

# STORM-RELATED CLOSURES OF I-5 AND I-90: *FREIGHT TRANSPORTATION ECONOMIC IMPACT ASSESSMENT REPORT*

Winter 2007-2008

**METHODOLOGY APPENDIX September 2008:  
WA-RD 708.2**



**Washington State  
Department of Transportation**

# ***Methodology Appendix*** **Storm-Related Closures of I-5 and I-90: Freight Transportation Economic Impact Assessment Report**

*Winter 2007-2008*

**By:**

**Washington State Department of Transportation**

**Freight Systems Division**

Barbara Ivanov, Director

George Xu, Ph.D., Planning and Strategic Assessment Manager

**Washington State University**

**Social and Economic Sciences Research Center**

Danna Moore, Ph.D., Assistant Director

Bruce Austin, Information Systems Coordinator/Data Analyst

Yi-Jen Wang, Ph.D., Study Director

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Department of Transportation, Federal Highway Administration.**

**WA-RD 708.2**



**Washington State  
Department of Transportation**

## TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO. WA-RD 708.2	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.	
4. TITLE AND SUBTITLE  Methodology Appendix Storm Related Closures of I-5 and I-90: Freight Transportation Economic Impact Assessment Report Winter 2007-08		5. REPORT DATE  September 2008	
		6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S)  <i>Wa. State Dept. of Transportation Freight Systems Division</i> Barbara Ivanov, Director George Xu, Ph.D., Planning and Strategic Assessment Manager		8. PERFORMING ORGANIZATION REPORT NO.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS  <i>Washington State Department of Transportation</i> <i>Freight Systems Division</i> <i>PO Box 47407</i> <i>Olympia, WA 98504-7407</i>		10. WORK UNIT NO.	
		11. CONTRACT OR GRANT NO.	
12. SPONSORING AGENCY NAME AND ADDRESS  Washington State Department of Transportation Office of Research and Library Services PO Box 7372 Olympia, Washington 98504-7372		13. TYPE OF REPORT AND PERIOD COVERED  Final	
		14. SPONSORING AGENCY CODE	
15. SUPPLEMENTARY NOTES  This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.			
16. ABSTRACT  The Washington Department of Transportation (WSDOT), under contract with the Social & Economic Sciences Research Center (SESRC) at Washington State University, conducted a study that designs and implements a mixed-mode (telephone and Internet) survey of Washington State freight-dependent businesses and the trucking industry. This survey was used to determine the economic impact on the trucking industry of the I-5 and I-90 emergency closures that occurred during winter 2007-2008. This survey was also used to profile and quantify the economic impacts of road closures caused by natural interruptions. Three types of economic impacts were quantified:  <div style="margin-left: 40px;"> Direct revenue losses incurred by the freight community.  Additional costs incurred during the closures.  Additional costs incurred after the closures. </div> This appendix details the methodology used to assess the economic impacts of the I-5 and I-90 winter storm closures during winter 2007-08.			
17. KEY WORDS  Highway closures, economic impact, methodology, freight		18. DISTRIBUTION STATEMENT  No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616	
19. SECURITY CLASSIF. (of this report)  None	20. SECURITY CLASSIF. (of this page)  None	21. NO. OF PAGES	22. PRICE

