Appendix A

Survey Instrument
Cover Letter
Endorsement Letter
Reminder Letters
Thank You Letter

PERMIT VEHICLE USAGE SURVEY

**This survey is being conducted to update information on the actual use of weight-permit vehicles in New York State.
All information reported on these survey forms will be kept STRICTLY CONFIDENTIAL. The information will be used for aggregate statistical analyses only.**

INSTRUCTIONS:

This questionnaire is for a specific permit vehicle in your fleet. It was selected at random from all weight-permit vehicles in New York State. The information is to be filled in for a single specified day. Three types of forms are included in this survey: (1) a BLUE form for information about the particular vehicle and about the general operation of your company, (2) a TAN form to record start-of-day trip information for the vehicle, and (3) several WHITE forms (with GREEN shading) for all trips made on the survey day.

THE SPECIFIC SURVEY DAY IS .....**THURSDAY,...2/21/91**

Please read through all of the survey questions, including those on the TRIP LOG SURVEY FORMS (tan and white), before the survey day to be certain that the driver of the selected vehicle collects the information requested.

To ensure that these forms are filled out clearly and consistently, they should be reviewed in the office before returning. Please be certain the driver records the needed information that you do not collect routinely.

WHEN COMPLETING THE QUESTIONNAIRE, PLEASE PROCEED AS FOLLOWS:

1. **Fill out Questions 1 thru 17 on the blue form.**
2. **Fill out the tan forms for the start of the first trip on the survey day.**
3. **Fill out the white forms (with green shading) for all other trips made on the survey day.**
4. **Please return all survey forms in the enclosed postage-paid envelope.**

Conducted by Cornell University
in conjunction with
Permanent Advisory Committee on Truck Weights
New York State Department of Transportation

If you have any questions, please call: (607) 255-3690
The School of Civil and Environmental Engineering at Cornell University
and ask for a truck weight survey coordinator.

PERMIT VEHICLE INFORMATION

THE FOLLOWING VEHICLE WAS RANDOMLY SELECTED FOR THIS SURVEY:

VIN NUMBER:

YEAR, MAKE:

Please answer the following questions for this vehicle.

1. Do you still operate this vehicle as a weight-permit vehicle?

YES ☐ *(go to Question 2)* NO ☐ *(go to Question 13)*

2. Is this vehicle: owned by your company ☐

leased by your company ☐

If vehicle is leased, from whom is it leased?

Name ....

Address ....

....

3. Was this vehicle used by your company on 2/21/91?

YES ☐ *(go to Question 5, inside back cover)* NO ☐ *(go to Question 4)*

4. If vehicle was not used by you on 2/21/91, then:

was it being serviced?	YES	☐	NO	☐
was it on standby?	YES	☐	NO	☐
was it on lease to another company?	YES	☐	NO	☐

If vehicle was leased out, to whom was it leased?

Name ....

Address ....

....

If none of the above apply, then please describe why vehicle was not used?

....

....

Please continue with Question 5 (inside back cover)

TRIP LOG SURVEY FORMS

FOR THE FOLLOWING VEHICLE:

VIN NUMBER:

YEAR, MAKE:

FOR TRIPS MADE ON: ......THURSDAY, 2/21/91........

PLEASE FILL OUT THESE TRIP LOG FORMS FOR THE **SPECIFIED VEHICLE** AND THE **SPECIFIED SURVEY DAY**

ALL INFORMATION WILL BE KEPT

<u>CONFIDENTIAL</u>

IT WILL BE USED ONLY FOR STATISTICAL PURPOSES

START OF THE SURVEY DAY

From what LOCATION did this permit vehicle start for the FIRST TRIP on ....2/21/91.......... ?

Street: ....
Town: ....
County: ....
State and Zip Code: ....

If this vehicle was on the road at midnight at the start of 2/21/91......................., please specify from what location it started the overnight trip:

Street: ....
Town: ....
County: ....
State and Zip Code: ....

Please check the type of location from which the vehicle started on its first trip:

- ☐ Construction or excavation site
- ☐ Quarry; sand, gravel pit; mine; gas or oil well
- ☐ Concrete or asphalt plant
- ☐ Refinery or chemical plant
- ☐ Manufacturing or processing plant
- ☐ Truck terminal
- ☐ Truck repair facility
- ☐ Rail terminal
- ☐ Ship, container or barge terminal
- ☐ Junkyard or disposal site
- ☐ Wholesale establishment
- ☐ Retail establishment
- ☐ Warehouse
- ☐ Farm
- ☐ Forest
- ☐ Sawmill or lumber yard
- ☐ Residential area
- ☐ Electric, gas, or telephone facility
- ☐ Other (please specify) ....

NOW PLEASE COMPLETE A TRIP LOG (WHITE FORM)

FOR EACH TRIP MADE ON THE SURVEY DAY

INSTRUCTIONS FOR TRIP LOG FORMS

The following is a trip log for recording all trips this truck made during the survey day. The questions appear on the margin on the left hand side. Please record the trip information in the columns to the right of the question. (Please use one column for each trip)

(If you need additional trip log forms, please feel free to make xerox copies)

NOTE: **If this truck is a tank truck or a garbage truck, you might find it difficult to provide the requested axle loading information for each segment of the truck's journey. In that case, please provide the load information to the best of your ability.**

NOTE

For the purpose of this survey, a **TRIP** is defined as a journey from an origin to a destination with the same gross load of the truck. The moment the gross load changes, we go on to the next trip. That is why a truck returning empty after delivering the goods is considered to be a separate trip. However, if the empty return trip is to the original starting point, simply check the YES box at the bottom of each trip column, and then go on to a new column to report subsequent trips. If, however, the truck is carrying a load on its return trip, or if the empty return trip is to a new destination, then these trips must be reported separately in new columns.

	1st TRIP	2nd TRIP
a. At what TIME did you begin this trip?	am ☐ pm ☐	am ☐ pm ☐
b. What was the MILEAGE READING at the START of this trip?	miles	miles
c. Was the vehicle LOADED or EMPTY at the start of the trip?	LOADED ☐ EMPTY ☐	LOADED ☐ EMPTY ☐
d. What was the LOAD on AXLE No.1 (front)	(in pounds) 1..........................	(in pounds) 1..........................
on AXLE No.2	2..........................	2..........................
on AXLE No.3	3..........................	3..........................
on AXLE No.4	4..........................	4..........................
on AXLE No.5	5..........................	5..........................
on AXLE No.6	6..........................	6..........................
and Gross load	GrossWt.................	GrossWt.................
e. What TYPE OF LOAD (commodity) did your truck carry? (e.g. sand)		
f. What was the DESTINATION of this trip? (Where did you go?) Street/Road:	....	....
City/Town/Village:	....	....
County:	....	....
State and Zip Code:	....	....
g. At what TIME did you arrive at the destination?	am ☐ pm ☐	am ☐ pm ☐
h. What was the MILEAGE READING at the END of this trip?	miles	miles
i. What is the TOTAL MILEAGE of this trip? (SUBSTRACT (h-b))	miles	miles
j. Approximately how many miles of this trip were made on	(in miles)	(in miles)
[i] Interstate highways (e.g. I-90, I-88)	....	....
[ii] State and U.S. highways (e.g. US 20, SR 146)	....	....
[iii] Local roads and county roads	....	....
k. After this trip, did you go back EMPTY to the place from where you started this trip?	YES ☐ NO ☐	YES ☐ NO ☐
l. If so, at what TIME did you return there?	am ☐ pm ☐	am ☐ pm ☐
	END OF DAY? STOP!	END OF DAY? STOP!

(Note: Use the next trip column to describe the NEXT LOADED TRIP)

3rd TRIP

am
pm

miles

LOADED ☐ EMPTY ☐

(in pounds)

1 ....
2 ....
3 ....
4 ....
5 ....
6 ....
GrossWt ....

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES ☐ NO ☐

am
pm

END OF DAY? STOP!

4th TRIP

am
pm

miles

LOADED ☐ EMPTY ☐

(in pounds)

1 ....
2 ....
3 ....
4 ....
5 ....
6 ....
GrossWt ....

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES ☐ NO ☐

am
pm

END OF DAY? STOP!

5th TRIP

am
pm

miles

LOADED ☐ EMPTY ☐

(in pounds)

1 ....
2 ....
3 ....
4 ....
5 ....
6 ....
GrossWt ....

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES ☐ NO ☐

am
pm

END OF DAY? STOP!

