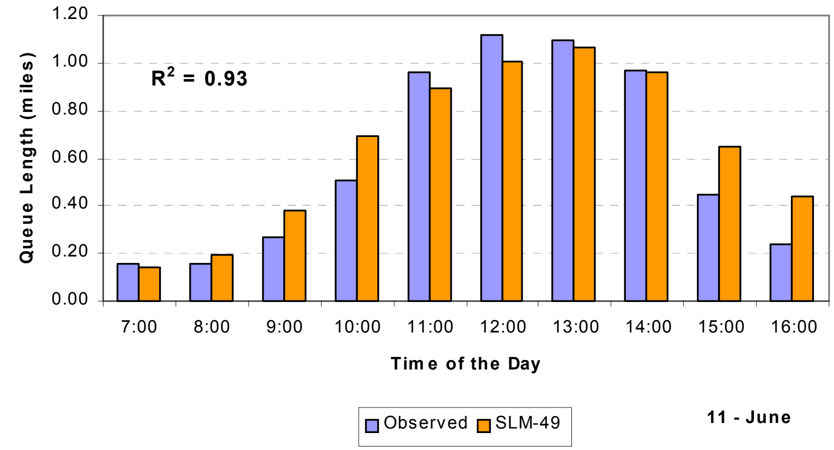
Statistical measure of the travel time valuation is presented in **Exhibit 3.3. Exhibit 3.3** shows that the $R^2$ for the pre-cleared travel time is 0.94 or above in all cases, representing a very good fit to observed conditions. The $R^2$ for non-precleared travel time ranges from 0.73 to 0.82. This level of calibration is also considered to be acceptable.

**Exhibit 3.3 – $R^2$ of Southbound Precleared and Non-precleared Travel Time**

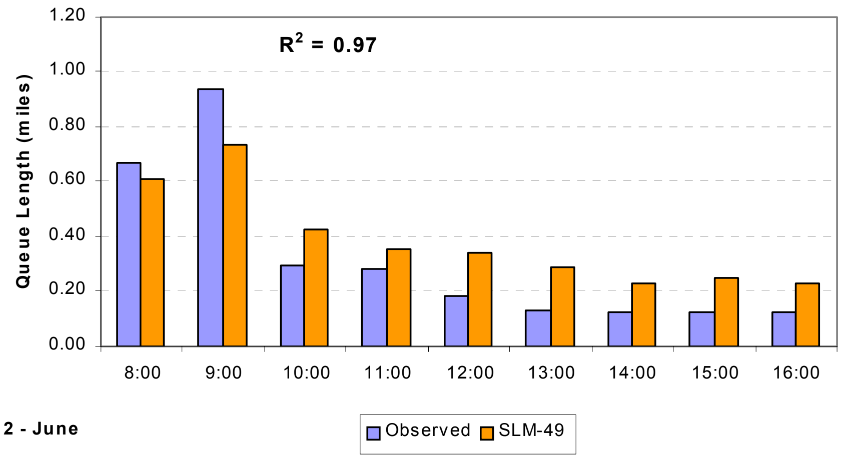
| Date | $R^2$ of Travel Time | |
|---|---|---|
| | Precleared | Non-precleared |
| 10-Jun | 0.97 | 0.81 |
| 11-Jun | 0.94 | 0.78 |
| 12-Jun | 0.95 | 0.73 |
| 13-Jun | 0.95 | 0.82 |



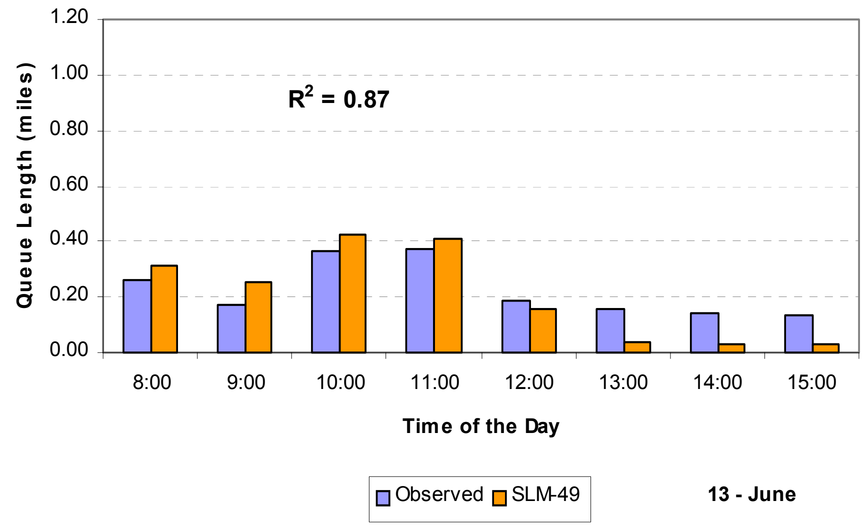

10 - June




11 - June




12 - June




13 - June

The measure of model goodness of fit provide a high level of confidence that the SLM-49 simulates the southbound border operations at the Pacific Highway Crossing.

*Northbound Model Validation*

The structure of the northbound model differs from the southbound model in three main respects:

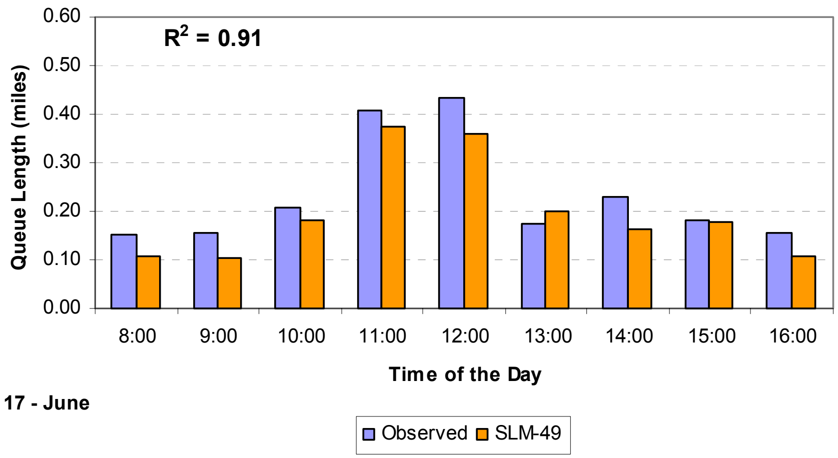
- The number of operating booths is related to the queue length (i.e. it is demand responsive reflecting current operations);
- The pre-cleared and non-precleared commercial vehicles share the traffic stream until after primary inspection at the customs booth.
- The northbound direction has two separate time distribution modules similar to the customs broker module in the customs booth in the southbound direction. The first is located at the parking lot south of the duty free stores, and the second is related to the non-precleared parking lot proceeding from the primary inspection booths.

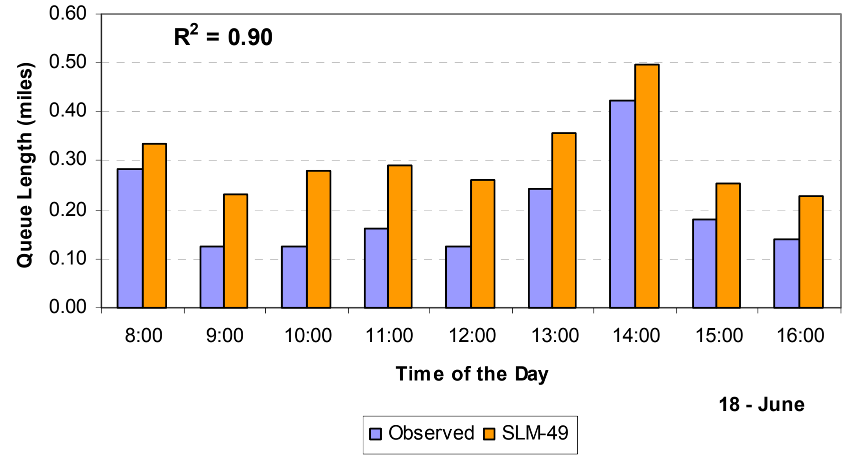
The result of the northbound model calibration to queue length for each day in the southbound direction is illustrated in **Exhibit 3.4.** The $R^2$ for queue length throughout the four days ranges from 0.83 to 0.91, which is considered well within the acceptable range.

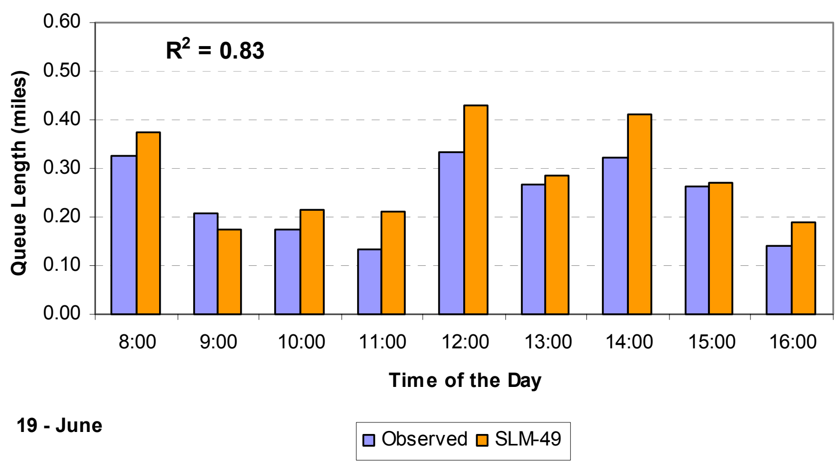
Similar to the southbound direction, statistical measure of the validation to travel time is presented in **Exhibits 3.5.** Given that the pre-cleared and non-precleared generally share the traffic stream until primary inspection, the $R^2$ for travel time in **Exhibit 3.5** has been computed for a combination of both streams. However, please note that this does include the limited number of vehicles that stop at the upstream parking lot. The $R^2$ ranges from 0.80 to 0.95, also considered within the acceptable range.