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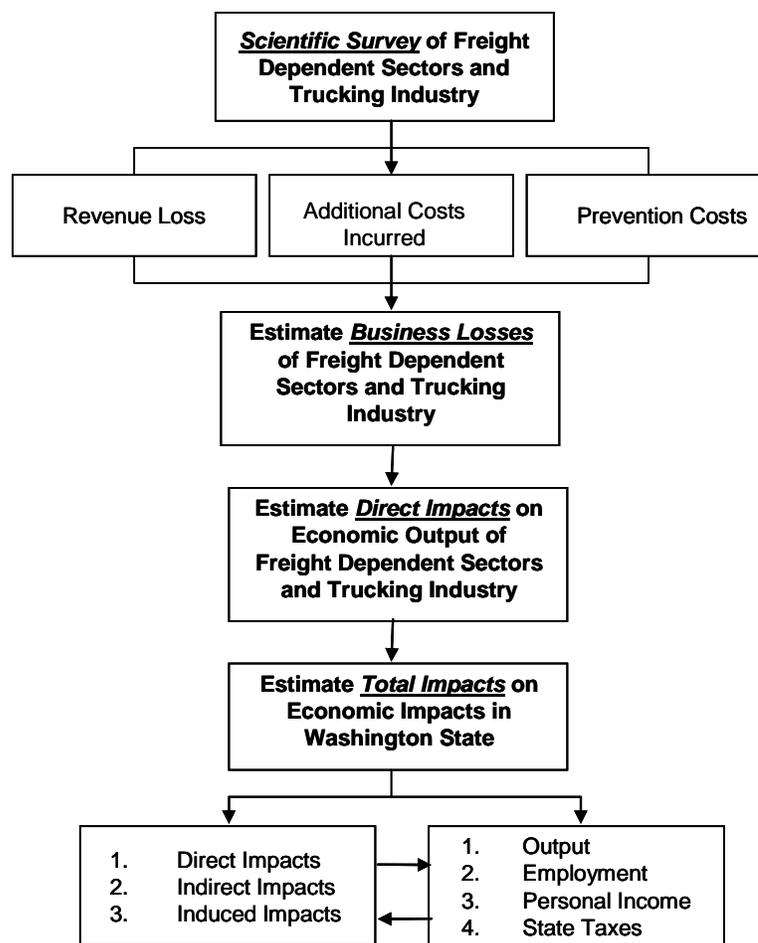
## 1.0 INTRODUCTION AND OVERVIEW OF METHODOLOGY

The Washington Department of Transportation (WSDOT), under contract with the Social & Economic Sciences Research Center (SESRC) at Washington State University, conducted a study that designs and implements a mixed-mode (telephone and Internet) survey of Washington State freight-dependent businesses and the trucking industry. This survey was used to determine the economic impact on the trucking industry of the I-5 and I-90 emergency closures that occurred during winter 2007-2008. This survey was also used to profile and quantify the economic impacts of road closures caused by natural interruptions. Three types of economic impacts were quantified:

- Direct revenue losses incurred by the freight community.
- Additional costs incurred during the closures.
- Additional costs incurred after the closures.

Exhibit A-1 below shows the process used to assess the economic impacts of the I-5 and I-90 winter storm closures during winter 2007-08.

**Exhibit A-1: Process to Assess Economic Impacts of I-5 and I-90 Winter Storm Closures**



A direct survey method was used to obtain the estimates of losses from businesses that were impacted by these closures. WSDOT used the information obtained through this analytic process, combined with information obtained from other sources, to estimate the overall impacts on Washington State's economy using the input-output model IMPLAN. The IMPLAN model was then used to do input-output analysis and assess the overall impacts on Washington State's economy and impacts on output, employment, government taxes, and personal income.

## **2.0 SURVEY METHODOLOGY AND ECONOMIC ANALYSIS**

### **2.1 Mix-Mode Survey Conducted**

The method used for this study is a scientific survey of freight dependent businesses and the trucking industry that were affected by the winter closures of 2007-2008. This approach involved a combination of telephone surveys, supplemented by postal letters that served as a pre-notification about the telephone and Internet survey options. Respondents were first sent a pre-notification letter telling them that the SESRC may be contacting them by telephone to conduct an approximately 15- to 20-minute telephone survey. Respondents had the option to complete the survey on the Internet, if they preferred. The pre-notification letter included a unique access code along with the Internet survey Web URL that respondents used.

### **2.2 Population and Sample**

The population for the survey consisted of all businesses in the trucking industry registered in the State of Washington, as well as companies in freight dependent sectors who are also commercial truck registrants in Washington. Databases obtained from the Employment Security Department, Department of Licensing, and Department of Community, Trade, and Economic Development were integrated to create a population dataset. The dataset includes fields such as business names, industry identifier (NAICS code), business addresses, phone numbers, email addresses, county, region, number of employees, and sales revenues. The identified population consists of 4,735 businesses, including 2,045 trucking firms in Washington. The total number of the freight sector truck owners (excluding truck owners in the trucking industry) registered in Washington State is 2,690. The sample SESRC used for the survey consisted of 2,758 complete records.