FILL IN ANY MORE TRIPS ON THE NEXT PAGE

	6th TRIP	7th TRIP
a. At what TIME did you begin this trip?	am / pm	am / pm
b. What was the MILEAGE READING at the START of this trip?	miles	miles
c. Was the vehicle LOADED or EMPTY at the start of the trip?	LOADED / EMPTY	LOADED / EMPTY
d. What was the LOAD on AXLE No.1 (front) on AXLE No.2 on AXLE No.3 on AXLE No.4 on AXLE No.5 on AXLE No.6 and Gross load	(in pounds) 1........ 2........ 3........ 4........ 5........ 6........ GrossWt........	(in pounds) 1........ 2........ 3........ 4........ 5........ 6........ GrossWt........
e. What TYPE OF LOAD (commodity) did your truck carry? (e.g. sand)		
f. What was the DESTINATION of this trip? (Where did you go?) Street/Road: City/Town/Village: County: State and Zip Code:	....	....
g. At what TIME did you arrive at the destination?	am / pm	am / pm
h. What was the MILEAGE READING at the END of this trip?	miles	miles
i. What is the TOTAL MILEAGE of this trip? (SUBSTRACT (h-b))	miles	miles
j. Approximately how many miles of this trip were made on [i] Interstate highways (e.g. I-90, I-88) [ii] State and U.S. highways (e.g. US 20, SR 146) [iii] Local roads and county roads	(in miles)	(in miles) ....
k. After this trip, did you go back EMPTY to the place from where you started this trip?	YES / NO	YES / NO
l. If so, at what TIME did you return there?	am / pm	am / pm
(Note: Use the next trip column to describe the NEXT LOADED TRIP)	END OF DAY? STOP!	END OF DAY? STOP!

8th TRIP

am
pm

miles

LOADED EMPTY

(in pounds)

1.........................
2.........................
3.........................
4.........................
5.........................
6.........................
GrossWt.................

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES NO

am
pm

END OF DAY? STOP!

9th TRIP

am
pm

miles

LOADED EMPTY

(in pounds)

1.........................
2.........................
3.........................
4.........................
5.........................
6.........................
GrossWt.................

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES NO

am
pm

END OF DAY? STOP!

10th TRIP

am
pm

miles

LOADED EMPTY

(in pounds)

1.........................
2.........................
3.........................
4.........................
5.........................
6.........................
GrossWt.................

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES NO

am
pm

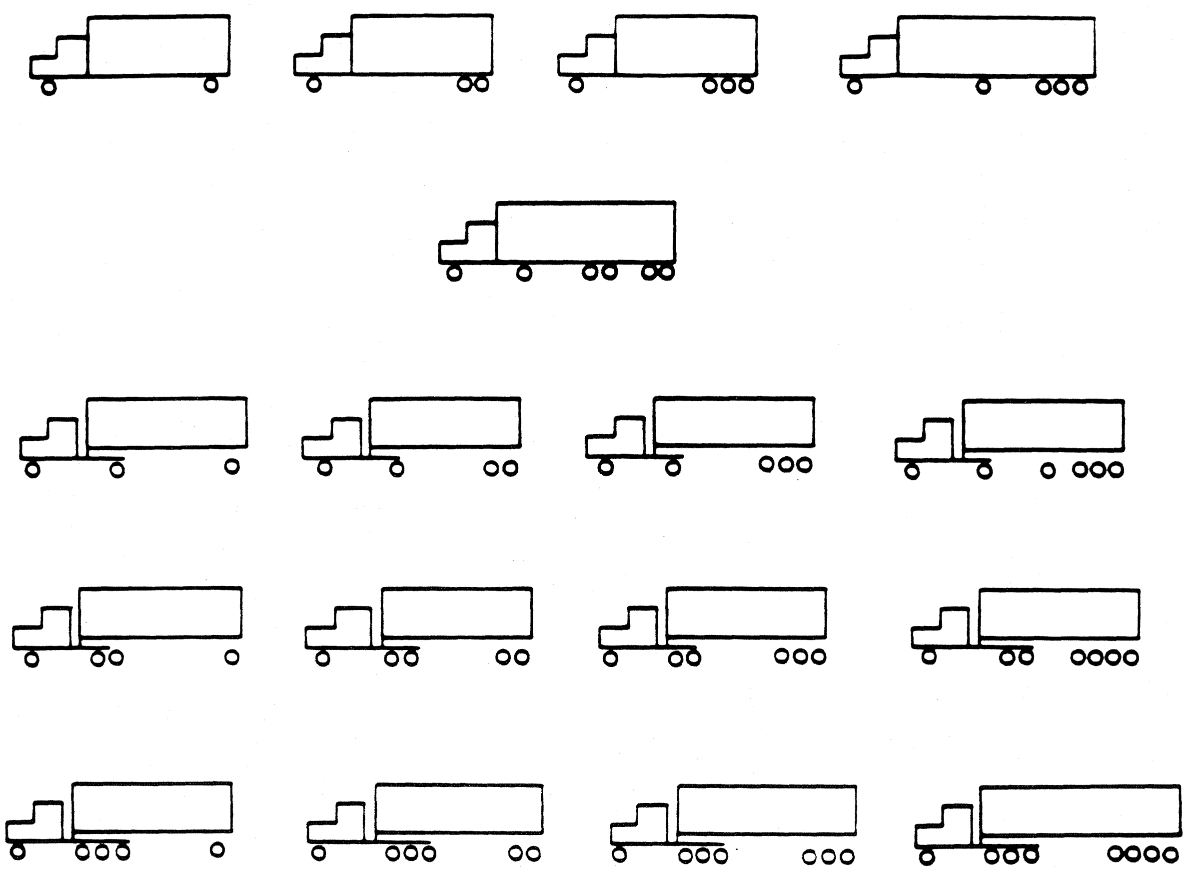
END OF DAY? STOP!

FILL IN ANY MORE TRIPS ON THE NEXT PAGE

	11th TRIP	12th TRIP
a. At what TIME did you begin this trip?	am ☐ pm ☐	am ☐ pm ☐
b. What was the MILEAGE READING at the START of this trip?	miles	miles
c. Was the vehicle LOADED or EMPTY at the start of the trip?	LOADED ☐ EMPTY ☐	LOADED ☐ EMPTY ☐
d. What was the LOAD on AXLE No.1 (front) on AXLE No.2 on AXLE No.3 on AXLE No.4 on AXLE No.5 on AXLE No.6 and Gross load	(in pounds) 1......................... 2......................... 3......................... 4......................... 5......................... 6......................... GrossWt...............	(in pounds) 1......................... 2......................... 3......................... 4......................... 5......................... 6......................... GrossWt...............
e. What TYPE OF LOAD (commodity) did your truck carry? (e.g. sand)		
f. What was the DESTINATION of this trip? (Where did you go?) Street/Road: City/Town/Village: County: State and Zip Code:	....	....
g. At what TIME did you arrive at the destination?	am ☐ pm ☐	am ☐ pm ☐
h. What was the MILEAGE READING at the END of this trip?	miles	miles
i. What is the TOTAL MILEAGE of this trip? (SUBSTRACT (h-b))	miles	miles
j. Approximately how many miles of this trip were made on [i] Interstate highways (e.g. I-90, I-88) [ii] State and U.S. highways (e.g. US 20, SR 146) [iii] Local roads and county roads	(in miles)	(in miles) ....
k. After this trip, did you go back EMPTY to the place from where you started this trip?	YES ☐ NO ☐	YES ☐ NO ☐
l. If so, at what TIME did you return there?	am ☐ pm ☐	am ☐ pm ☐
(Note: Use the next trip column to describe the NEXT LOADED TRIP)	END OF DAY? STOP!	END OF DAY? STOP!

AXLE ARRANGEMENTS

Please circle the applicable axle arrangement for the selected vehicle. (Ignore body type)



If you operate a vehicle with a different configuration, please draw a sketch.

END OF THE SURVEY DAY

IF THE VEHICLE WAS STILL ON THE ROAD AT MIDNIGHT

OF ....THURSDAY,..2/21/91...,

PLEASE REMEMBER TO FILL IN A REGULAR TRIP LOG FORM

(WHITE FORM WITH GREEN SHADING), GIVING THE DESTINATION

AND OTHER DETAILS FOR THE END OF THAT TRIP.

COMMENTS

If you have any comments on the operation of this vehicle on the survey day

and/or on the weight-permit system, please feel free to note them below.

....

....

....

....

....

....

....

....

....

....

....

....

....

THANK YOU FOR YOUR COOPERATION.