**Exhibit 3.5 – $R^2$ of Northbound Travel Time**

| Date | Travel Time* |
|---|---|
| **17-Jun** | 0.81 |
| **18-Jun** | 0.80 |
| **19-Jun** | 0.95 |
| **20-Jun** | 0.82 |



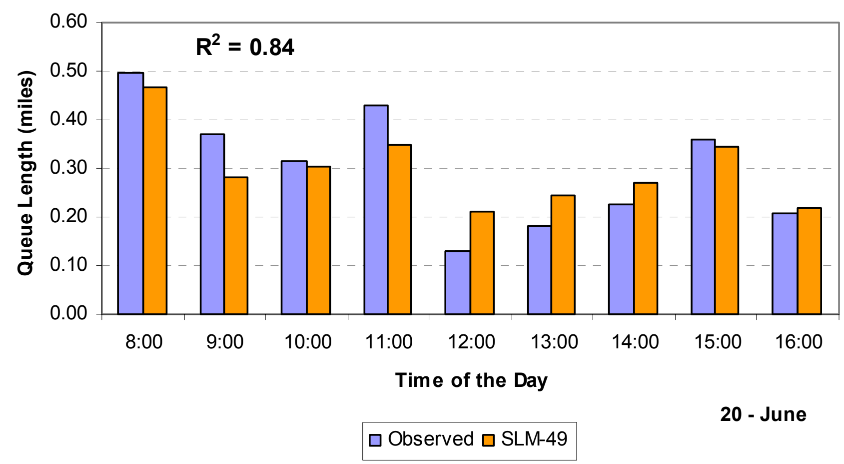






**Exhibit 3.4 – Northbound Model Validation to Queue Length (June 17 to June 20, 2002)**

## 3.3 “Representative Day” Considerations

The previous section described the validation of the mechanics of SLM-49 to nine hours of observations on four weekdays per direction in June, 2003. Given confidence in the model mechanics, it was necessary to produce a series of “"representative days" for the following reasons:

- the variation in demand and travel time/queue and customs booth processing that was experienced between days during the survey period is noteworthy. The "representative day" models are based upon an average demand (as derived from a longer time period) and typical border staffing/processing rates;
- as noted, the model was calibrated to a nine hour operating conditions. The "representative day" model was expanded to cover a 24 hour period;
- SLM-49 was calibrated to a summer weekday condition. However, the potential benefits of ITS deployment should reflect the variation in commercial vehicle demand and operating conditions between winter and summer seasons, and between weekdays and weekend days. Consequently, given demand and operating conditions, the model structure and parameters were applied to create models for these other periods.

This resulted in eight "representative day" 24 hour base year models, and these are identified in **Exhibit 3.6.**

**Exhibit 3.6 – Base Year Representative Day Models**

| Direction | Summer | | Winter | |
|---|---|---|---|---|
| | Weekday | Weekend Day | Weekday | Weekend Day |
| Southbound | x | x | x | x |
| Northbound | x | x | x | x |

*"Representative Day" 24 Hour Demand Profiles*

The representative day 24 hour commercial vehicle demand profiles for the base year developed during the IMTC Cross-Border Trade and Travel Survey were used for model development. The 24 hour commercial vehicle demand for each period by direction is provided in **Exhibit 3.7.**

**Exhibit 3.7 – Base Year 24 Hour Commercial Vehicle Demand by Period**

| Representative Day | Direction | |
|---|---|---|
| | SB | NB |
| **Summer weekday** | 1843 | 1594 |
| **Summer weekend day** | 969 | 840 |
| **Winter weekday** | 1642 | 1517 |
| **Winter weekend day** | 801 | 703 |

Due to the cumulative nature of queuing, the arrival rate of commercial vehicles, or the demand profile throughout a 24 hour period, can influence estimates of travel time and queue. The 24 hour profiles developed for the IMTC Cross-Border Trade and Travel Survey were adopted for this study, and are presented in **Exhibit 3.8.**

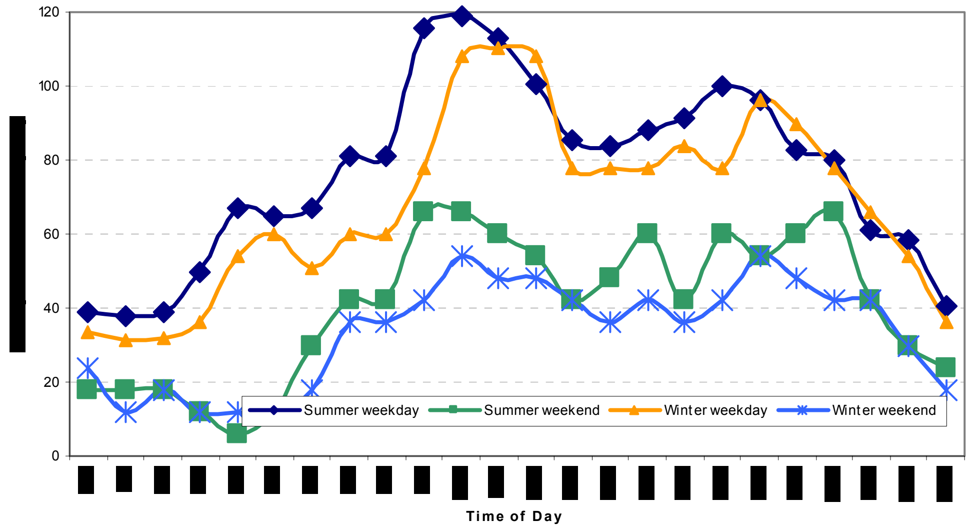
Other salient considerations in describing the commercial vehicle demand for all time periods included:

- in the southbound direction, the pre-cleared/non-precleared split reflected the average observed in the survey, i.e. 45 percent non-precleared and 55 percent precleared or empty;
- in the northbound direction, the pre-cleared/non-precleared split reflected the average observed in the survey, i.e. 21 percent of vehicles were referred to the holding area after primary inspection. Given that the secondary inspection target is 3 percent of all commercial vehicles, it was assumed that 18 percent of commercial vehicles were non-precleared, and the remaining commercial vehicles are either pre-cleared or empty;
- the average vehicle composition by direction, as observed during the survey was adopted.

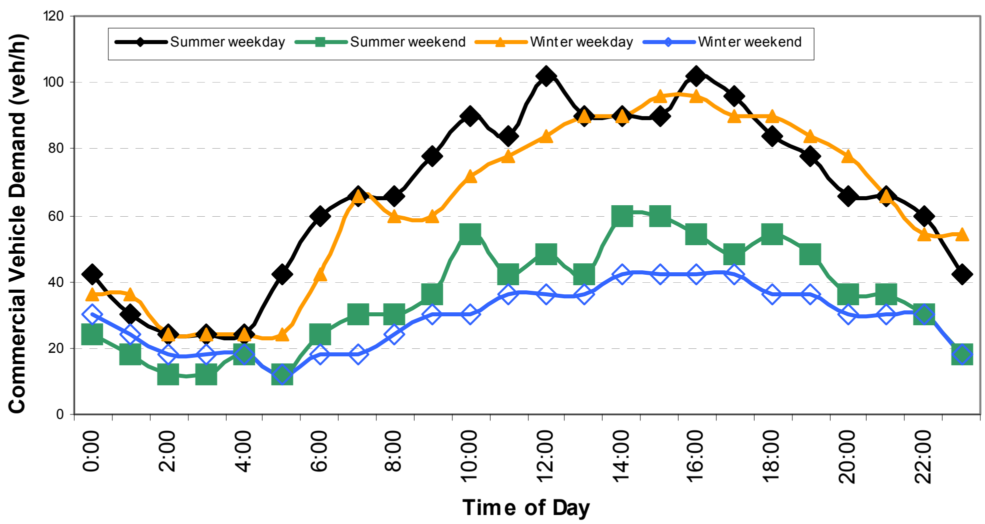
*"Representative Day" 24 Hour Customs Processing Profiles*

In combination with commercial vehicle demand, customs booth processing and vehicle transit time profiles throughout the day play a significant role in modelling border operations on a "representative day". Assumptions regarding customs processing was based upon interviews with U.S. Customs and the CCRA and the border operations survey.

## Southbound Base Year 24 Hour Commercial Vehicle Demand Profile




## Northbound Base Year 24 Hour Commercial Vehicle Demand Profile



**Southbound**

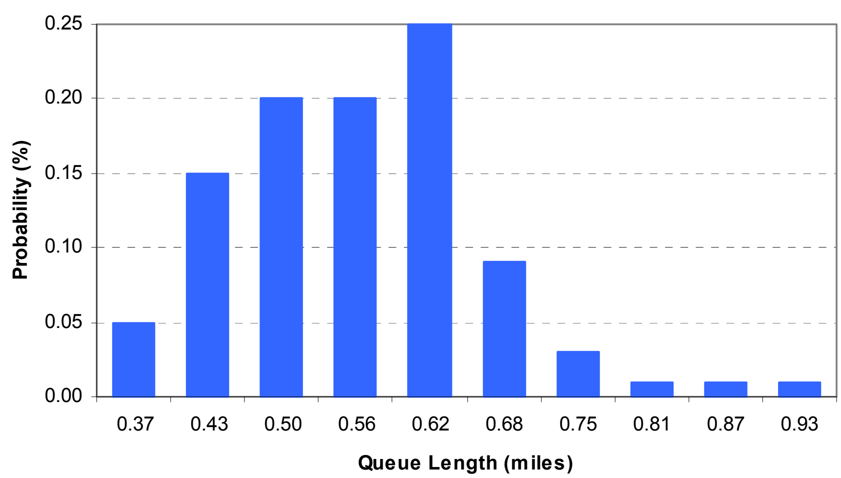
In the southbound direction, it was assumed that, at minimum, one commercial vehicle customs booth would be open throughout the day during all periods. On weekdays, it was assumed that two customs booths would be open from 8:00 AM to late evening. A second booth was assumed to be open for three hours on the summer weekend day.

The results of the border operations survey presented in **Section 2** illustrated that the customs booth processing time varied between time intervals, and between days. In the southbound direction, the total processing time ranged between 60 to 90 seconds per vehicle. A total processing rate was randomly generated using a random seed, and assigned to each 10 minute time interval. By changing the random seed, SLM-49 may be applied, if necessary, using other potential total processing rates, where the results of the different model runs may be averaged.

**Northbound**

As noted in **Section 2**, the number of operating booths in the northbound direction is responsive to the demand or queue length. The point at which the second booth is opened can reasonably vary between 0.37 to 0.93 mile (600 to 1,500 metres). For the purpose of defining a "representative day", a "trigger" queue length within this range was randomly assigned to each time interval, based upon the probability distribution shown in **Exhibit 3.9.** SLM-49 employs a test which "opens" the second customs booth if the estimated queue length for the time interval exceeds the "trigger" queue length.

**Exhibit 3.9 – Probability of Queue Length at Which the Second Northbound Customs Booth Opens**




It was noted in **Section 2** that the range of customs booth processing time/vehicle transition time in the northbound direction varied between 60 to 80 seconds per vehicle. Similar to the southbound direction, a total processing rate was randomly generated using a random seed, and assigned to each 10 minute time interval. By changing the random seed, SLM-49 may be applied, if deemed necessary, using other potential total processing rates, where the results of the different model runs may be averaged.