### 2.3 Cooperation and Response Rate

The cooperation rate is the ratio of the number of completed and partially completed interviews compared to the number of completed, partially completed, and refusal cases. The formula for calculating the cooperation rate is:

$$\frac{(CM + PC)}{(CM + PC + RF)}$$

Where:

*CM* = number of completed interviews

*PC* = number of partially completed interviews

*RF* = number of refusals

The cooperation rate is 95.7 percent for the overall fielded sample.

The response rate is the ratio of the number of completed and partially completed interviews, compared to the number of completed, partially completed, eligible non-interviews, and unknown eligibility non-interviews. The formula for calculating the response rate is:

$$\frac{(CM + PC)}{(CM + PC + RF + EN + UE)}$$

Where:

*CM* = number of completed interviews

*PC* = number of partially completed interviews

*RF* = number of refusals

*EN* = number of eligible, non-interview

*UE* = number of unknown eligible, non-interview

For the total fielded sample, the response rate was 69.6 percent.

### 2.4 Sampling Error

Sampling error is a measure of the degree to which a randomly selected sample of respondents represents the population from which it is drawn. Sampling error also is the basis upon which tests of statistical significance are calculated. One formula for calculating the sample error for a proportion at the 95 percent confidence level is presented below, and this can be used to calculate the sample error for survey results in this report.

$$SE = 2\sqrt{\frac{PQ}{n-1}\left(\frac{N-n}{N}\right)}$$

Where:

*SE*= sampling error

$P$  = proportion of “yes” responses for a specific question

$Q$  = proportion of “no” responses for a specific question

$N$  = population size for the survey

$n$  = sample size, number of completed interviews for specific questions

For this survey, completed interviews were obtained from 2,045 licensed trucking businesses, plus 713 private fleets, yielding a margin of error of about  $\pm 1.9$  percent at the 95 percent confidence level.

### 2.5 Design of Questionnaires

The SESRC worked with WSDOT’s Freight Systems Division staff to develop the questionnaire. The respondent had a choice of either completing a telephone interview or Internet version of the questionnaire.

**Telephone Survey Questionnaire.** The goal of the telephone survey was to design a survey questionnaire that would comprise a 15-minute interview. The script contained 216 questions, of which 92 had open-ended response components. The SESRC then programmed the script into SESRC’s Computer Assisted Telephone Interviewing (CATI) system. The CATI program also facilitates the sample administration during the project calling period. The CATI was pre-tested by SESRC staff members and WSDOT representatives.

**Web Questionnaire.** A Web survey option was developed and used to give respondents an option as to how they preferred to complete the survey. The Web option was also used to provide interviewers with a strategy to convert refusals to the telephone survey. The Internet version contained 119 screens, including an introductory screen and a survey completion screen.

### 2.6 Contents of Questionnaires

The questions in the survey were organized into four types, to achieve a systematic understanding of the economic impacts of the I-5 and I-90 closures:

- **Company Profile.** These questions were used to understand who was impacted during the road closures. For example, companies were asked to identify themselves as a shipper, carrier, or both. They were also asked to identify if they transport perishable goods in their truck loads.
- **Profile of the Impacts.** These questions were designed to understand what kind of impacts affected businesses incurred. For example, the respondents were asked to identify revenue losses, additional costs incurred during the closures, and future costs to prevent similar losses. They were also asked to identify and assess different types of costs incurred, such as fuel costs and overtime pay for drivers.
- **Actions Taken to Continue Businesses and Mitigate the Impacts.** These questions were designed to understand how the affected businesses

- **Magnitude of the Impacts.** These questions were designed to gather information and data that can be used in statistical analysis and economic modeling to quantify the economic impacts of the closures of I-5 and I-90 on the state’s economy. The respondents were asked to report their losses and increased costs.

### 3.0 ESTIMATION OF ECONOMIC IMPACTS

#### 3.1 Estimation of Direct Economic Impacts of the Road Closures

Respondents were asked to assess three types of direct impacts:

- Lost sales incurred due to the road closures.
- Additional costs incurred (such as additional fuel cost and overtime pay for drivers).
- Incremental spending to prevent or reduce future impacts.