	16th TRIP	17th TRIP
a. At what TIME did you begin this trip?	am ☐ pm ☐	am ☐ pm ☐
b. What was the MILEAGE READING at the START of this trip?	miles	miles
c. Was the vehicle LOADED or EMPTY at the start of the trip?	LOADED ☐ EMPTY ☐	LOADED ☐ EMPTY ☐
d. What was the LOAD on AXLE No.1 (front) on AXLE No.2 on AXLE No.3 on AXLE No.4 on AXLE No.5 on AXLE No.6 and Gross load	(in pounds) 1........ 2........ 3........ 4........ 5........ 6........ GrossWt........	(in pounds) 1........ 2........ 3........ 4........ 5........ 6........ GrossWt........
e. What TYPE OF LOAD (commodity) did your truck carry? (e.g. sand)		
f. What was the DESTINATION of this trip? (Where did you go?) Street/Road: City/Town/Village: County: State and Zip Code:	....	....
g. At what TIME did you arrive at the destination?	am ☐ pm ☐	am ☐ pm ☐
h. What was the MILEAGE READING at the END of this trip?	miles	miles
i. What is the TOTAL MILEAGE of this trip? (SUBSTRACT (h-b))	miles	miles
j. Approximately how many miles of this trip were made on [i] Interstate highways (e.g. I-90, I-88) [ii] State and U.S. highways (e.g. US 20, SR 146) [iii] Local roads and county roads	(in miles)	(in miles) ....
k. After this trip, did you go back EMPTY to the place from where you started this trip?	YES ☐ NO ☐	YES ☐ NO ☐
l. If so, at what TIME did you return there?	am ☐ pm ☐	am ☐ pm ☐
(Note: Use the next trip column to describe the NEXT LOADED TRIP)	END OF DAY? STOP!	END OF DAY? STOP!

13th TRIP

am
pm

miles

LOADED EMPTY

(in pounds)

1........................
2........................
3........................
4........................
5........................
6........................
GrossWt.................

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES NO

am
pm

END OF DAY? STOP!

14th TRIP

am
pm

miles

LOADED EMPTY

(in pounds)

1........................
2........................
3........................
4........................
5........................
6........................
GrossWt.................

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES NO

am
pm

END OF DAY? STOP!

15th TRIP

am
pm

miles

LOADED EMPTY

(in pounds)

1........................
2........................
3........................
4........................
5........................
6........................
GrossWt.................

....
....
....
....

am
pm

miles

miles

(in miles)

....
....
....

YES NO

am
pm

END OF DAY? STOP!

FILL IN ANY MORE TRIPS ON THE NEXT PAGE

PERMIT VEHICLE DESCRIPTION

Please supply the following information for the specified permit vehicle (combination) as it was configured on ......2/21/91.........

5. Please circle the AXLE ARRANGEMENT on the opposite page which best matches the specified permit vehicle. Also, please mark the specific location of any lift axles with an X on the vehicle picture you circled.

6a. Please record the distance from the centerline of the steering axle to the centerline of:

2nd. axle	.......ft.	.......in.
3rd. axle	.......ft.	.......in.
4th. axle	.......ft.	.......in.
5th. axle	.......ft.	.......in.
6th. axle	.......ft.	.......in.
Fifth wheel (where applicable)	.......ft.	.......in.

6b. Please record the number of tires for each of the axles:

2nd. ....
3rd. ....
4th. ....
5th. ....
6th. ....

7. Tire Sizes: Steering axle .... Drive axle(s) .... Trailer(s) ....

8. Tire Pressures : Steering axle .... Drive axle(s) .... Trailer(s) ....

9. What is the vehicle type of the specified permit vehicle?

- ☐ Rigid or Straight Truck
- ☐ Truck & Trailer
- ☐ Tractor/Trailer
- ☐ Double or Combination
- ☐ Other (please specify) ....

10. What is the body type of the specified permit vehicle?

- ☐ Van
- ☐ Flatbed or Platform
- ☐ Dump
- ☐ Concrete Mixer
- ☐ Tanker
- ☐ Reefer
- ☐ Belly-Dump
- ☐ Hopper
- ☐ Container Chassis
- ☐ Low-Boy (goose neck)
- ☐ Pole or logging
- ☐ Other (please specify) ....

11. Tare weight of vehicle (or combination): .... lbs.

12. Axle weight ratings:

Steering axle	....	lbs.
Drive axle(s)	....	lbs.
Trailer axle(s)	....	lbs.

Please continue with Question 13.

OPERATOR CHARACTERISTICS

13. What is the primary type of business of your company?

- ☐ Agriculture
- ☐ Forestry and Lumbering
- ☐ Mining and Quarrying
- ☐ Construction
- ☐ Manufacturing
- ☐ Wholesale trade
- ☐ Retail Trade
- ☐ For-hire Transportation
- ☐ Utilities
- ☐ Other (Please specify)........................

14. In which New York State counties and/or U.S. states do you operate your weight-permit vehicles?

....

....

....

15. How many trucks are in your total fleet? ....

16. Please indicate the number of trucks in your total fleet that fall into the permit and non-permit categories shown for the following vehicle types:

Vehicle Type	Permit Vehicles		Non-Permit Vehicles	
	Owned	Leased	Owned	Leased
Rigid or Straight Truck				
Truck & Trailer				
Tractor/Trailer				
Double or Combination				
Other (Please specify):				

and the following body types:

Body Type	Permit Vehicles		Non-Permit Vehicles	
	Owned	Leased	Owned	Leased
Van				
Flatbed or Platform				
Dump				
Concrete Mixer				
Tanker				
Reefer				
Belly-Dump				
Hopper				
Container Chassis				
Low-Boy (Goose Neck)				
Pole or Logging				
Other (Please specify):				

17. If you no longer operate the vehicle specified above as a weight-permit vehicle, please indicate why:

- ☐ Vehicle has been sold
- ☐ Vehicle has been scrapped
- ☐ Permit not renewed
- ☐ Other (Please specify):.......................................

Now please complete the rest of the questionnaire.

FORMS FILLED OUT BY: .... DATE: .... PHONE: ....

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Cornell University

HOLLISTER HALL, ITHACA, NY 14853-3501

Office of the Director

October 9, 1991

Dear Permit Vehicle Operator:

We trust that you have received our letter of last week announcing the upcoming arrival of a questionnaire for one or more of your permit vehicles. As we indicated in that letter, your company has been selected on the basis of a random sample of weight permit vehicles that was provided from the applications filed with the New York State Department of Transportation. This study is endorsed by the New York State Motor Truck Association.

We are asking for your cooperation in filling out the questionnaire(s) enclosed in this mailing. This can be done by the vehicle driver(s), or, if it is more appropriate for your operation, by your office staff. Although you were contacted last summer and last winter, it is equally important that you respond to this request so that we can compare seasonal usage of permit vehicles. This is the last of the three planned surveys.

As before, the information requested will be kept in strict confidence and will only be used for statistical analysis purposes. As we stated before, the purpose of this study is to determine the value of the divisible-load permit system and to make recommendations to the NYS legislature as to whether the program should be continued and expanded.

We recognize the time and effort required to fill out the questionnaire. But your cooperation is most important in order to make the results of this survey useful and statistically meaningful. Also, your comments on the survey and the permit-vehicle system are most welcome.

Since only a relatively small number of vehicles have been selected at random, each response is important for the statistical validity of the study.

Please observe the **specified survey day** that appears on the questionnaire. If you do not know the precise answer to a particular question, please provide your best estimate.

Also, even if the **specified vehicle** was not in operation on the survey day, or if you transferred the permit, or if you sold the vehicle, please **fill out the blue sheets anyway** and return the questionnaire in the enclosed postage-paid, self-addressed return envelope. Please do not hesitate to call us at **607-255-3690** if you have a question.

We look forward to receiving your completed questionnaire(s). Please accept our sincere appreciation in advance.

Sincerely yours,

Richard E. Schuler
Professor of Economics and
Civil and Environmental Eng.

Arnim H. Meyburg
Professor of Transportation
Engineering

Telephone (607) 255-3438; Telex WUI 6713054
BITNET: HOL@CRNLVAX5; FAX: (607) 255-9004

DOUGLAS A. HUGHES
EXECUTIVE DIRECTOR
518-438-8184

August 13, 1990

Dear Permit Vehicle Operator:

As you know, legislation allowing the operation of vehicles exceeding the federal statutes for divisible loads has been in effect in New York State since 1986. The legislation is under review regularly in New York State and it is following with interest in other states.

The legislation also established the "Permanent Advisory Committee on Truck Weights," consisting of industry and government representatives, to oversee the effect of this legislation. This Committee has cooperated with a research team at Cornell University to perform studies of the economic consequences of increased truck weights. For this purpose, the Cornell team has developed the enclosed "Permit Vehicle Usage Survey" questionnaire to collect firsthand information from you, the user.

Your company was selected on the basis of a random sample of weight-permit vehicles that was provided from the applications filed with the New York State Department of Transportation. The information requested in this questionnaire will be kept in strict confidence and will only be used for statistical analysis purposes. Some questions in the survey (axle loadings, state/county road mileage, etc.) seek information that is not readily available, but we hope you'll provide your best estimate in these instances.