*"Representative Day" Customs Broker Modules*

Travel time allocated to customs brokers are a significant component of the border operations time for non-precleared commercial vehicles. The average time distribution, and hence the time these vehicles re-enter the traffic stream is based upon the distributions illustrated in **Section 2.**

## 3.4 Southbound Representative Days

Given the preceding assumptions, and the calibrated SLM-49, four southbound “representative day” models were developed for the southbound direction. Travel characteristics that supported the definition of the southbound summer weekday are described in **Exhibit 3.10.** The comparative statistics are shown for the survey period. The final definition of the summer southbound representative day considered the following:

- the queue and travel time experienced on June 10$^{th}$ and 11$^{th}$ is considered more of ‘normal’ conditions than that experienced on June 12$^{th}$ and 13$^{th}$;
- the commercial vehicle demand between 8:00 AM and 5:00 PM extracted from the IMTC profile exceeded the observed demand for both survey days. In order to compare similar conditions, the IMTC profile was first factored to the average demand experienced on June 10$^{th}$ and June 11$^{th}$. This produced average daily survey period statistics that fit well within the range of the observed conditions, with an inclination towards the first two survey days.
- the final "representative day" employed the IMTC average summer day profile, which showed 878 commercial vehicles during the survey period. The increased average queue length and travel time demand reflects the increased "representative day" demand.

**Exhibit 3.10 – Definition of Southbound Representative Summer Weekday (8:00 AM to 5:00 PM)**

| Criteria | Observed | | | | Representative Day | |
|---|---|---|---|---|---|---|
| | 10-Jun | 11-Jun | 12-Jun | 13-Jun | Factored | Final |
| **Demand** | 724 | 810 | 759 | 681 | 767 | 878 |
| **Average Queue Length (miles)** | 0.68 | 0.62 | 0.31 | 0.22 | 0.55 | 0.89 |
| **Average Precleared Travel Time (min)** | 51 | 41 | 22 | 15 | 31 | 49 |
| **Average Non-precleared Travel Time (min)** | 70 | 56 | 38 | 35 | 46 | 72 |

With the exception of the potential number of open booths, the model parameters adopted for the southbound model were transferred to the winter weekday and weekend day periods. The general characteristics between 8:00 AM and 5:00 PM for southbound "representative day" are provided in **Exhibit 3.11,** and average 24 hour queue profiles for each of these days are provided in **Exhibit 3.12.**

**Exhibit 3.11 – General Characteristics of Southbound Representative Days (8:00 AM to 5:00 PM)**

| Criteria | Summer | | Winter | |
|---|---|---|---|---|
| | Weekday | Weekend Day | Weekday | Weekend Day |
| **Demand** | 878 | 480 | 783 | 384 |
| **Average Queue Length (miles)** | 0.88 | 0.27 | 0.66 | 0.18 |
| **Average Precleared Travel Time (min)** | 49 | 23 | 40 | 21 |
| **Average Non-precleared Travel Time (min)** | 72 | 39 | 69 | 30 |

In general, border operations are most constrained during a representative summer weekday, where, at its peak, the queue can exceed one mile. Due to a decreased demand and different arrival rate throughout the day, the southbound maximum queue on a representative winter day is approximately 1 mile. The representative queue and travel time on weekends is less pronounced.

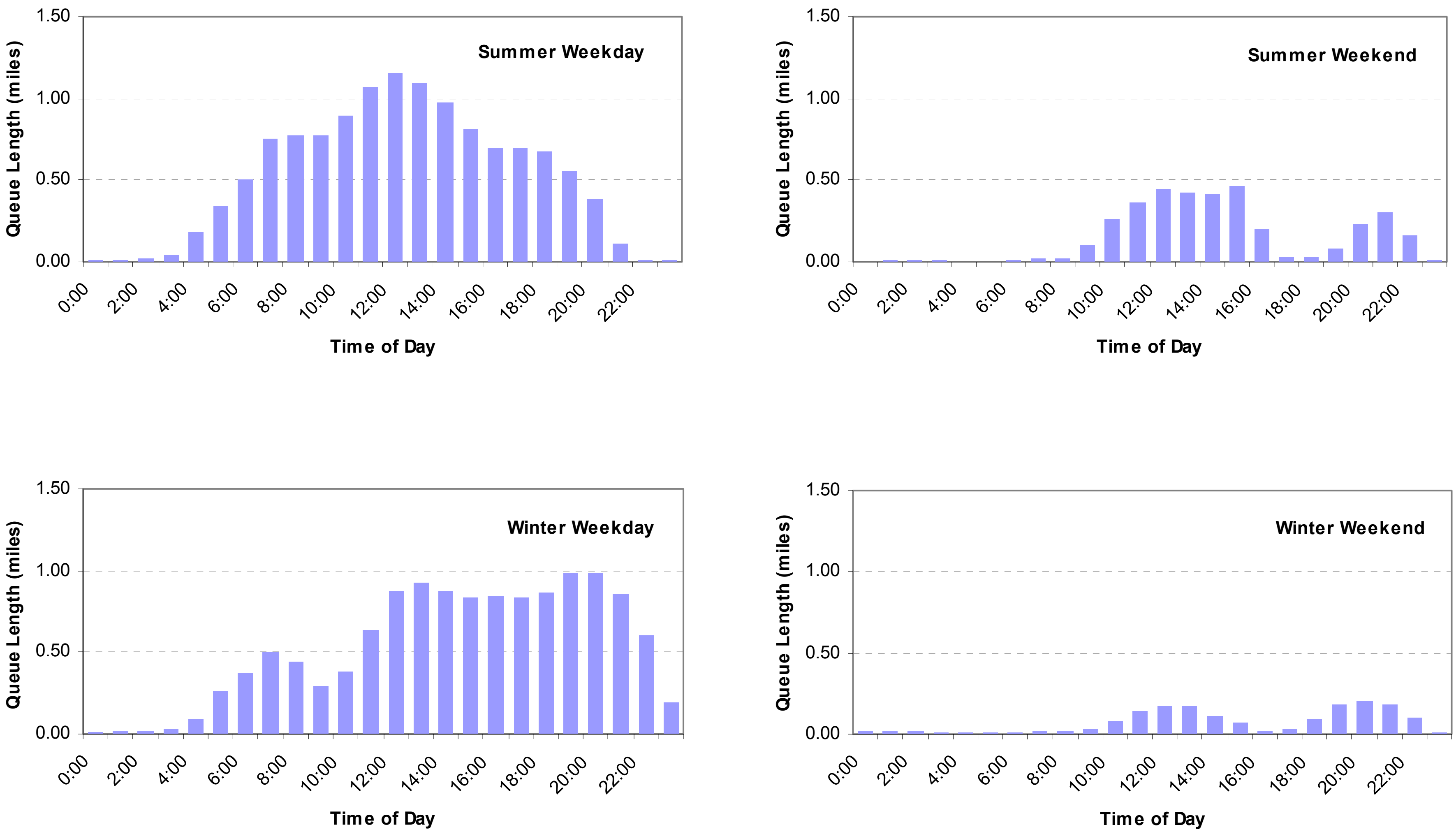





**Exhibit 3.12 – Southbound Representative Day Queue Length (miles)**

## 3.5 Northbound Representative Days

The development of the northbound "representative day" followed a similar process to the southbound direction. Travel characteristics that supported the definition of the northbound summer weekday are described in **Exhibit 3.13.** The comparative statistics are shown for the survey period. The final definition of the winter southbound representative day considered the following:

- In order to assist with customs officer training, two booths were open during for the majority of the survey period on June 19$^{th}$ and 20$^{th}$. As this is not consistent with the demand responsive policy, it is suggested that the observations of June 17$^{th}$ and 18$^{th}$ should be considered more representative;
- As in the southbound direction, the commercial vehicle demand between 8:00 AM and 5:00 PM extracted from the IMTC profile exceeded the observed demand for the survey days. In order to compare similar conditions, the IMTC profile was first factored to the average demand experienced on June 17$^{th}$ and June 18$^{th}$. This produced average survey period statistics that are consistent with observed conditions.
- the final "representative day" employed the IMTC average summer day profile, which showed 792 commercial vehicles during the survey period. The increased average queue length and travel time demand reflects the increased "representative day" demand. The final "representative day" demand is similar to that experienced June 20$^{th}$, and the average travel characteristics are similar to what would have likely been experienced has the second booth not been open for the entire afternoon.

**Exhibit 3.13 – Definition of Northbound Representative Summer Weekday (8:00 AM to 5:00 PM)**

| Criteria | Observed | | | | Representative Day | |
|---|---|---|---|---|---|---|
| | 17-Jun | 18-Jun | 19-Jun | 20-Jun | Factored | Final |
| **Demand** | 612 | 673 | 762 | 778 | 643 | 792 |
| **Average Queue Length (miles)** | 0.23 | 0.20 | 0.23 | 0.29 | 0.24 | 0.29 |
| **Average Travel Time w/o Parking Lot (min)** | 11 | 9 | 9 | 12 | 13 | 14 |
| **Average Travel Time with Parking Lot (min)** | 13 | 12 | 11 | 14 | 16 | 19 |

The model parameters adopted for the northbound model were transferred to the winter weekday and weekend day periods. The general characteristics between 8:00 AM and 5:00 PM for northbound "representative day" are provided in **Exhibit 3.14,** and average 24 hour queue profiles for each of these days are provided in **Exhibit 3.15.**