The method used to estimate direct impacts was:

First, for all businesses surveyed in the sample, SESRC calculated the revenue of impacted truck owners as percentage of the revenue of total truck owners in the sample.

$$p = \frac{R_i}{R_t}$$

Where:

$p$  = the revenue of impacted truck owners as percentage of the revenue of total truck owners in the sample

$R_i$  = Revenue of all impacted businesses in the sample

$R_t$  = Revenue of all impacted and non-impacted businesses in the sample

The sample error of total revenue of impacted businesses was then estimated.

$$SE = 1.96 \sqrt{\frac{PQ}{n-1}}$$

Where:

$SE$  = sampling error

$P$  = proportion of total revenue of impacted businesses in the sample

$Q$  = proportion of total revenue of not impacted businesses in the sample

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$n$  = sample size

Third, the total revenue of all impacted businesses based on proportion of the sample was estimated. The confidence intervals at 95 percent significance using sample standard deviations were also estimated.

For each reported impact (revenue loss and additional costs), the sample loss ratio was calculated using the following formula:

$$\lambda_i = \frac{C_i}{R}$$

Where:

$\lambda_i$  = Loss ratio for impact  $i$

$C_i$  = Total loss for impact  $i$  reported by impacted businesses in the sample

$R$  = Total revenue of impacted businesses in the sample

The loss ratios and the revenue of all impacted businesses were used to estimate the direct economic impacts of I-5 and I-90 closures, respectively. The results of this analysis are shown in Exhibits A-2 and A-3.

**Exhibit A-2: Estimated Direct Economic Impact of I-5 Closure  
for December 3 to December 7, 2007**

Freight Sectors	Total Annual Revenue of Impacted Business	Revenue Loss		Total Additional Costs During the Closure		Total Additional Costs after the Closure		Total Impact	
		Loss (\$)	Loss as % of Total Annual Revenue of Impacted Businesses	Additional Costs during the Closure	Additional Costs as % of Total Annual Revenue of Impacted Businesses	Additional Costs after the Closure	Additional Costs as % of Total Annual Revenue of Impacted Businesses	Total Impact (\$)	Total Impact as % of Total Annual Revenue of Impacted Business
<b>Total</b>	<b>\$6,040,665,572</b>	<b>\$13,727,642</b>	0.2273%	<b>\$9,122,386</b>	0.1510%	<b>\$447,364</b>	0.007%	<b>\$23,297,392</b>	0.386%
<b>Trucking</b>	\$790,372,662	\$2,310,394	0.2923%	\$1,716,311	0.2172%	\$66,657	0.008%	\$4,093,362	0.518%
<b>Freight Dependent</b>	\$5,250,292,911	\$11,417,248	0.2175%	\$7,406,075	0.1411%	\$380,707	0.0073%	\$19,204,030	0.366%

Source: WSU/WSDOT Economic Impact Survey of I-5 and I-90 Winter Storm Closures

**Exhibit A-3: Estimated Direct Economic Impact of I-90 Closures  
for January 29 to February 3, 2008**

Freight Sectors	Total Annual Revenue of Impacted Business	Revenue Loss		Total Additional Costs during the Closure		Total Additional Costs after the Closure		Total Impact	
		Loss (\$)	Loss as % of Total Annual Revenue of Impacted Businesses	Additional Costs During the Closure	Additional Costs as % of Total Annual Revenue of Impacted Businesses	Additional Costs after the Closure	Additional Costs as % of Total Annual Revenue of Impacted Businesses	Total Impact (\$)	Total Impact as % of Total Annual Revenue of Impacted Business
<b>Total</b>	\$5,118,971,967	\$7,856,779	0.1535%	\$5,384,511	0.1052%	\$567,034	0.011%	\$13,808,324	0.270%
<b>Trucking</b>	\$567,250,883	\$1,108,784	0.1955%	\$894,989	0.1578%	\$90,537	0.016%	\$2,094,309	0.369%
<b>Other Freight</b>	\$4,551,721,085	\$6,747,995	0.1483%	\$4,489,522	0.0986%	\$476,498	0.0105%	\$11,714,015	0.257%