Sincerely,

Douglas A. Hughes

NEW YORK STATE MOTOR TRUCK ASSOCIATION, INC.
1234 Western Avenue
Albany, New York 12203

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
Cornell University
HOLLISTER HALL, ITHACA, NY 14853-3501

Office of the Director

November 6, 1991

Dear Permit-Vehicle Operator:

A couple of weeks ago we sent you a questionnaire for one (or more) of your vehicles that operates with a divisible-load permit. Your vehicle(s) had been selected at random in a scientific sample of permit vehicles, to determine their usage pattern. Since the total number of trucks selected is rather small we are dependent on getting a good response rate from operators like you whose trucks were selected.

In case you already completed the questionnaire, please accept our thanks for your help and cooperation. In case you have not been able to complete it yet, we would like to ask you to still make the effort to fill it in. We ask you to please complete the trip logs for the same day of the week that is specified on the questionnaire. (Please ignore the date.)

If you threw out the questionnaire because the specified vehicle was not in operation at the time, please be so kind and tell us that. You can just send us a note telling us the make, year and VIN of the truck and a brief statement why it was not in operation. This information is important to get a complete picture of the usage for the divisible-load permit fleet, including vehicles that were not in operation.

We know that our request is an imposition on your busy work schedule. But we would like to remind you that the information you provide will contribute to a better overall picture of the value of the divisible-load permit vehicle program in New York State. This information is necessary for the legislature to decide as to whether to continue and/or to modify the program.

We thank you in advance for your help and cooperation.

Sincerely yours,

Richard E. Schuler Professor of Economics and Civil and Environmental Eng'g.	Arnim H. Meyburg Professor of Transportation Engineering

Telephone (607) 255-3438; Telex WUI 6713054
BITNET: HOL@CRNLVAX5; FAX: (607) 255-9004

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
Cornell University
HOLLISTER HALL, ITHACA, NY 14853-3501

Office of the Director

October 21, 1991

Dear Weight-Permit Vehicle Operator:

We hope you were able to complete the **"Permit Vehicle Usage Survey"** questionnaire that we mailed to you a few days ago. We sincerely appreciate the time and effort required to fill out the forms and we thank you for returning them to us.

If for some reason you were unable to fill out the forms on the specified date, we would greatly appreciate if you could find the time to complete the questionnaire for the same day of next week (that is, please ignore the specified **date**, but use the specified **weekday**). Since these questionnaires were sent only to a small random sample of the total number of trucks in New York State that have weight permits, we are relying on a large response to provide an accurate assessment of the use of these permitted vehicles.

If you had or have any concerns or questions, please feel free to contact us at the telephone number indicated on the first page of the questionnaire and on this stationary. Also, if you no longer have your copy of the questionnaire, please give us a call and we will send you another copy immediately.

Thanks again for your cooperation in this important undertaking.

Sincerely yours,

Richard E. Schuler
Professor of Economics and
Civil and Environmental Eng'g.

Arnim H. Meyburg
Professor of Transportation
Engineering

Telephone (607) 255-3438; Telex WUI 6713054
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SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Cornell University

HOLLISTER HALL, ITHACA, NY 14853-3501

Office of the Director

12/17/1990

Dear Permit-Vehicle Operator:

This is a belated response to our "Divisible-Load Permit Vehicle Usage Survey" of late summer/early fall. I want to express our appreciation for your cooperation in this important undertaking by filling out the questionnaire and returning it to us. After having received a sizeable number of responses from operators like yourself, we have spent a substantial amount of time coding the data and putting them into the computer for subsequent analyses. And we are still busy running statistical analyses.

I want to assure you again that the information you provided will be kept in strictest confidence. As matter of fact, the results of our statistical analyses cannot be traced to any specific operator. That is why we need a good response rate to make the results meaningful across the whole population of divisible-load permit vehicle operators. Therefore, your response was very important. And we are very thankful for it. It will contribute to making our analyses more meaningful. Ultimately, we want to be able to advise the policy-decisionmakers about the benefits and the costs of the divisible-load permit vehicle program.

Please also express our appreciation to any other individuals in your firm who might have helped with the completion of the questionnaire. We recognize that it is a rather long and involved survey form and it takes a certain amount of effort and care to complete it.

We wish you and your colleagues a very happy Holiday Season and a pleasant and healthy New Year.

Sincerely yours,

Arnim H. Meyburg,
Professor of Transportation
Engineering and Planning

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Appendix B

Secondary Economic Impact Analysis Methodology

APPENDIX B

DETAILED DESCRIPTION OF METHODOLOGY FOR COMPUTING SECONDARY ECONOMIC IMPACTS

With the help of the input-output table described in Chapter 6 and reproduced in this Appendix as Table B.1, a simple linear model of the state's economy can be written. If we let X_c be the total dollar value of output produced by the construction industry in New York, then moving down the construction column we can write:

$$X_c = A_{cc} X_c + A_{mc} X_c + V_c \qquad \text{(B.1)}$$

Since A_{cc} represents the ratio of dollars of construction required to produce a dollar's worth of construction output, then $A_{cc} X_c$ is the total dollar volume of construction activity required to produce X_c dollar volume of construction output. Similarly $A_{mc} X_c$ is the total dollar amount of manufacturing input required to produce X_c dollar volume of production output. The sum of these terms represents the total payments to producers of inputs (intermediate goods) that are required to produce X_c dollar volume of construction output. If we subtract these payments for intermediate goods from the total value of output, we are left with the residual, V_c, as shown in equation (B.1a), which is called value-added.

$$V_c = X_c - A_{cc} X_c - A_{mc} X_c \qquad \text{(B.1a)}$$

This residual represents the dollars available in the construction industry to pay the workers, taxes and interest and a profit on invested capital. The level of value added is also approximately equal to what is frequently called the gross state product (GSP) in that industry. It is, in this case, a measure of the net economic gain generated by the construction industry. Similarly, looking at the manufacturing industry, its production can be characterized by equation (B.2).

$$X_m = A_{cm} X_m + A_{mm} X_m + V_m \qquad \text{(B.2)}$$

Finally, if we add up the net gain (value added) for each industry, we can compute the total gross state product as in equation (B.3).

$$GSP = V_c + V_m \qquad \text{(B.3)}$$

A second way of looking at the input-output (Table B.1) is to read across each row. In this case, we can add up all of the construction used in New York State, as an example, as summarized in equation (B.4).

$$A_{cc} X_c + A_{cm} X_m + Y_c = X_c \qquad \text{(B.4)}$$

Here again, $A_{cc} X_c$ tells us the total amount of construction volume needed to produce X_c dollar's worth of construction. $A_{cm} X_m$ tells us how many dollars' worth of construction activity is used to produce the state's manufacturing output. In order to add up to the total dollar value of all construction activity in the state, we must add in the dollar volume delivered to consumers for their own use -- the final demand component, Y_c. -A similar equation can be written to add up the dollar output for manufacturing as shown in equation (B.5).

$$A_{mc} X_c + A_{mm} X_m + Y_m = X_m \tag{B.5}$$

Here Y_m represents the final consumer demand for the output of manufacturers. These final demand figures also provide an alternative way of adding up the GSP as shown in equation (B.6).

$$GSP = Y_c + Y_m \tag{B.6}$$

Comparing equations (B.3) with (B.6) simply implies that what is spent on final demand must be earned through some productive activity.

Now for further economic analysis, combine equations (B.4) and (B.5), and re-write them as a simultaneous set of linear equations in matrix notation as shown in equation (B.7).

$$\begin{matrix} A_{cc} & A_{cm} \\ A_{mc} & A_{mm} \end{matrix} \quad \begin{matrix} X_c \\ X_m \end{matrix} + \begin{matrix} Y_c \\ Y_m \end{matrix} = \begin{matrix} X_c \\ X_m \end{matrix} \tag{B.7}$$

$$A \quad X + Y = X$$

Here A is the matrix of input-output coefficients, X is the vector of industry output levels, and Y is the vector of final demands. If we assume the level of final demand is given, and we want to know how much input is required from which industry in order to satisfy those levels of final demand, we can solve equation (B.7) as follows:

$$[I-A]^{-1} Y = X \tag{B.8}$$

Where $[\,]^{-1}$ is the inverse operator and I is the identity matrix. Finally, since it is anticipated that changed trucking regulations will alter the cost of doing business in most of the state's industries, and that those price changes will affect the state's demand for products, we are interested in determining how the state's total output will be affected by the estimated changes in final demand. These summary equilibrium effects, allowing for the interactions of intermediate goods throughout the state's economy, can be found by differentiating equation (B.8).

$$\frac{dX}{dY} = [I-A]^{-1} \qquad \text{(B.9)}$$

It is precisely this matrix of total output effects that is used to develop the RIMS II coefficients reported in Table 6.1 in the body of the report.