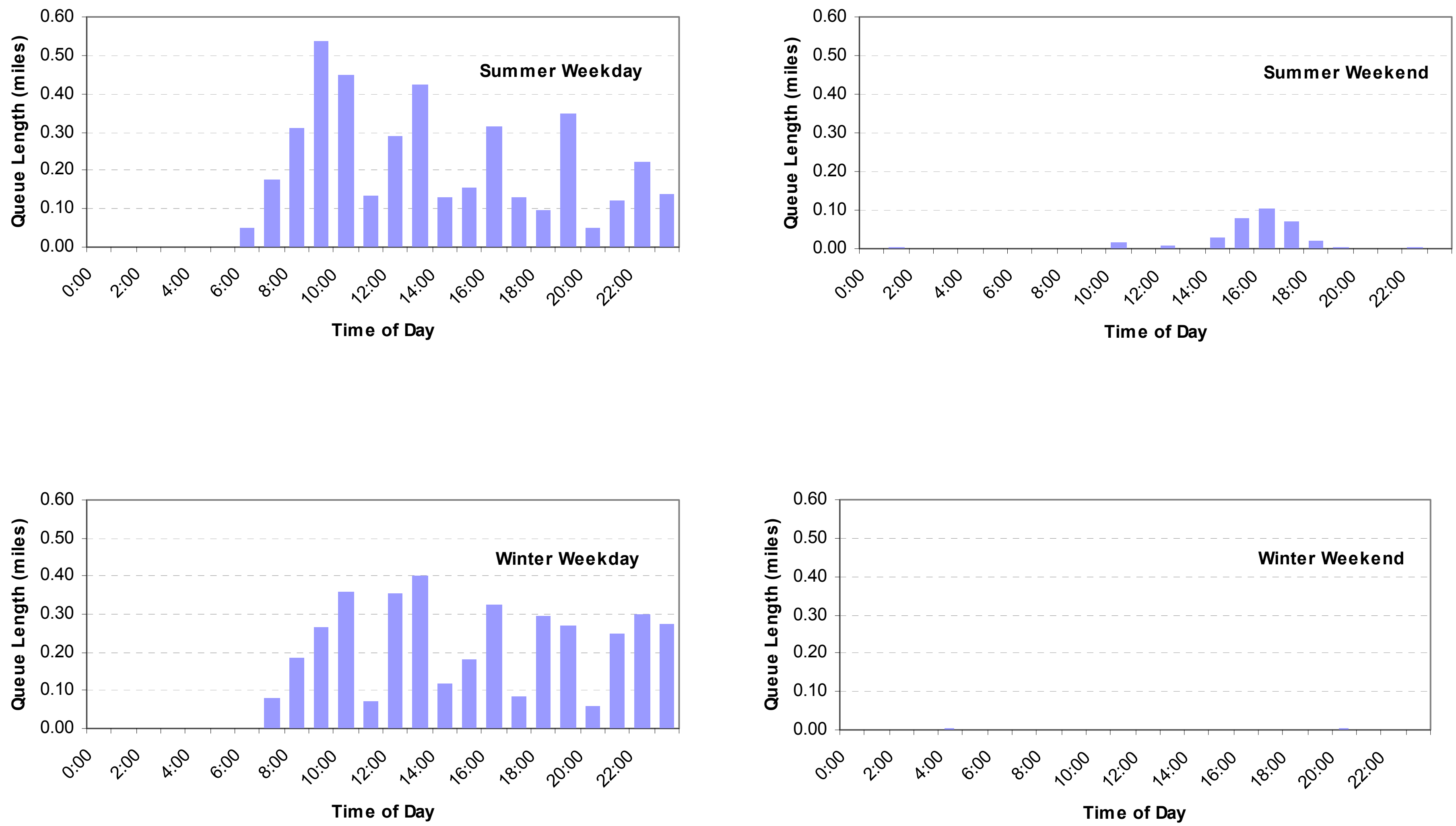





**Exhibit 3.15 – Northbound Representative Day Hourly Queue Length (miles)**

**Exhibit 3.14 – General Characteristics of Northbound Representative Days (8:00 AM to 5:00 PM)**

| Criteria | Summer | | Winter | |
|---|---|---|---|---|
| | Weekday | Weekend Day | Weekday | Weekend Day |
| **Demand** | 792 | 426 | 727 | 384 |
| **Average Queue Length (miles)** | 0.29 | 0.03 | 0.24 | 0.01 |
| **Average Travel Time w/o Parking Lot (min)** | 14 | 2 | 13 | 1 |
| **Average Travel Time with Parking Lot (min)** | 19 | 2 | 16 | 1 |

As in the southbound direction, border operations are most constrained during a representative summer weekday, where, at its peak, the queue can be approximately ¾ mile. Due to a decreased demand and different arrival rate throughout the day, the northbound queue on a representative winter day is approximately ½ mile. The profiles illustrated in **Exhibit 3.15** reflect the CCRA policy for opening the second customs booth. It is noteworthy that the representative queue on weekends is limited in the summer, and virtually non-existent in the winter.

## 3.6 Base Year Border Operations

The development of the eight "representative day" models enabled estimation of base year annual[5] border operations average travel time and total costs to commercial vehicles. The average annual travel time including customs broker related time in both directions, weighted by season and day of week over 24 hours, is provided in **Exhibit 3.16.** The average travel time for southbound commercial vehicles ranges from between 31 to 46 minutes per vehicle. The precleared average travel time in the northbound direction is less than the southbound direction; however the non-precleared time is close to double the non-precleared time in the southbound direction.

**Exhibit 3.16 – Average Annual Border Operations Travel Time (min/veh)**

| Truck Trip Type | Travel Time (min) | |
|---|---|---|
| | SB | NB |
| Precleared | 31 | 9 |
| Non-precleared | 46 | 91 |

It is understood that the cost of border operations at Pacific Highway Crossing and en-route truck inspection sites extends throughout the entire logistics supply chain. For example, in order to minimize investment in capital and inventory many

[5] Assuming that ‘summer and ‘winter’ each represent 6 months of the year, and that there are 264 weekdays and 101 weekend days per year.

manufacturers and distributors rely upon just-in-time delivery as a de facto extension their activities. However, confidence in the ability to have goods delivered 'just-in-time' is compromised at nodes such as Pacific Highway Crossing. Industry compensates for this through additional investment in capital and inventory, such lost opportunity cost may vary by commodity. Although SLM-49 may be enhanced to consider commodity flow, extended to other nodes on the logistics supply chain and integrated with macroscopic network models to represent travel on the entire logistic supply chain, the purpose of this analysis is to focus upon direct commercial vehicles costs of border operation the Pacific Highway Crossing node. These direct costs are presented in **Exhibit 3.17[6].**

**Exhibit 3.17 – Base Year Annual Cost of Border Operations by Source ($US)**

| Source of Cost | Annual Cost ($M) | | |
|---|---|---|---|
| | SB | NB | Total |
| **Approach to Customs Booth** | $11.1 | $2.7 | $13.8 |
| **Customs Booth Related** | $0.5 | $0.3 | $0.8 |
| **Customs Broker Related** | $2.1 | $5.3 | $7.4 |
| **Total Cost** | $13.6 | $8.4 | $22.0 |

The total annual commercial vehicle cost of border operations at the Pacific Highway Crossing is estimated at approximately $22 million, or $13.6 and $8.4 million in the southbound and northbound direction respectively. The primary source of border operations cost varies by direction of travel. For example, in the southbound direction, approximately 80 percent of the cost of southbound border operations is attributed to travel time on the approach to the border, and much of this travel time is experienced by both precleared and non-precleared commercial vehicles.

However, in the northbound direction, only 30 percent of the cost of northbound border operations is attributed to travel time on the approach to CCRA booths. Approximately 65 percent of the cost of northbound border operations is attributed to the 18 percent of commercial vehicles that require processing through customs brokers / CCRA. Overall, approximately 35 percent of the cost of border operations is attributed to customs broker related time.

The estimated base year annual cost of border operations by truck trip type is provided in **Exhibit 3.18.**

[6] Based upon an assumed value of time of U.S $36 and U.S $45 per hour for light and heavy commercial vehicles, respectively.

**Exhibit 3.18 – Base Year Annual Cost of Border Operations by Truck Trip Type ($US)**

| Truck Trip Type | Direction | | |
|---|---|---|---|
| | **SB** | **NB** | **Total** |
| **Precleared** | $6.5 | $2.6 | $9.0 |
| **Non-precleared** | $7.2 | $5.8 | $13.0 |
| **Total** | $13.6 | $8.4 | $22.0 |

Approximately 40 percent of the total annual cost of border operations ($7.8 million) is attributed to pre-cleared trucks, where the majority of this cost is incurred in the southbound direction.

**Exhibits 3.17** and **3.18** may be used to inform public policy and to focus capital and operational investments. For example, a southbound lane dedicated to ITS would provide significant benefits to both precleared and non-precleared trucks. However, in the northbound direction the primary value of ITS may be related to conversion of truck trips that are presently non-precleared.

# 4.0 2013 Representative Day Conditions

The previous section described the base year "representative day" that was used to evaluate the ITS deployment and dedicated traffic lane for the base year. However, as the project will continue to provide value in the future, year 2013 SLM-49 models were developed for each of the representative time periods. These models establish a basis for evaluating the benefits of ITS in year 2013, and enable interpolation of benefits in the intervening years.

Forecasts of future year travel conditions require base input assumptions such as total demand and demand profile, number of operating customs booths etc. Based upon the operations survey, it has been noted that border operations are sensitive to these assumptions. *Consequently, the future year models should be considered to represent potential border operations under a given set of realistic assumptions.*

The first part of this section describes future year assumptions including the method used to forecast Pacific Highway Crossing commercial vehicle demand to 2013[7], and other key border operations assumptions such as the number of open customs booths. By applying these input assumptions in SLM-49, estimated future year 2013 border operations conditions are described in the second section.

## 4.1 2013 Future Year Assumptions

*Commodity Based 2013 Commercial Vehicle Forecast*

As the movement of commodities is the fundamental driver of commercial vehicle activity, forecasts of commercial vehicle movements were based upon the projection of commodity flow over the border in both directions. It is noted that the transportation of commodities across Canadian-U.S. Ports of Entry results from complex and interrelated trade relationships among commodities, markets and prices. Relative prices, shifting markets, governmental policies, all have a dynamic impact on the demand for commodities away from their points of production or manufacture. Hence, specific estimates of the resultant trade flows are subject to the same risks and uncertainties.

It is possible, however, by allowing the market and institutional forces to shape the shipments of the commodities and products, to make reasoned and useful estimates of commodity flow by commercial vehicles through individual Ports of Entry and custom stations. Developing an understanding of the expected growth or decline in commodity flow permits these estimates and offers a

[7] Based upon Lower Mainland Border Crossing Commercial and Passenger Vehicle Forecasts, TSi Consultants in association with Cambridge Systematics for Transport Canada, 2002.

qualitative confidence interval to be used by planners around those estimates. This seems particularly suited to Canadian-U.S. traffic flows across the border due to the demand for movements coming from place bound resource industries, identifiable mills/factory locations and population nodes, especially in British Columbia.

The forecasting approach employed in this study assumes that industry structures are relatively stable. It is noted that forestry related products constitute a large portion of all southbound truck movements. However, there is a level of uncertainty regarding the softwood lumber trade agreements with the United States. For the purpose of this medium-term commercial vehicle forecast, it was assumed that a new softwood lumber agreement would be settled in the short term, and that dampened demand would be compensated by a low Canadian dollar relative to the U.S. dollar. Hence it was assumed that recent trends in wood and wood product exports would be maintained.

The following sources of data were used to characterize current and historic trade conditions and provide a basis for year 2013 forecasts.

**IMTC Cross Border Trade and Travel Survey**

The IMTC Cross Border Trade and Travel Survey was carried out in the summer and fall of 2000 at all four border crossings in the Lower Mainland during weekdays and weekends. Approximately 2,000 surveys were completed for commercial vehicles. This database was used for analysis of commodity flow for commercial vehicles.

**U.S. Census Data**

The U.S. Census provided commodity flow data for U.S. imports and exports by combined 10 digit Harmonized System Commodity Code through the District of Seattle (Washington) with Canada for the past 10 years. Based upon the IMTC data collection results, two additional groups were added, namely commercial vehicle movements where the commodity being transported was unknown, or where the commercial vehicle was empty.

Forecasts of 24 hour summer and winter weekday and weekend day commercial vehicle movements in both directions at the border were produced using the following general methodology:

1. Using linear regression, develop statistical trend relationships for exports and imports by commodity grouping based upon the U.S. Census data;
2. Apply these statistical relationships to produce forecasts and growth rates for imports and exports by commodity group; and,
3. Apply the commodity specific growth rate to the commodity distribution as observed in the IMTC Cross Border Trade and Travel Survey.

Note that this methodology does not account for variation in commodity flow demand due to change in mode split (i.e. rail vs. truck) or route assignment (i.e. diversion to alternative border crossings).