Source: WSU/WSDOT Economic Impact Survey of I-5 and I-90 Winter Storm Closures

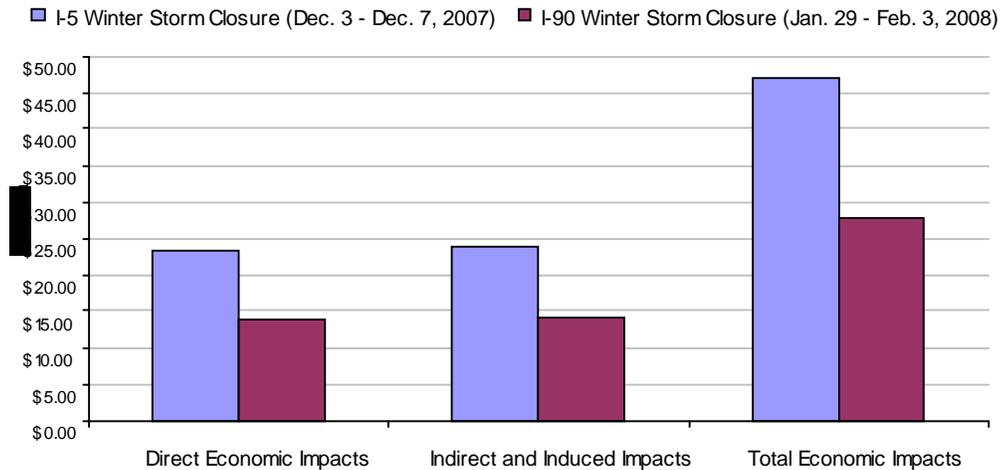
### 3.2 Estimation of Total Economic Impacts of the Road Closures

**Direct, Indirect, and Induced Impacts.** The direct economic impacts of the road closures represent the losses to the trucking industry and freight dependent businesses. These direct impacts include business revenues and operation costs, which can affect employment, personal income, and other economic activities. These direct impacts can then cause indirect impacts as they can further affect business activities of their suppliers and customers, and government revenues such as taxes. The indirect impacts can further cause induced impacts as decreased spending and reduced efficiency cascades through the economy. The total economic impacts include direct impacts, indirect impacts, and induced impacts.

**Inputs and Outputs.** Input-output analysis is used to calculate cascading impacts of the road closures. IMPLAN was used by WSDOT staff to assess the overall economic impacts, which are shown in Exhibit A-4. Since the input-output model requires inputs in terms of revenue or employment, the additional costs incurred both during and after the road closures were converted into revenue changes based on the price elasticity of truck transportation. This assumed that additional costs of truck freight transportation were built into the price of service and passed along to the consumers.

Direct impacts of trucking industry and freight dependent sectors were also input into the IMPLAN model, to assess the total economic impacts on the Washington State economy. Indicators used to measure the impacts included economic outputs, employment, personal income, and state sales taxes.

**Exhibit A-4: Total Impacts vs. Direct Impacts**



Source: WSU/WSDOT Economic Impact Survey of I-5 and I-90 Winter Storm Closures

### 3.3 Lessons Learned

The analysis and research from this project will enable WSDOT to understand and more accurately measure the economic impacts of future disruptions to freight systems. Since this research is a step towards improving the methodology used by transportation professionals, staff is interested in sharing the lessons learned.

**Limited Resources.** WSDOT originally planned to use both the state and the USDOT commercial vehicle license lists to survey both in-state and out-of-state trucking companies doing business in Washington. However, researchers were not able to include out-of-state truck companies due database integration issues and the limited amount of time available to conduct the survey. Resources were not available to quantify the closures’ impacts on neighboring states and provinces, so the report’s findings should be considered conservative estimates that understate the magnitude of the total economic impacts.

In the future, if there is a need to quantify economic impacts at the regional and/or industry sector level, studies patterned on this work should plan to budget more resources. Although the survey achieved a 70 percent response rate, the total sample size was not large enough to provide statistically valid information about the impacts on specific industry sectors in various regional economies.

**Unexpected Results and Survey Design.** The survey questionnaire design also did not always produce the results the Freight Systems Division expected. Some of the study's most useful information came from correlating answers from several questions. After the survey was completed, staff learned that some survey questions had been inadvertently phrased in a way that made it impossible to make correlations. Going forward, staff recognize that the survey design can be improved for similar studies.