In order to understand the information contained in these output mulitpliers, the algebraic solution is developed for the simple two-good economy illustrated in equations (B.4) and (B.5). Solving both equations for their final demands yields:

$$Y_c = (1-A_{cc})\, X_c - A_{cm}\, X_m \qquad \text{(B.10)}$$

$$Y_m = A_{mc}\ X_c + (1- A_{mm})\, X_m$$

or: $Y = [I-A]\ X$

Now solving (B.10) simultaneously for X_c and X_m, as shown in equation (B.11), we develop the equations shown in matrix notation in equation (B.8).

$$X_c = \frac{(1-A_{mm})\, Y_c + A_{mc}\, Y_m}{(1-A_{cc})\,(1-A_{mm}) - A_{mc}\, A_{cm}} \qquad \text{(B.11a)}$$

$$X_m = \frac{A_{cm}\ Y_c + (1-A_{cc})\, Y_m}{(1-A_{cc})\,(1-A_{mm}) - A_{mc}\, A_{cm}} \qquad \text{(B.11b)}$$

$$X = [I-A]^{-1} Y$$

Finally, for simplicity if we call $(1-A_{cc})\,(1-A_{mm}) - A_{mc}\, A_{cm} = \Delta$, then we can differentiate equations (B.11) to find the effects of changes in final demand on the level of output. These partial effects are summarized in equations (B.12).

$$\frac{dX_c}{dY_c} = \frac{(1-A_{mm})}{\Delta}\ ;\ \frac{dX_c}{dY_m} = \frac{A_{mc}}{\Delta} \qquad \text{(B.12a)}$$

$$\frac{dX_m}{dY_c} = \frac{(1-A_{cm})}{\Delta}\ ;\ \frac{dX_m}{dY_m} = \frac{(A_{cc})}{\Delta} \qquad \text{(B.12b)}$$

The total output effects of a change in the final demand for a particular product is found by adding the relevant derivatives as shown in equations (B.13).

$$\frac{dX}{dY_c} = \frac{dX_c}{dY_c} + \frac{dX_m}{dY_c} = \frac{(1-A_{mm}) + A_{cm}}{\Delta} \qquad \text{(B.13a)}$$

$$\frac{dX}{dY_m} = \frac{dX_c}{dY_m} + \frac{dX_m}{dY_m} = \frac{A_{mc} + (1- A_{cc})}{\Delta} \qquad \text{(B.13b)}$$

These are precisely how the RIMS II output multipliers are computed that are summarized in Table 6.1 in the body of the report. A similar related procedure is used by the U.S. Department of Commerce to estimate the earnings and employment multipliers. Note, however, that the actual input-output table is not required if the multipliers are available.

B.1 Estimating Secondary Economic Impacts - First Approximations

The first-order economic impacts are expressed in terms of a change in trucking cost for a particular industry that results from a change in the weight regulations. As an example, let C_c represent the lowered trucking costs that might be experienced in the construction industry as the legal weight limits were relaxed with the implementation of the current permit system. Similarly, many other industries like manufacturing would experience cost reductions, C_m. The total effect on New York's economy, however, would be greater than the sum of these independent expenditure reductions, $C_c + C_m$, since the changing industry costs induce offsetting changes in the demand for each industry's output. Again, taking construction as an example, the direct effect upon construction expenditures resulting from the changed regulation is shown as the first term on the right-hand side of equation (B.14), but in addition we have the offsetting changed demand effect shown by the second term.

$$\frac{dY_c}{dReg} = q_c \frac{dP_c}{dReg} + P_c \frac{dq_c}{dP_c} \frac{dP_c}{dReg} \qquad \text{(B.14)}$$

Note, for most goods and services dq/dP is negative. Now, if we assume that the initial consequence of the changed regulation does not change the volume of trucking services used by the construction industry nor the volume of construction activity, the effective initial price change in construction can be represented as:

$$\frac{\frac{dP_c}{dReg}}{P_c} = \frac{C_c}{X_c} \qquad \text{(B.15)}$$

Equation (B.15) merely represents the trucking cost change in construction as a fraction of the total value of production in the construction industry. If all quantities remain constant, initially, and the industry is highly competitive, this ratio represents the percentage change in the price of construction. Substituting equation (B.15) into (B.14) and manipulating terms results in equation (B.16).

$$\frac{dY_c}{dReg} = q_c P_c \frac{\frac{dP_c}{dReg}}{P_c} \left(1 + \frac{dq_c}{dP_c}\frac{P_c}{q_c}\right) = Y_c \left(\frac{C_c}{X_c}\right)(1 - \eta_c) \tag{B.16}$$

Y_C

where: $\eta_c = -\frac{dq_c}{dP_c}\frac{P_c}{q_c} =$ price elasticity of demand for construction.

Thus a key determinant of the direction of the total economic impact of a changed trucking regulation is the size of the price elasticity of demand for the output of New York State industries that use trucking services. In particular, if $\eta_C > 1$ (demand is said to be elastic), a decrease in trucking costs ($C_C < 0$) will result in expanded dollar volume of final demand for the construction industry; conversely, if $\eta_C < 1$ (demand is inelastic), decreased trucking costs will result in a reduced dollar volume of final demand for construction. In this second case, the quantity of construction will have increased in response to the cost decrease, but not sufficiently to result in overall higher dollar revenues to the industry.

The use of this method for estimating the final demand impacts of changed regulations requires not only the estimates developed in this study of direct trucking cost impacts, C_C, but also estimates of final dollar demand, Y_C, and total dollar value of output, X_C, by NYS industry. The key variables, however, are estimates by industry of the price elasticities of those industry's demands, η_C. In particular, if demand is elastic, changed regulations that reduce trucking costs will expand the dollar value of final demand for that industry's output, which in turn through the input-output model multipliers will have a multiplicative expansionary effect on all of the state's industries serving the construction industry, in this example. Conversely, an inelastic final demand will result in a multiplicative contraction of the state's economy as a result of the changed regulations that reduce trucking costs.

This procedure will be used to estimate the secondary (macroeconomic) economic impacts in this report; however, if a current detailed input-output model were available for New York State, a more detailed procedure could be used, as is outlined in the following section.

B.2 Estimating Secondary Economic Impacts -- An Alternative Method

What the methodology outlined in the previous section does not take into account is the fact that a change in trucking costs in the construction industry can affect not only the costs and prices of outputs in construction, but also because construction is used as an input in virtually all other NYS industries, it will in the long run affect the prices of all other outputs in the state. Similarly, the changing trucking costs in other New York State industries will affect the prices of construction -- as an example, through increased equipment prices as trucking costs rise in manufacturing.

These interactive price effects can be considered if, as in the preceding section, it is assumed that all physical flows of quantities remain constant, initially. In that case, the total industry price impacts can be estimated by moving down the columns of the input-output Table B.1. In particular, consider equation (B.1) in terms of its component parts:

$$\underbrace{x_cP_c}_{X_c} = \underbrace{\left(\frac{x_{cc}P_c}{x_cP_c}\right)}_{A_{cc}} x_cP_c + \underbrace{\left(\frac{x_{mc}P_m}{x_cP_c}\right)}_{A_{mc}} x_cP_c + V_c \tag{B.17}$$

Here, x_c is the physical flow of construction services, x_{cc} is the physical flow of construction into construction, x_{mc} is the physical flow of manufacturing into construction, and P_c is the price of construction. Now, allow the prices in equation (B.17) to vary as a result of changed trucking regulations, which also imposes the direct percentage cost burden, C_c/X_c, as in equation (B.15). The result is summarized as follows, where value-added V_c is assumed to remain constant , as are all of the physical product flows.

$$x_c \frac{dP_c}{dReg} = x_{cc} \frac{dP_c}{dReg} + x_{mc} \frac{dP_m}{dReg} + C_c \tag{B.18}$$

Divide equation (B.18) by the total value of industry output, $X_c = x_cP_c$, and restate all price changes as percentages:

$$\frac{\frac{dP_c}{dReg}}{P_c} = \underbrace{\frac{x_{cc}P_c}{X_c}}_{A_{cc}} \left(\frac{\frac{dP_c}{dReg}}{P_c}\right) + \underbrace{\frac{x_{mc}P_m}{X_c}}_{A_{mc}} \left(\frac{\frac{dP_m}{dReg}}{P_m}\right) + \frac{C_c}{X_c} \tag{B.19}$$

Similarly, equation (B.12) can be arranged as in (B.20):

$$\frac{\frac{dP_m}{dReg}}{P_m} = A_{cm} \left(\frac{\frac{dP_c}{dReg}}{P_c}\right) + A_{mm} \left(\frac{\frac{dP_m}{dReg}}{P_m}\right) + \frac{C_m}{X_m} \tag{B.20}$$

Now, equations (B.19) and (B.20) can be solved simultaneously for the percentage price changes in each industry that are induced by the trucking cost changes, C_c and C_m.

$$\frac{\frac{dP_c}{dReg}}{P_c} = \frac{(1-A_{mm})\left(\frac{C_c}{X_c}\right) + A_{cm}\left(\frac{C_m}{X_m}\right)}{\Delta} \qquad (B.21)$$

$$\frac{\frac{dP_m}{dReg}}{P_m} = \frac{A_{mc}\left(\frac{C_c}{X_c}\right) + (1-A_{cc})\left(\frac{C_m}{X_m}\right)}{\Delta} \qquad (B.22)$$

Here Δ is the determinant that was defined following equation (B.11). In matrix notation, the system of equations (B.21) and (B.22) can be represented as:

$$\frac{\frac{dP}{dReg}}{P} = [I-A']^{-1}\left(\frac{C}{X}\right) \qquad (B.23)$$

where A' is the transpose of the direct coefficients input-output matrix. This computational procedure is illustrated in this analysis by using an input-output matrix for the entire northeast region of the U.S., not just NYS. Therefore the results should not be used as actual estimates of secondary impacts; they are merely illustrative of the likely magnitude of effects.