In general, exports of most commodity groups are expected to grow at between 3% to 5% per year towards horizon year 2013. The highest growth rates are anticipated in the bulk minerals and miscellaneous shipments groups.

It was assumed empty truck movements are the return trip from a commodity shipment, and that the growth in empty trucks is directly related to the growth in shipments in the opposite direction. Hence the weighted average growth rate in commodity movement for the southbound movements was applied to northbound movements, and vice versa. It was assumed that the 'unknown' grouping would grow by the weighted average growth rate of all commodity movements. Finally, it has been assumed that the dampening of cross-border commercial vehicle volume experienced in the wake of September 11th is a short term phenomena. In order to reflect this within the medium term forecast, the incremental 10 year growth in demand as estimated in previous work has been offset by two years such that it reflects 2013 estimates.

Base year and future year 2013 commercial vehicle estimates are provided in **Exhibit 4.2.**

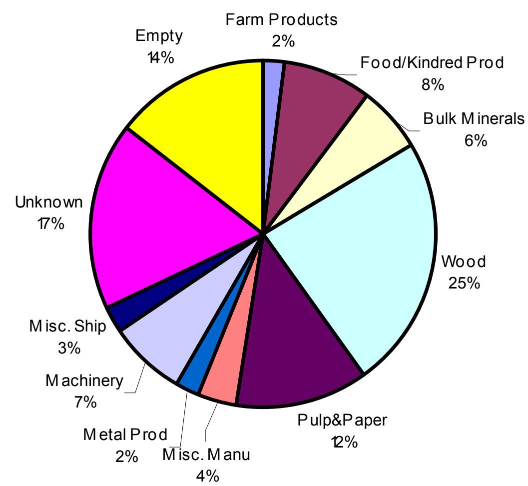
**Exhibit 4.2 – Base Year and Future Year 2013 Pacific Highway Crossing 24 Hour Commercial Vehicle Estimates**

| Time Period | 24 hour Vehicles by Direction | | |
|---|---|---|---|
| | **SB** | **NB** | **Total** |
| **Base Year** | | | |
| *Summer Weekday* | 1,840 | 1,590 | 3,440 |
| *Winter Weekday* | 1,640 | 1,520 | 3,160 |
| *Summer Weekend Day* | 970 | 840 | 1,810 |
| *Winter Weekend Day* | 800 | 700 | 1,510 |
| **Future Year 2013** | | | |
| *Summer Weekday* | 3,200 | 2,820 | 6,020 |
| *Winter Weekday* | 2,950 | 2,710 | 5,670 |
| *Summer Weekend Day* | 1,700 | 1,540 | 3,240 |
| *Winter Weekend Day* | 1,670 | 1,210 | 2,880 |

Commercial vehicle movements are expected to grow at a rate of close to 5 percent per year towards the future year 2013. The forecast summer weekday volume commercial vehicles at Pacific border crossing is expected to grow by close to 75 percent to over 6,000 crossings per day by 2013. The peak southbound direction is estimated to carry over 3,200 commercial vehicle trips per day.

**Exhibit 4.3** provides the forecast commodity distribution for an average summer day in 2013, and is comparable to **Exhibit 2.5.**

**Exhibit 4.3 – Future Year 2013 SADT Commodity Distribution**




The future year forecast distribution in **Exhibit 4.3** shows that wood related and food/kindred products are expected to increase as a proportion of total commodity flow. This exhibit gives an indication of the types of industry that may be afforded relief due to the ITS deployment / dedicated lane on an average summer day.

Other assumptions regarding future year demand include:

- The base year fleet composition by truck type was assumed to remain constant;
- The proportion of Canadian vs. U.S registered vehicles would remain constant;
- The base year distribution of commercial vehicle demand throughout the day was retained; and,
- It is reasonable to assume that the proportion of precleared commercial vehicles would increase over time. Therefore, the precleared/non-precleared split was adjusted to 60/40 in the southbound direction. As the non-precleared demand is already relatively low in the northbound direction, the northbound proportion of precleared/non-precleared was not adjusted.

*Customs Booth Related Operations*

Assumptions regarding customs booth operations are also a significant factor in defining future year border operations scenarios. For all models, the base year "representative day" customs booth related processing rates were applied to the future year.

In the southbound direction it was assumed that a third operating booth would be available for the majority of the summer and winter weekdays. It was assumed that a second booth was available for approximately 12 hours on weekend days. In the northbound direction, it was assumed that a second booth would be open for the majority of the day, and a third booth would open based upon forecast queue length.

*Customs Broker Related Operations*

Base year customs broker related time as observed in the border operations survey was transferred to the future year without adjustment. Future year assumptions are summarized in **Exhibit 4.4.**

**Exhibit 4.4 – Summary of Future Year Assumptions**

| Assumption | Base Year | | Year 2013 | |
|---|---|---|---|---|
| | SB | NB | SB | NB |
| **Operating Customs Booth(s)** | | | | |
| Weekday | 2 | 2* | 2 or 3 | 3* |
| Weekend day | 1 or 2 | 1 or 2* | 1 or 2 | 1 or 2* |
| Customs booth processing rate | based on the observed data and the application of random number generator | | same as base year conditions | |
| **Precleared and Non-precleared Split** | | | | |
| Precleared (PC) | 0.45 | 0.45 | 0.40 | 0.40 |
| Non-precleared (NPC) | 0.55 | 0.55 | 0.60 | 0.60 |
| **Fleet Composition** | from the observed data | | same as base year | |
| **Travel Demand Profile** | based upon IMTC profile | | based upon IMTC profile | |

* One of the customs booths is demand responsive

## 4.2 Future Year 2013 Base Conditions

The assumptions described in the preceding section were applied to SLM-49 by season and day of week to estimate travel time and cost associated with future year border operations. In summary, the estimated average annual travel time for the base and future year are provided in **Exhibit 4.5.**

**Exhibit 4.5 – Base Year and 2013 Average Annual Travel Time**

| Truck Trip Type | Year | | | |
|---|---|---|---|---|
| | Base | | 2013 | |
| | SB | NB | SB | NB |
| Precleared | 31 | 9 | 56 | 9 |
| Non-precleared | 46 | 91 | 71 | 92 |

**Exhibit 4.5** shows that the precleared travel time in the southbound direction would be expected to increase to 56 minutes per vehicle by 2013. Non-precleared vehicles in the southbound direction would be expected to experience a similar magnitude of increase in travel time.

The northbound direction would not be expected to experience a significant increase in travel time. This is related to the “demand responsive" policy which, by definition constrains travel time per vehicle to conditions similar to that presently observed.

The estimated annual cost of border operations is provided in **Exhibit 4.6.** The annual cost of border operations would be expected to increase by 250 percent from $22 million in the base year to $54 million in year 2013. It is noted that the majority of this increase in border operation cost would be expected in the southbound direction. In general, this reflects the near doubling of demand relative to a 50 percent increase in capacity at the customs booths (i.e. on additional booth)[8]. The cost of border operations would be expected to diminish if additional booths were opened.

**Exhibit 4.6 – Base and Future Year 2013 Annual Cost of Border Operations by Source ($US)**

| Source of Cost | Year | | | | | |
|---|---|---|---|---|---|---|
| | Base | | | 2013 | | |
| | SB | NB | Total | SB | NB | Total |
| Approach to Customs Booth | $11.1 | $2.7 | $13.8 | $36.0 | $4.5 | $40.6 |
| Customs Booth Related | $0.5 | $0.3 | $0.8 | $0.8 | $0.6 | $1.4 |
| Customs Broker Related | $2.1 | $5.3 | $7.4 | $3.4 | $9.0 | $12.4 |
| **Total Cost** | $13.6 | $8.4 | $22.0 | $40.3 | $14.1 | $54.4 |

The increase in border operations cost in the northbound direction is roughly proportional to the increase in demand. This is directly related to the assumption regarding the opening of a third booth, as demand requires.

The estimated future year 2013 border operation costs by truck trip type are provided in **Exhibit 4.7.** The total cost of border operations are fairly evenly split between precleared and non-precleared commercial vehicles. Non-precleared vehicles account for approximately 70 percent of the border operations costs in the northbound direction.

**Exhibit 4.7 – Future Year 2013 Annual Cost of Border Operations by Truck Trip Type ($US)**

| Truck Trip Type | Year | | | | | |
|---|---|---|---|---|---|---|
| | Base | | | 2013 | | |
| | SB | NB | Total | SB | NB | Total |
| Precleared | $6.5 | $2.6 | $9.0 | $22.0 | $4.4 | $26.4 |
| Non-precleared | $7.2 | $5.8 | $13.0 | $18.3 | $9.7 | $28.0 |
| **Total** | $13.6 | $8.4 | $22.0 | $40.3 | $14.1 | $54.4 |

[8] Based upon a 'reasonable' scenario discussed with US Customs

# 5.0 ITS Benefits Evaluation

Previous sections of this report described commercial vehicle operations at the Pacific Highway Crossing, the development of SLM-49, the characteristics of base and future year "representative days", and cost estimates of border operations by source.

In particular, **Section 3** described the sensitivity of queue and travel time to variables such as travel demand, processing rates and the number of operating booths. In this context, this section provides an evaluation of the ITS deployment and commensurate dedicated lane. The first part of this section describes the technique used to estimate commercial vehicle border operations benefits for cost source. The second part of this section provides the net present value of the benefits under three potential ITS scenarios. The final section summarizes conclusions of the ITS evaluation.

## 5.1 Benefit Estimation by Cost Source

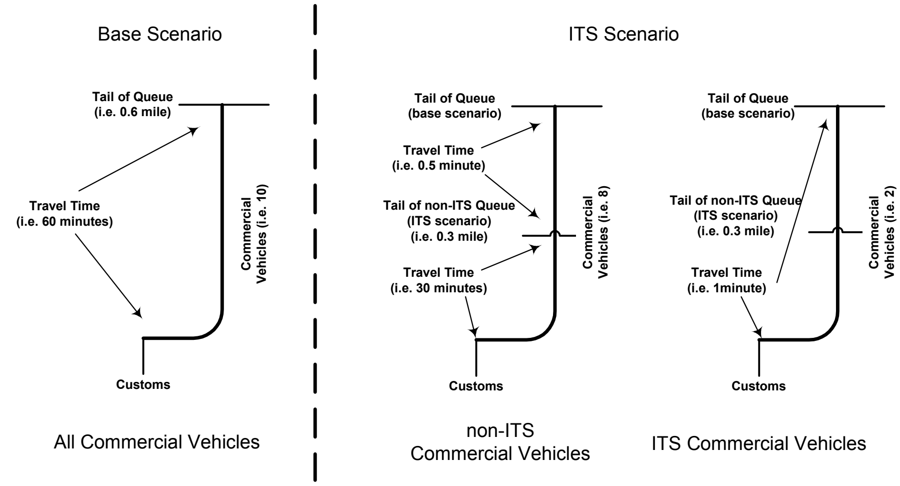
The travel time benefits for commercial vehicles were estimated for each "representative day". They were subsequently converted to a dollar value, and factored to estimated annual benefits. For the purpose of this analysis the following base assumptions were made:

- The proposed ITS lanes would extend for approximately 0.5 miles from the customs booths;
- Three potential ITS scenarios of ITS demand were evaluated;
- Of the converted ITS demand, approximately 70 percent was converted from precleared and 30 percent was converted from non-precleared;
- ITS trucks would experience customs booth related time consistent with the other commercial vehicle booths;
- The value of time for commercial vehicles registered in the United States was US $36 and $45 per hour for light and heavy commercial vehicles, respectively; and,
- The summer and winter periods extend for 6 months each, and there are 261 weekdays and 101 weekend days in a typical year.

*Approach to Customs Booths*

**Exhibit 5.1** provides an example on the estimation of travel time benefits on the approach to the customs booths. The left hand side of **Exhibit 5.1** gives a travel time for commercial vehicles for a 10 minute interval for the base scenario. In this interval 10 commercial vehicles arrive and, given a processing rate and conditions from the preceding interval, the queue and travel time have been estimated at 0.6 miles and 60 minutes, respectively.

**Exhibit 5.1 – Sample 'Approach to Customs Booth' Benefits Estimation**




The right hand side of **Exhibit 5.1** illustrates the ITS scenario, and assumes that ITS commercial vehicles comprise of 20 percent of total vehicles. In this scenario, the cost of travel equivalent to the base scenario for general purpose (non-ITS) demand would consist of travel time in the reduced queue and travel time between the tail end of the queue in the base and test scenarios, respectively. The benefits for non-ITS trucks are the differential travel time between the two scenarios.

The estimation of benefits for the ITS trucks is similar in nature, where, in this example, the queue is limited. As these commercial vehicles effectively use a queue bypass, the benefits per commercial vehicle may be significantly higher than the benefits attributed to general purpose commercial vehicles. Using SLM-49, these benefits are estimated for precleared, non-precleared and ITS commercial vehicles for every 10 minute time interval throughout each representative day.

### *Customs Broker Related Time*

The benefits due to a reduction in customs broker related time is attributable only to commercial vehicles that have been converted to ITS. Consequently, the benefits of reduced customs broker related time is the product of the customs broker related time distribution and the number of converted ITS trucks. The highest benefits per vehicle would be attributed to northbound ITS trucks due to the higher average time incurred at the customs broker.

### *Customs Booth Related Time*

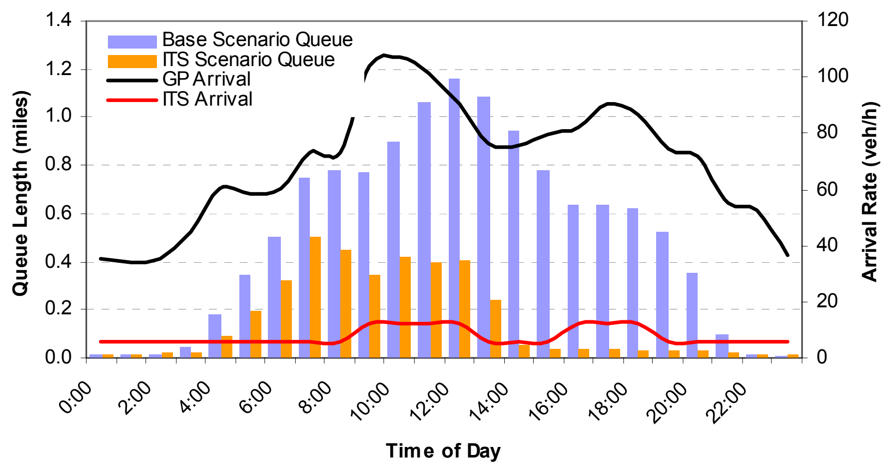
In was demonstrated in Section 3 that customs booth related travel time constitutes approximately 3 percent of the overall border operations related time in the base year. Consequently, the direct benefits of reduced customs booth related time for ITS commercial vehicles would be limited. However, please note that the benefits (or costs) of changes in customs booth related time would have an influence upon travel time on the approach to the border.

## 5.2 ITS Deployment Benefits for a Base Year Southbound Summer Weekday

The purpose of this section is to demonstrate the evaluation of the benefits, using the base year southbound summer weekday as an example. For this example, the ITS deployment / dedicated lane was evaluated based upon the scenario that 10 percent of the total demand would be converted to ITS. The impact of this scenario on the approach to the Customs booth for a representative summer weekday is illustrated in **Exhibit 5.2.**

The blue and orange bars represent the non-ITS queue for the base and ITS scenarios, respectively. Under either scenario, the ITS demand throughout the day is limited and, given its own dedicated booth, did not generate a significant queue. Under the assumption of 10 percent ITS conversion, 10 percent of the demand is effectively removed from the non-ITS traffic stream. **Exhibit 5.2** shows that the queue length for non-ITS demand can be expected to decrease to a maximum of approximately 0.5 miles, and dissipate by mid afternoon.

**Exhibit 5.2 – Non-ITS Queue Length for a Representative Base Year Summer Weekday (10% ITS Conversion)**




It is evident from **Exhibit 5.2** that the ITS deployment will provide substantial travel time benefits for both the ITS and non-ITS commercial vehicles. The overall benefits of the ITS deployment / dedicated lane would include time savings related to customs brokers, and can be expected to vary by season and day of week. This variation is shown in **Exhibit 5.3.**

**Exhibit 5.3 – Base Year Commercial Vehicle Border Operations Benefits by Season and Day of Week (10% ITS) ($US million)**

| Season / Day | SB | NB | Total |
|---|---|---|---|
| **Summer** | | | |
| Weekday | 63% | 46% | 61% |
| Weekend Day | 4% | 10% | 5% |
| *Total* | 67% | 56% | 65% |
| **Winter** | | | |
| Weekday | 32% | 39% | 33% |
| Weekend Day | 2% | 5% | 2% |
| *Total* | 33% | 44% | 35% |
| **Total** | | | |
| Weekday | 94% | 85% | 93% |
| Weekend Day | 6% | 15% | 7% |

Due to higher demand and congestion during the summer season, approximately 65 percent of the commercial vehicle border operations benefits will be during the summer. Furthermore, 93 percent of the benefits can be expected on weekdays.

SLM-49 also enables the benefits to be isolated by cost source and truck type. This was estimated for each season and day of week, and the base year annual benefits are provided in **Exhibit 5.4.**

**Exhibit 5.4 – Base Year Benefits by Source and Trip Type (10% ITS Conversion) ($US million)***

<table>
<tr><th rowspan="2">Cost Source and Trip Type</th><th colspan="2">Direction</th><th rowspan="2">Total</th></tr>
<tr><th>SB</th><th>NB</th></tr>
<tr><td colspan="4">Approach to Customs Booth</td></tr>
<tr><td>ITS (converted from PC)</td><td>$0.8</td><td rowspan="2">$0.2</td><td rowspan="2">$1.3</td></tr>
<tr><td>ITS (converted from NPC)</td><td>$0.3</td></tr>
<tr><td>Total ITS</td><td>$1.1</td><td>$0.2</td><td>$1.3</td></tr>
<tr><td>Precleared (PC) (remainder)</td><td>$3.6</td><td rowspan="2">$0.1</td><td rowspan="2">$6.4</td></tr>
<tr><td>Non-precleared (NPC) (remainder)</td><td>$2.8</td></tr>
<tr><td>Total Non-ITS</td><td>$6.3</td><td>$0.1</td><td>$6.4</td></tr>
<tr><td>Total Approach To Customs</td><td>$7.4</td><td>$0.3</td><td>$7.7</td></tr>
<tr><td colspan="4">Customs Broker Related</td></tr>
<tr><td>ITS (converted from NPC)</td><td>$0.2</td><td>$0.8</td><td>$0.9</td></tr>
<tr><td>Total Benefit</td><td>$7.5</td><td>$1.1</td><td>$8.6</td></tr>
</table>

* - totals may not add up due to rounding

Assuming that 10 percent of the demand would be converted to ITS, the total estimated benefit of ITS deployment / dedicated lane in the base year is $8.6 million. Given estimated project costs is in the range of $10 million, the commercial vehicle border operations benefits would justify the project in the very short term.

The majority of these benefits ($7.5 million) are derived in the southbound direction. Overall, approximately 90 percent of the benefits are related to the approach to the Customs booth, and 10 percent of total benefits are custom broker related.

*Southbound*

In the southbound direction, the majority of these benefits are related to time savings on the approach to the customs booth. Again, it is noteworthy that the diversion of 10 percent of the traffic stream to ITS effectively reduces the general purpose queue and travel time. Consequently, over 85 percent of the benefits in the southbound direction are related to non-ITS commercial vehicles, and the total benefits related to ITS vehicles is approximately $1.3 million. In the southbound direction, the benefits related to the customs broker is limited.

*Northbound*

The base year benefits in the northbound direction are approximately 1 million, or 15 percent of the total benefits. Of this, approximately 75 percent of the benefits are attributed to customs broker related time savings. Although the proportion of commercial vehicles assumed to have converted from non-precleared to ITS is limited, the benefits attribute to this conversion are significant due to the relatively high customs broker related time in the northbound direction (approximately 75 minutes per vehicle).

Approximately 25 percent ($0.2 million) of the benefits are attributed to travel time on the approach to customs in the northbound direction, and the majority of these benefits are attributed to ITS commercial vehicles. The benefits for non-ITS commercial vehicles in the northbound direction are constrained by the “demand responsive” opening of an additional booth. In other words, the reduction in demand due to conversion to ITS reduces demand sufficiently that the additional booth may not open as frequently throughout the day. This effectively creates overall daily conditions for non-ITS demand that is similar to the base condition.

Based upon future year representative days, year 2013 benefits assuming 15 percent ITS demand are provided in **Exhibit 5.5.** The estimated overall benefits are $29.3 million, where 90 percent of these benefits are derived from the southbound direction. Similar to the base year scenario, the primary source for the benefits is on the southbound approach to the customs booths; and the majority of these benefits are related to non-ITS commercial vehicles.

**Exhibit 5.5 – Future Year 2013 Benefits by Source and Trip Type (15% ITS) ($US million)**

| Cost Source and Trip Type | Direction | | Total |
|---|---|---|---|
| | SB | NB | |
| **Approach to Customs Booth** | | | |
| ITS (converted from PC) | $3.1 | $0.5 | $5.1 |
| ITS (converted from NPC) | $1.5 | | |
| *Total ITS* | *$4.6* | *$0.5* | *$5.1* |
| Precleared (PC) (remainder) | $13.1 | $0.1 | $21.5 |
| Non-precleared (NPC) (remainder) | $8.3 | | |
| *Total General Purpose* | *$21.4* | *$0.1* | *$21.5* |
| *Total Approach To Customs* | *$26.0* | *$0.6* | *$26.6* |
| **Customs Broker Related** | | | |
| ITS (converted from NPC) | $0.4 | $2.2 | $2.6 |
| **Total Benefit** | $26.4 | $2.9 | $29.3 |

In the northbound direction, the majority of the benefits are attributed to customs broker related time. The estimated future year benefits attributed to ITS vehicles in the northbound direction is approximately $US 2.5 million.