TABLE B.1: STYLISTIC REPRESENTATION OF INPUT-OUTPUT COEFFICIENTS FOR A SIMPLE ECONOMY

		OUTPUT INDUSTRIES		
		Construction	*Manufacturing*	FINAL DEMAND
INPUT INDUSTRIES	*Construction*	Acc	Acm	Yc
	Manufacturing	Amc	Amm	Ym
	VALUE ADDED	Vc	Vm	

Appendix C

Literature Review and References

LITERATURE REVIEW

A comprehensive literature review with respect to heavy vehicle operations and their impacts was conducted as the first phase of the project. Since the Cornell research team had conducted such a survey covering the period up to 1987, the present effort concentrated on the period between 1987 and 1992. Given the focus of this research project, the literature search concentrated on a limited number of subareas of heavy vehicle impact analysis.

Needless to say, relatively little research work has been performed in the area of impact analysis of heavy vehicle operations. Nevertheless, a number of papers and reports were identified and reviewed that have a bearing on our attempt to better understand the impacts of such operations. The discussion of the results of the literature search is arranged according to the following categories:

A. General Heavy Vehicle References
B. Economics and Regulation of Heavy Vehicle Operations
C. Infrastructure Impacts (Pavement)
D. Size/Weight Regulations
E. Violations and Enforcement of Truck Weight Regulations

A. General Heavy Vehicle References

Monitoring the operations of heavy vehicles continues to be a major concern among operators and public agencies alike. Efficiency of operations and prevention of size/weight violations are the motivating factors behind these efforts. The following discussion provides a sample of recent investigations into this topic area.

Several studies are being carried out to examine the use of automatic technology to monitor traffic, to identify vehicles, to weigh vehicles, etc. This will reduce the time a vehicle spends waiting in line at weigh stations. It will allow the operator to keep track of the company's vehicles and will help in general road design purposes. Cumbersome manual efforts can be done away with due to the use of automatic systems. There is a general belief that the technology involved in this is feasible, but implementing it is expensive and will pay off only if there is sufficient participation from the state's heavy vehicle fleet.

For example, a study by Henion and Koos (1987) examines the use of Automatic Vehicle Identification (AVI) and Weigh-in-Motion (WIM)) technologies. An article in the July/August 1988 edition of Transportation Research News discusses the Heavy Vehicle Electronic License Plate Program (HELP). Presently, 13 states and the Port Authority of NY/NJ have opted for HELP. A feasibility study of the technologies involved in HELP is completed and soon a practical demonstration is to be carried out. The study by Grenzeback, Stowers and Boghani (1988) deals with the feasibility of the Heavy Vehicle Monitoring System (HVM). It claims that HVM can be implemented in a number of ways with different degrees of participation from the private and the public sector.

A study by Woo and Hoel (1988) deals with the data collection aspect of heavy vehicles. Heavy Vehicle data are collected by D.O.T, as well as by a number of other agencies. This leads to the fact that data on heavy vehicles are very difficult to obtain, particularly with respect to uniform and compatible format, survey procedure, etc. A study by Reel (1987) examines the traffic data collected and compares them with those needed to forecast the 18-Kip Equivalent Single-Axle Load (E.S.A.L.).

A study by the National Highway Traffic Safety Administration (1987) developed guidelines for law enforcement agencies to ensure commercial vehicle safety needs . NAASRA (in Australia) did a study in 1987 in which it proposed guidelines to achieve uniformity of weighing procedures. These guidelines were intended to avoid prosecution when no weighing offense had occurred and to avoid inaccuracies which might prevent significant overloads from escaping prosecution.

In a study by Filseth (1987) about overloading of trucks in the nine member countries of the Southern Africa Transport and Communications Commission (SATCC), lack of proper regulations against overloading and lack of manpower and weighing equipment were cited as the main reasons for overloading.

The August 1989 edition of Distribution carried an article that restated the problems associated with the lack of uniformity of federal and state truck size/weight regulations . 48- and 53-foot trailers are permitted on Interstates . But their access to the state and local roads is limited by a series of conflicting rules one of which limits the mileage beyond the interstate. The Interstate Truckload Carriers Conference urged the F.H.W.A. to accept trucks on the state and local roads having a length of 41 feet or less (from the kingpin to the center of the rear axle).

B. Economics and Regulation of Heavy Vehicle Operations

Four studies relating vehicle weight and dimensions to vehicle productivity, i.e. vehicle operating costs, were found. The study by Godwin, Morris, Cohen and Skinner (1987) deals with the so-called Turner proposal of allowing heavy vehicles to carry heavier gross loads, if the number of axles are increased, thereby decreasing the load per axle. The study concludes that the Turner proposal is very beneficial to both the vehicle operators as well as to the road maintenance authorities.

Another study carried out by Maine D.O.T. (1988) examines the effect of the introduction of the 100,000 pound general commodity vehicle. The study concluded that a total of 500 vehicles would shift to using this bigger vehicle, resulting in an increased pavement damage cost of about $450,000. [Note: Using the assumptions and parameters from this Maine study for the data generated in our study would roughly correspond to an increased pavement damage cost of about $12 million per year for the 12,822 divisible-load permit vehicles of New York State.]

Neudorf and Sparks (1987) carried out a general productivity evaluation for heavy trucks in Canada. Their study found that 7- and 8-axle trucks, especially 7-axle trucks are more productive than the standard 5-axle eighteen-wheelers common in the U.S. Another interesting observation is that the same vehicle can be the most or the least productive, depending in which province of Canada it is operating, since regulations concerning heavy trucks differ from province to province. The same might very well hold true for the U.S. since heavy vehicle regulations differ from state to state.

A study by Croft and Miller (1987) about the so-called A-Trains and the B-Doubles operated long-distance in predominantly sparsely populated areas in Australia found that economic benefits are derived from the operation of these long vehicles. These vehicles do not cause any added pavement damage. However, they do pose a safety hazard, especially during passing maneuvers due to their extreme length. Recently, there has been talk of introducing such vehicles in the U.S., though opposition is expected from the railway industry and from automobile and safety lobbies.

Ever since deregulation of the Interstate trucking industry in 1980, one of the most debatable questions in trucking has been "Is deregulation good or bad?". It was believed at the time the deregulation was announced that it was going to lead to a lot of new entries into the trucking industry, thereby increasing the competition leading to decreased profits. But that does not seem to have happened judging from the results of the literature search. The article by Michel and Shaked (1987) states that since deregulation most trucking firms seem to have shown a gain but it also says that most of the gain has been due to factors that have had nothing to do with deregulation. According to this article, large regional firms seem to outperform small regional firms and national firms. It seems to be generally accepted that the truckload carriers that have performed best (20% return on equity) since deregulation are the so called "high-service truckload carriers". These combine high service with low operating costs. According to the article by Legg and Larkin (1988), these "high-service" truckload carriers have been created by private firms buying equipment and hiring drivers from companies that previously used to do their hauling themselves.

Another article by Daughety and Nelson (1988) examines the trucking scenario from 1953-82. Some observations that emerge are: 1) Similarities between early periods of regulation and early periods of deregulation are more pronounced than those between early and late periods of regulation, and 2) The heaviest burden of regulation was born by the firms which had the highest operating costs.

According to the article "Private Fleet Costs : Driving You to the Brink" (Distribution, August 1987), cost of operating shipper-owned vehicles (small operators) continue to rise, albeit moderately so. Privately owned straight trucks and vans are more expensive (\$2.1/ mile) to operate than tractor trailers (\$1.4/mile). Another article by Cavinato (1989) says that private fleets once regarded as a fixed part of the corporate landscape are coming under scrutiny more than ever before. The reason is that it is so much less hassle to hire an outside trucking firm than operating a private fleet of heavy vehicles.

According to a paper by Rakowski (1988), there is a general trend towards bigness in the "Less than Truckload" (LTL) sector. The smaller operators are getting forced out of business because of the nationwide operations of the larger companies. Rakowski claims that deregulation lead to increased profits rather than increased competition. A contrasting finding is reported by Hoffman (Distribution, May 1989) who states that truckload firms are competing fiercely. The "high service truckload carriers" still realize substantial growth rates as they withdraw business from their competition. As a result, the trucking industry in general has to be on the lookout for new markets continuously. The amount of freight is not expanding as rapidly as the number of truck operators and trucks looking for it. Ha, Khasnabis and Jackson (1988) found that deregulation has increased the cost of small shipments in low volume markets. Freight consolidation is a good remedy for such small shipments as it reduces costs and increases the service quality.

Hoffman (Distribution, June 87 and August 1988) states that 1986 was a good year for the trucking industry. Operator profits and revenues went up. However, rising fuel costs and driver shortages forced profits to go down in 1987. Although the profits went down, the total freight carried in 1987 went up.

Martin (1989) examined the tank truck industry. The tank truck industry was in the red from 1982 to 1987. In 1988 things improved slightly. If things are to continue to look better, shippers will have to use carriers that provide safer and better service and they will have to pay higher rates.

McMullen's (1987) findings about the effects of deregulation run counter to the results of several studies reviewed above. He claims that there has been a substantial number of entries into the market by small firms. This has been due to the tremendous increase in the number of I.C.C certified motor carrier property brokers who have eliminated the difficulty of obtaining information which was one of the main obstacles for small firms. Also, most studies claim that revenues have gone up since deregulation. However, McMullen determined that both real revenues per mile and operating costs per mile have fallen in the post-regulation period. The maximum change has been in the operating costs which have gone down by a third, indicating that deregulation is causing firms to become more cost efficient. The reduction in real revenues is not very large.

The effects of deregulation have probably been summarized best by Kling (1988). He states that it is important to realize that the trucking industry is not yet stabilized since deregulation. Also, deregulation has led to the bankruptcy of a lot of small firms, both among pre- and post-deregulation entries into the trucking industry. Bigger firms are getting more and more powerful, since they can afford to offer lower rates because they have a larger market share. Especially in the LTL sector a transfer of power is taking place which may lead to the creation of an oligopoly. Also, lower freight rates are leading to the de unionization of the industry which, while partly responsible for the observed productivity gains, are also a possible cause for safety degradation resulting from increased work hours and decreased equipment maintenance, Kling states. Even though deregulation has led to positive aspects like lower freight rates and more competition, it seems that reregulation to counter some of the above mentioned negative aspects of deregulation may be a good idea, keeping in mind the efficiency and the equity distribution that are desired.

C. Infrastructure Impacts (Pavement)

A substantial number of studies examining the effect of the movement of heavy vehicles on the wear and tear of pavement were performed in recent years. Several of these deal with the general topic of the effect of trucks carrying different loads with different axle configurations and tire pressures on the various types of pavements under varied conditions, e.g. Austin Research Engineers (1987), University of Michigan (1991), Kentucky Transportation Research Program (1987). Other studies like those by the Texas Transportation Institute (1987) investigated how this loading consisting of different axle configurations and tire pressures is to be incorporated into pavement design. In a study by New York State Department of Transportation (1991), several roads were selected to monitor pavement performance and maintenance, as well as the traffic data on these roads to establish relationships between traffic loading and pavement maintenance.

A study by Thomas and La-Hue (1988) investigated the effect of increased truck traffic on pavement damage. Road traffic has increased much more than what the roads were initially designed to carry. Especially the truck composition which is the main contributor to the E.S.A.L.'s has gone up from 6% to about 40% of total traffic. Roads can be made to withstand this additional traffic. The author observes that an increase in thickness of the concrete pavement by 1 inch will double its load carrying capacity, i.e. E.S.A.L. life. Also, the cost of providing this additional thickness of 1 inch is much less if it is provided in the initial construction stage than if it is provided as a future rehabilitation of the roadway. Another interesting finding was that on average a 5% increase in gross vehicle weight causes a 23% increase in the E.S.A.L., a 10% increase causes a 49% increase in the E.S.A.L. and a 20% increase in weight causes a 114% increase in the E.S.A.L.

Terrell and Bell (1987) investigated the effect of overloading on pavements. Truck overloading is perceived as a moderate problem with about 20% of the trucks being overloaded costing the Federal Aid Highway System about $ 1 billion each year. Overload fines not being based on axle-weight-miles (i.e. not based on actual cost of pavement damage caused by the overloaded trucks), insufficient personnel to identify overloaded vehicles and operators of overloaded vehicles often escaping fines because of the failure of the judicial or the administrative procedures are some of the main problems causing the overloading.

Two studies regarding equivalency factors (factors that convert different trucks with different axle configurations into comparable numbers) were found. One study performed by the Organization for Economic Co-Operation and Development (O.E.C.D., 1988) gives the different values developed by different countries to which the power that the ratio (of the axle load of the truck to 18,000 pounds) is to be raised to give the E.S.A.L. of the axle for both flexible and rigid pavements. [Note: In this study of the NYS Permit Vehicle Fleet we have decided to use the 4th power as given by the AASHTO test, although a paper by Kenneth and Small suggests that it is the third power and not the 4th power which is correct].

A study by M.I.T. (1989) developed composite load equivalency factors, taking into consideration the vehicle characteristics, like axle configurations, suspension type and tire type, and also pavement characteristics, like pavement type and conditions.

The effect of tire pressure on the wear and tear of pavements is finding increasing attention in the research community. A study by Oregon State University (1987) found that 87% of the tires surveyed were of radial construction and had tire pressures of 102 psi, as opposed to 82 psi of bias ply tires. Also, the study indicated that a 20% increase in the tire pressure could result in a 40 to 60 % increase in the equivalency factors for dual-tire single axles of 18 kips and tandem axles of 34 kips.

A study by Bonaquist and Freund (1988) found that pavement damage depends more on the load of the vehicle than its tire pressure. Other studies have investigated the effect of different heavy vehicle suspension systems on pavements, e.g. Woodroofe and LeBlanc (1988), Cebon (1988), LeBlanc et al. (1988).

Another research area attempts to develop the optimum unit pavement damage costs per E.S.A.L. mile. Vitaliano and Held (1988) examined the time period between two pavement overlays and the cost of the pavement overlays carried out on 59 roads in a certain period of time (1982-85). Based on the functional category of the roads and their Average Annual Daily Traffic (AADT), the annual E.S.A.L. loadings for the roads were calculated.

The overlay costs as well as the average time between two overlays in this study were measured. The only data source here that is slightly doubtful is the annual E.S.A.L. loading which has been created from the A.A.D.T. and the axle load distribution based on the functional classification of the roads. The costs developed by this study vary from 1.15 cents per E.S.A.L. mile for Interstates to 28 cents for rural collector roads. Using a much simpler equation (Cost /E.S.A.L. mile = Cost of one mile of overlay /{Years between two overlays times the annual E.S.A.L loading }) and assuming that traffic is responsible for 75% of the damage (instead of the 50% assumed in this study), costs varying from 1.88 cents/E.S.A.L. mile for Interstates to 44.85 cents for rural collectors were obtained. An improvement to this approach would be one where it is possible to get both, the WIM data about the axle loads as well as the pavement overlay costs and the time intervals between overlays, about the same roads instead of having to reconstruct the E.S.A.L. loading of each road from its functional classification and its A.A.D.T. In the absence of research based on that information this study seems to be the best one available.

To a large extent our study is based on the methodology presented by Small and Winston (1989). The equations in the study by Vitaliano and Held (1988) are for all practical purposes the same as those by Small and Winston. The only difference is that Small and Winston attribute 100% of the pavement damage to traffic as against 50% in the paper by Vitaliano and Held. Small and Winston provide figures of cost/E.S.A.L mile of 1.48 cents for Rural Interstates to 125 cents for urban collector streets.

Another very important factor that went into consideration in deciding on the unit pavement damage costs per E.S.A.L. mile to be used for Interstates, state highways and local roads was the recommendation made by John Merris from Oregon State D.O.T. (personal communication, 1990). Merris, based on his extensive experience with determining unit pavement damage costs, suggested using values of about 5 cents per E.S.A.L mile for Interstates,10-30 cents for state highways and 40-50 cents for local roads. He also suggested that we might want to use slightly lower numbers than the ones he had quoted.