## 5.3 Overall ITS Benefits Evaluation

SLM-49 model runs similar to that described in the preceding section were conducted for each time period for the base and horizon year models for the following three scenarios identified in **Exhibit 5.6**.

**Exhibit 5.6 – ITS Scenarios**

| Scenario | % ITS Conversion Year | |
|---|---|---|
| | Base | 2013 |
| *1* | 10% | 15% |
| *2* | 15% | 25% |
| *3* | 25% | 35% |

Using as discount rate of 7 percent, the present value of benefits for ITS deployment and dedicated lane in both directions at the Pacific Highway Crossing is provided in **Exhibit 5.7.**

**Exhibit 5.7 – Present Value of Benefits for ITS Demand Scenarios ($US million)**

| Direction | | ITS Demand Scenario 1 | ITS Demand Scenario 2 | ITS Demand Scenario 3 |
|---|---|---|---|---|
| **SB** | | | | |
| | *ITS* | $19 | $32 | $40 |
| | *Non-ITS* | $86 | $92 | $88 |
| | *Total* | $105 | $124 | $128 |
| **NB** | | | | |
| | *ITS* | $12 | $20 | $29 |
| | *Non-ITS* | $1 | $3 | $5 |
| | *Total* | $13 | $23 | $34 |
| **Total** | | $118 | $147 | $162 |

The present value of the benefits related to ITS deployment / dedicated lane for the three scenarios ranges between $118 to $162 million. Of these benefits, $31 to $69 million are attributed to ITS commercial vehicles, and the remaining non-ITS commercial vehicles.

The benefits in the southbound direction also show a diminishing return with increased used of the ITS lane.  This is primarily related to two items:

- border operations are sensitive to changes in the demand, and the a large part of the reduction in non-ITS queue is experienced in the initial 10 to 15 percent shift in conversion to ITS.
- the benefits per ITS commercial vehicle diminishes as the ITS lane would begin to experience a queue at a level between 25 to 35 percent ITS.  This may not be a concern with the implementation of the FAST system.

The benefits in the northbound direction are, relative to the southbound direction, limited.  This is related to the 'demand responsive' booth opening policy where, given a reduced non-ITS demand, the additional booth may not open as frequently.  As the majority of the benefits in the northbound direction are derived from customs broker related time, the benefits in the northbound direction are closely related to the proportion of ITS demand that has been converted from the non-precleared traffic stream.

### *Other Considerations*

The previous section demonstrated that the benefits within the first two to three years of project implementation can be expected to justify the project.  The present value of the overall benefits range between $118 to $162 million.  This suggest that a substantial decrease in the present value of benefits would still provide positive benefit – cost ratio.

However, the estimation of total benefits should be considered in the context of the following:

- the future year models assume that border customs officer staffing operations would be increased relative to base year operations. However, without additional customs officer staffing, the benefits of the ITS deployment would be substantially higher.
- the benefits assume that the demand between the base and the future year would remains constant. However, introduction of ITS or the reduced queue in the non-ITS lanes may potentially divert demand from other crossings. These 'generated' trips would receive additional benefits. For example, a commercial vehicle driver would not divert to Pacific Highway Crossing from Huntingdon Crossing (Highway 13) if it did not provide travel time benefits. However, estimation of the benefits would require information regarding the operations at other border crossing ports of entry and network travel time between crossings. However, these potential benefits were not estimated as linking SLM-49 with other logistics supply chain nodes and network models was outside of the scope of this study.
- the improved border operations due to ITS may induce additional trips that have been foregone due to border congestion. These additional trips would create a direct economic benefit outside of the travel time benefits estimated by SLM-49.
- the benefits related to the approach to the customs booth in the southbound direction were substantial. Depending upon staffing policy, closing of a southbound booth commensurate with decreased demand may reduce the overall benefits for non-ITS demand.

# 6.0 Summary and Conclusions

Primary purposes of this study were to describe current border operations and to estimate potential commercial vehicle travel time benefits of the proposed ITS deployment and dedicated lane at the Pacific Highway Border Crossing. This section presents the salient conclusions.

## 6.1 Border Operations

The border operations survey demonstrated that the combination of commercial vehicle arrivals, customs broker related time and customs booth related processing time produces a set of operating conditions that are unique to each survey day. Border operations are sensitive to changes in these variables such as opening of an additional booth, reduction in processing time or a change in commercial vehicle demand.

The daily average annual border operations travel time in the southbound direction is estimated at 31 minutes for precleared commercial vehicles and 46 minutes for non-precleared commercial vehicles, or an overall average of 37 minutes per vehicle. In the northbound direction, the overall average commercial vehicle border operations time is 24 minutes. This is broken down into 9 minutes for precleared vehicles and 92 minutes for non-precleared vehicles (represent 18% of total northbound commercial vehicles), where the significant extra time for non-precleared vehicles is related to customs broker/CCRA activities after primary inspection.

Based upon commercial vehicle forecasts and customs operation assumptions, the daily average southbound border operations travel time would expect to increase to 62 minutes per vehicle by 2013. The daily average travel time in the northbound direction would not expect to increase significantly from base year observations due to the “demand responsive” policy of opening an additional booth during heavy demand periods.

The base year annual cost of border operations for commercial vehicles is estimated at $22.0 million. Of this, approximately 60 percent was attributed to the southbound commercial vehicles and 40 percent to the northbound commercial vehicles. The majority of the border operations cost in the southbound direction was related to the travel time to the customs booths. However, in the northbound direction the majority of the border operations cost was associated with customs brokers and related CCRA activities.

Other findings from the border operations survey are summarized as follows:

- The fleet composition varies by direction of travel. Of note, the number of commercial vehicles classified as passenger vehicles was 17 percent in the southbound direction and only 10 percent in the northbound direction;

- Approximately 45 percent of vehicles were not precleared in the southbound direction. This compares to 18 percent in the northbound direction;
- Close to 37 percent of vehicles in the northbound direction were empty. This compares to 10 percent in the northbound direction;
- The average commercial vehicle border operations travel time was 26 and 40 minutes in the northbound and southbound directions, respectively;
- In the northbound direction, the average travel time for non precleared vehicles was approximately 80 minutes longer than precleared vehicles;
- During the survey days, sustained northbound queuing over ½ mile was not experienced. Variation in queue length from day to day can in part be attributed to the number of operating CCRA booths;
- The average southbound border operations travel time ranged between 23 to 60 minutes for the four survey days. This variation can in part be attributed to variation in the service rate at the U.S. Customs booths; and,
- The maximum queue length in the southbound direction extended beyond one mile for sustained periods. A third U.S. Customs booth opening during one of these periods had a profound affect on the dissipation of the queue.

## 6.2 ITS Evaluation

The benefits of ITS deployment/dedicated lane were evaluated for three scenarios of assumed conversion to ITS. The benefits in the first year was estimated at $8.6 million. This demonstrates that the project may be economically justified within the first few years of operation.

The present value of ITS benefits were ranged from $118 million to $162 million. This suggests that a substantial reduction in the present value of ITS benefits would still provide a positive benefit – cost ratio. The majority of the benefits could be realized by non-ITS commercial vehicles experiencing congestion relief. However, the benefits for ITS related vehicles only would likely be sufficient to justify the project.

There might be additional benefits related to commercial vehicle trips diverted from other crossings, and induced trips due to less congestion at the border crossing.

## 6.3 The Way Forward

The border operations survey methodology has yielded important information regarding border operations. SLM-49 successfully combined the unique dynamics experienced at the Pacific Highway border crossing, with standard queuing theory. As such, SLM-49 extended the usefulness of the border operations data by providing an analytical basis for estimating commercial vehicle border operations costs by cost source, and enabling the estimation of benefits related to ITS deployment for both non-ITS and ITS traffic streams.

This study has provided insight into border operations, and identified efficiencies that may be achieved at one node on the logistics supply chain. Further analysis of the benefits of ITS on the logistics supply chain can be supported by extension of SLM-49 to:

- other border crossing Ports of Entry;
- other nodes on the logistics supply chain such as port container terminals and truck inspection sites (weigh scales);
- passenger vehicles nodes; and,
- border operation component of cross-border travel demand forecasting models.

# APPENDIX A

## SURVEY METHODLOGY

# A. Commercial Vehicle Survey Methodology

## A.1 Survey Methodology

The survey methodology was primarily developed to capture travel time and delay by major segment from the moment a commercial vehicle entered the study area to the completion of primary inspection at customs booths. The station locations are identified by red circles in **Exhibits 2.1** and **2.2** which are located in section 2 of the report**.** The specific role and function of each surveyor is described in **Exhibits A.2.1** and **A.2.2.**

Permission to station surveyors near the Customs booths was granted by U.S. Customs and the Canada Customs and Revenue Agency (CCRA). U.S. Immigration and Naturalization Services (INS) provided cross-border travel privileges for the management and conduct of the survey.

Data collected at each station enabled quantification of *travel time* in the general vicinity of the border crossing. The total elapsed travel time is related to the sum or parts of the travel time caused by roadway congestion, time expended for processing brokerage papers, and inspection and clearance time experienced at the customs booths.

## A.2 Application of Personal Digital Assistants

Matthew Li trains surveyors on surveyor roles and use of PDA.

The use of mobile computing devices, now commonly referred to as personal digital assistants (PDA), were used to record the entries. This technique has several advantages over the paper based systems including:

- Precise “timestamp” at every survey station;
- Field data entry and real-time error checking dramatically reduce data collection errors; and eliminate labor intensive scanning/data entry process;
- Eliminates labor intensive scanning/data entry process;
- Wireless data transfer enables rapid development of databases and daily logic /surveyor performance checks; and
- Efficient database development permits timely processing and production of analysis and graphical summary reports.

## Exhibit A.2.1 – Southbound Surveyor Role and Function

| SURVEYOR | SURVEY STATION | SURVEY DESCRIPTION |
|---|---|---|
| **1** | **Pacific Highway** | ▪ **Purpose:** Record when *and* where a truck first enters the queue.<br>▪ **Capture**: License plate of ALL SOUTHBOUND trucks.<br>▪ **Queue:** Record length of queue.<br>▪ **Location**: Rover/floating position. On west side of Pacific Highway depending upon queue length of truck traffic from the border to north on Pacific Highway. |
| **2** | **Duty Free Parking Lot (Staging Area C)** | ▪ **Purpose:** Record the amount of time spent at the Duty Free or customs broker *and* record trips going through the lot (if the rover at Station 1 is south of the Duty Free entrance, this would be the first record of the truck entering the system).<br>▪ **Capture**: License plate of ALL trucks at TWO times: 1. IN - When the driver stops and exits the truck; and 2. OUT - When the truck attempts to re-enter the traffic stream. On days 2-4 this station collected through trips, or trips that passed through this station but did not stop.<br>▪ **Location**: Rover/floating position within Duty Free area. Within Duty Free parking lot, depending on length of queue. |
| **3** | **Commercial Vehicle Pullout Parking Area On Pacific Hwy (Staging Area B)** | ▪ **Purpose:** Record the amount of time spent at the customs broker.<br>▪ **Capture**: License plate of ALL trucks at TWO times: 1. IN - When the driver stops and exits the truck; and 2. OUT - When the truck attempts to re-enter the traffic stream.<br>▪ **Location**: Rover/floating position within truck holding area. |
| **4** | **New Gravel Commercial Staging Area (Staging Area A)** | ▪ **Purpose:** In association with Surveyor 5, record the amount of time spent at the customs broker.<br>▪ **Capture**: License plate of ALL trucks when the driver stops and exits the truck.<br>▪ **Co-ordination:** Co-ordinate with Station 5.<br>▪ **Location**: Rover/floating position within gravel truck holding area. |
| **5** | **New Gravel Commercial Staging Area (Staging Area A)** | ▪ **Purpose:** In association with Surveyor 4, record the amount of time spent at the customs broker.<br>▪ **Capture**: License plate of ALL trucks when the truck attempts to re-enter the traffic stream.<br>▪ **Co-ordination:** Co-ordinate with Station 4.<br>▪ **Location**: Rover/floating position within gravel truck holding area. |
| **6, 7 & 8** | **U.S. Customs Booths** | ▪ **Purpose:** Record the time that trucks spend at the Customs booth and when they exit the system.<br>▪ **Capture**: License plate of ALL trucks at TWO points: 1. IN - When the truck stops at the Customs booth; and 2. OUT - When the truck begins to exit the Customs booth.<br>▪ **Vehicle Type:** Record vehicle type including empty/full (classification).<br>▪ **Location**: Station 6 is the right lane and station 7 the left lane at the U.S. Customs booths. Station 8 is used infrequently when a third booth is opened. |

## Exhibit A.2.2 – Northbound Surveyor Role and Function

| SURVEYOR | SURVEY STATION | SURVEY DESCRIPTION |
|---|---|---|
| **1** | **SR- 543** | ▪ **Purpose:** Record when *and* where a truck first enters the queue.<br>▪ **Capture**: License plate of ALL NORTHBOUND trucks.<br>▪ **Queue:** Record length of queue.<br>▪ **Location**: Rover/floating position. On east side of SR-543. Depending upon queue length of truck traffic towards Boblett Rd by Exxon Gas Station. |
| **2** | **Truck Holding Area** | ▪ **Purpose:** Record the amount of time spent at the truck holding area.<br>▪ **Capture**: License plate of ALL trucks at TWO times: 1. IN - When the driver stops and exits the truck; and 2. OUT - When the truck attempts to re-enter the traffic stream.<br>▪ **Location**: Rover/floating position within truck holding area. |
| **3 & 4** | **Canadian Custom Booths** | ▪ **Purpose:** Record the time that trucks spend at the Customs booth and when they exit the system.<br>▪ **Capture**: License plate of ALL trucks at TWO times: 1. IN - When the truck stops at the Customs booth; and 2. OUT - When the truck begins to exit the Customs booth.<br>▪ **Vehicle Type:** Record vehicle type (classification). Pickup empty/full tally sheet from CCRA officer every half hour.<br>▪ **Location**: Station 3 is the left lane and station 4 the right lane at the Canada Customs booths. |
| **5** | **Canadian Custom Truck Parking Area Exit (automated booth)** | ▪ **Purpose:** Record the time that trucks spend at the brokers and when they exit the system.<br>▪ **Capture**: License plate of ALL trucks leaving truck holding area via the automated booth.<br>▪ **Location**: Stationary position located behind the gates on a traffic island. |

## A.3 Data Collected

The primary items of data collected included the first four characters in the license plate and a timestamp for each observation. For vehicles with multiple plates, local license (British Columbia or Washington) or the license plate nearest to the surveyor was recorded. Synchronized time stamps were automatically recorded in each of the PDA at all the stations when the license plate data were entered.

Surveyors at morning gathering place.

In addition to license plate data, the following data were also collected:

- Vehicle classifications collected at the customs booths. These included passenger vehicles (that proceeded through the commercial vehicle clearance operations), light trucks and various combination of heavy trucks. These are described in more detail in **Appendix C**.
- Empty trucks could be identified at the US Customs booths as they generally were expected to pull forward for a brief inspection at the booth prior to release. These trucks were recorded using the PDAs. In the northbound direction, CCRA officials recorded the number of empty trucks using a tally sheet on a 30 minute basis.
- Length of queue along Pacific Highway and SR 543; and,
- Occupancy of truck staging areas.

## A.4 Survey Schedule and Duration

Four days of data were collected in each direction. The survey dates and duration are provided in **Exhibit A.4.1**. Note that the survey started one hour early on June 11. The purpose of this was to obtain data observations for an earlier start time. As there was no real queue at the time, this extra hour was compensated for on June 13.

Recording an entry using a PDA.

**Exhibit A.4.1 – Survey Dates and Duration**

| Dates | Duration |
|---|---|
| *Southbound* | |
| June 10, 2002 | 8:00 AM to 5:00 PM |
| June 11, 2002 | 7:00 AM to 5:00 PM |
| June 12, 2002 | 8:00 AM to 5:00 PM |
| June 13, 2002 | 8:00 AM to 4:00 PM |
| *Northbound* | |
| June 17, 2002 | 8:00 AM to 5:00 PM |
| June 18, 2002 | 8:00 AM to 5:00 PM |
| June 19, 2002 | 8:00 AM to 5:00 PM |
| June 20, 2002 | 8:00 AM to 5:00 PM |

### A.5 Data Cleaning and Logic Checks

The data collected during the survey was subjected to a number of logic checks where erroneous entries were identified and corrected:

- License plate validity – search and correction of invalid characters etc..
- License plate matching – for stations where in's and out's were recorded. Similar but not matching plates were identified and corrected based upon entries at other stations; and,
- In's and out's – Identify and, if necessary, correct records where only an 'in' or 'out' was recorded e.g. some records that did not need modification were those that did not show an 'in' for trucks that were parked prior to the start of the survey period.

Records from each individual station were aggregated into a master table for each day. This required matching truck records at stations sequentially throughout the border clearance operations. The number of commercial vehicles processed at the Customs booth served as a control for the master table, and the 'hit rate' for aggregation of individual station tables to the master table was between 90 to 95 percent for trucks.

# APPENDIX B

## DATABASE STRUCTURE

The following exhibits proved a description of the master tables. A consolidated table is provided for each direction. Records of truck trips that were captured at Customs booths but not at upstream locations have been removed.

### Exhibit B.1 – Southbound Database Structure

| Field | Field Name | Type | Description |
|---|---|---|---|
| 1 | DAY | Numeric | day of Week: June 10= 1, June 11= 2, June 12= 3, June 13= 4 |
| 2 | LICENSE | Character | license plate |
| 3 | QUEUELEN | Numeric | head of queue at time of record entry (metres north of U.S. Customs booths) |
| 4 | TIMESTN1 | DateTime | time recorded at station 1 (rover) |
| 5 | TIMESTN2i | DateTime | time of driver exiting stopped vehicle in duty free/commercial vehicle staging area (C) |
| 6 | TIMESTN2o | DateTime | time of driver/truck re-entering traffic stream at duty free/commercial vehicle staging area (C) |
| 7 | STN2THRU | Character | Is a truck passing through station 2 without stopping (days 2- 4 only) |
| 8 | THRUTIME | DateTime | time of commercial vehicle passing through station 2 without stopping (days 2- 4 only) |
| 9 | TIMESTN3i | DateTime | time of driver exiting stopped vehicle in staging area (B): station 3 |
| 10 | TIMESTN3o | DateTime | time of driver/truck re-entering traffic stream in staging area (B): station 3 |
| 11 | TIMESTN4 | DateTime | time of driver exiting stopped vehicle in staging area (C): station 4 |
| 12 | TIMESTN5 | DateTime | time of driver/truck re-entering traffic stream in staging area (C): station 5 |
| 13 | TIMESTNi | DateTime | time of vehicle arriving at customs booth |
| 14 | TIMESTNo | DateTime | time of vehicle proceeding from customs booth |
| 15 | VEHTYPE | Character | commercial vehicle type (see codes below) |
| 16 | STNID | Numeric | customs booth number |
| 17 | CARGO | Character | empty or full commercial vehicles |

### Exhibit B.2 – Northbound Database Structure

| Field | Field Name | Type | Description |
|---|---|---|---|
| 1 | DAY | Numeric | day of Week: June 17= 1, June 18= 2, June 19= 3, June 20= 4 |
| 2 | LICENSE | Character | license plate |
| 3 | QUEUELEN | Numeric | head of queue at time of record entry (metres south of CCRA booths) |
| 4 | TIMESTN1 | DateTime | time recorded at station 1 (rover) |
| 5 | TIMESTN2i | DateTime | time of driver exiting stopped vehicle in staging area: station 2 |
| 6 | TIMESTN2o | DateTime | time of driver/truck re-entering traffic stream in staging area: station 2 |
| 7 | TIMESTNi | DateTime | time of vehicle arriving at customs booth |
| 8 | TIMESTNo | DateTime | time of vehicle proceeding from customs booth |
| 9 | TIMESTN5 | DateTime | time of vehicle exiting from commercial vehicle holding compound (automated booth) |
| 10 | VEHTYPE | Character | commercial vehicle type (see codes) |
| 11 | STNID | Numeric | customs booth number |

### Exhibit B.3 – Vehicle Classification Codes

| Code: | Description: |
|---|---|
| 1 | Passenger Vehicle |
| 2 | Single Unit Light Truck |
| 3 | Single Unit Heavy Truck (2 or more axles) |
| 4 | Truck/Trailer Combo |
| 5 | Tractor Only |
| 6 | Tractor/Trailer Combo |
| 7 | Tractor/Container Combo |
| 8 | Other |

# APPENDIX C

## VEHICLE CLASSIFICATION

# TYPE/BREAKDOWN

**1 PASSENGER VEHICLES: CARS, VANS, SUVS**

**2 LIGHT TRUCKS**

**Single unit – two axles or less**

- **Panel vans**
- **Cube vans**

**3-7 HEAVY TRUCKS**

**3 Single unit – three or more axles**


*Single Unit (three or more axles)*

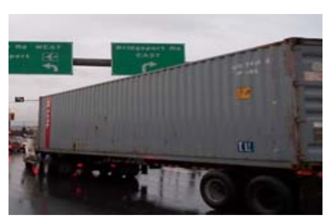
**4 Truck/Trailer Combo (rare)**

**5 Tractor only**

**6 Tractor/Trailer Combo**


*Tractor* *Trailer*

**7 Tractor/Container Combo**



**8 Other?**