Based on these two sources (Vitaliano/Held and Merris), it was decided to use a cost of about two cents/E.S.A.L mile for Interstates, six cents for state highways, and 40 cents for local roads. These numbers mainly come from the study by Vitaliano and Held but differ from it in that a simpler cost equation, as explained earlier, was used. Also, 75% of the road damage has been attributed to the traffic instead of 50%.

The rest of the studies were helpful in telling us that the costs used in this study are in the ballpark of the costs used in similar studies elsewhere. The following are some of the other studies that were examined.

A study by Byrd, Tellamy, MacDonald, and Lewis (1988) determined the additional pavement damage costs, by computing from the pavement design principles the extra pavement thickness (.1 inch) required to withstand this increased annual E.S.A.L. mile loading due to the permit fleet operation. It then divided the cost of the increased pavement thickness for all the NYS highways by the number of years the road will last under the increased E.S.A.L. loading. The resulting costs are very low and are very theoretical. Hence, this methodology was not adopted for this study.

The Federal Highway Administration's cost allocation study of 1982 uses the methodology of dividing the costs of the pavement overlay by the E.S.A.L. life of the pavement until an overlay is required to arrive at the unit pavement damage costs per E.S.A.L. mile. This methodology is acceptable. However, we question the E.S.A.L. lives of the various categories of roads used in this study. The E.S.A.L. lives seem to be obtained through a theoretical process (i.e. a road having base course of "x" inches and "y" inches of asphalt should therefore have an E.S.A.L. life of "z" E.S.A.L.'s), as against actually measured E.S.A.L. life values. It is the opinion of other researchers too that the unit costs per E.S.A.L. mile obtained in the FHWA study are slightly on the high side, in addition to being outdated, given that the study was carried out in 1982. The costs obtained in the FHWA study are 5-15 cents for Interstates, 13-40 for state highways and 31-50 cents for local roads.

A study carried out by Maine D.O.T (1988) has calculated a per E.S.A.L mile cost of 3.41 cents for all roads other than local roads. The life of the road (i.e. the time period between pavement overlays) has been taken to be 13.33 years for all the different types of roads.

Oregon D.O.T. (1986) came up with costs of 1 cent for Interstates, 26 cents for high volume urban arterials and 51 cents for local roads. A later study by the same agency (1989) recommended a cost of 5 to 10 cents per E.S.A.L. mile for the transportation of indivisible loads, since the roads involved were relatively high quality roads like Interstates and major primary routes.

Idaho D.O.T (1986) proposed costs per E.S.A.L. mile of 6.3 cents for Interstates, 36.7 cents for primary and 123.3 cents for secondary roads.

D. Size/Weight Regulations

One of the most important changes in truck regulations has been the deregulation of 1980. In order to examine the effect deregulation has had on the trucking industry, please refer to section "B. Economics and Regulation of Heavy Vehicle Operations" of this literature review. The following review section discusses the remaining discrepancy between federal and state regulations.

Ettorre (1988) observed that in spite of the federal deregulation of the interstate trucking industry in 1980, the majority of states retained their own regulations on intrastate trucking. An estimated 60% of trucking tonnage does not cross state lines. However, even states seem to be moving away slowly from rate regulation. A study by the Federal Highway Administration (1989) on state practices concerning permits and penalties for overweight vehicles summarized the findings about whether each state is enforcing the truck size/weight regulations and whether state truck weight laws enacted between October 1986 through September 1987 are in conformity with federal laws.

A study by Duncan (1988) concerning regulations stated that the list of proposed constraints aimed at the commercial trucking industry is long and it is likely to result in higher costs and new operating problems for carriers. Duncan claims that these regulations will not solve traffic congestion problems.

Humphrey (1988) discusses the non-uniformity that exists among the oversize/overweight permits across various states of the U.S. The report discusses the problems this non-uniformity causes, the reasons that lead to this non-uniformity and the efforts that are being made right now to achieve a greater degree of uniformity.

An article in Transportation Research News (July/August 1987) described an agreement made by 5 of the 6 New England States to establish common guidelines for issuing permits to non-divisible oversized trucks. The agreement took place through a consortium organized and managed by M.I.T. It is significant in that it marks the first time that states have formally cooperated to simplify size and weight permits for intrastate truck traffic.

Among the international studies reviewed in the course of this research effort were those performed in the U.K. (HMSO, 1987), in New Zealand (Edgar, 1987) and in Canada (Roads and Transportation Association of Canada, 1987). These studies also deal with the problem of developing an appropriate regulatory environment in which improved opportunities are provided to exploit the capacities of both the highway system and the motor carrier fleet.

E. Violations and Enforcement of Truck Weight Regulations

Very few studies exist that deal with the topic of "fines" for operating overloaded vehicles. Prentice and Hildebrand (1988) examine an economic approach to truck weight regulation enforcement. Their study discusses the best way of employing a fine structure. It is a known fact that the costs associated with enforcing complete compliance are excessive. In the absence of effective enforcement, individual truckers have an incentive to overload their vehicles. This study uses a game theory approach to establish the optimal minimum cost of regulation enforcement, i.e. "an equilibrium point where neither the truck operator nor the government have any incentive to alter their action irrespective of the other party's action."

Most of the other studies identified in this effort deal with the problem of overloading of trucks and express the opinion that a fine structure is unable to control these violations. For example, the paper by Euritt (1988) examined fine schedules in Texas and the effect they had on the overloading of vehicles. The paper found that fine schedules are inadequate. The fines are so small, the probability of being caught is so low, and the benefits obtained by operators from overloading their vehicles are so high that they are not sufficiently encouraged to abide by the legal weight limits.

An article in Traffic Safety (November 1987) reported a crackdown by Minnesota State Patrol on interstate truck operators who cheat on their log books. The crackdown was carried out in August and of the 190 inspections that were made, 8 drivers were put " out of service " and several others were issued warnings.

A study by FHWA (March 1989) examined containerized freight transportation involved in international maritime shipping. These containers tend to travel part of their distance by truck. If these containers are overloaded they cause increased pavement damage and violations of the bridge formula. The study concludes that overloading of freight containers is a problem and that, depending upon the size of the container, as many as 17-40% of them are overloaded. This overloading primarily occurs with high-density commodities and the shippers load the containers to capacity to take full advantage of the container's volume, ignoring weight implications.

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SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Cornell University

HOLLISTER HALL, ITHACA, NY 14853-3501

Office of the Director

October 9, 1991

Dear Permit Vehicle Operator:

We trust that you have received our letter of last week announcing the upcoming arrival of a questionnaire for one or more of your permit vehicles. As we indicated in that letter, your company has been selected on the basis of a random sample of weight permit vehicles that was provided from the applications filed with the New York State Department of Transportation. This study is endorsed by the New York State Motor Truck Association.

We are asking for your cooperation in filling out the questionnaire(s) enclosed in this mailing. This can be done by the vehicle driver(s), or, if it is more appropriate for your operation, by your office staff. Although you were contacted last summer and last winter, it is equally important that you respond to this request so that we can compare seasonal usage of permit vehicles. This is the last of the three planned surveys.

As before, the information requested will be kept in strict confidence and will only be used for statistical analysis purposes. As we stated before, the purpose of this study is to determine the value of the divisible-load permit system and to make recommendations to the NYS legislature as to whether the program should be continued and expanded.

We recognize the time and effort required to fill out the questionnaire. But your cooperation is most important in order to make the results of this survey useful and statistically meaningful. Also, your comments on the survey and the permit-vehicle system are most welcome.

Since only a relatively small number of vehicles have been selected at random, each response is important for the statistical validity of the study.

Please observe the **specified survey day** that appears on the questionnaire. If you do not know the precise answer to a particular question, please provide your best estimate.

Also, even if the **specified vehicle** was not in operation on the survey day, or if you transferred the permit, or if you sold the vehicle, please **fill out the blue sheets anyway** and return the questionnaire in the enclosed postage-paid, self-addressed return envelope. Please do not hesitate to call us at **607-255-3690** if you have a question.

We look forward to receiving your completed questionnaire(s). Please accept our sincere appreciation in advance.

Sincerely yours,

Richard E. Schuler
Professor of Economics and
Civil and Environmental Eng.

Arnim H. Meyburg
Professor of Transportation
Engineering

Telephone (607) 255-3438; Telex WUI 6713054
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DOUGLAS A. HUGHES
EXECUTIVE DIRECTOR
518-438-8184

August 13, 1990

Dear Permit Vehicle Operator:

As you know, legislation allowing the operation of vehicles exceeding the federal statutes for divisible loads has been in effect in New York State since 1986. The legislation is under review regularly in New York State and it is following with interest in other states.

The legislation also established the "Permanent Advisory Committee on Truck Weights," consisting of industry and government representatives, to oversee the effect of this legislation. This Committee has cooperated with a research team at Cornell University to perform studies of the economic consequences of increased truck weights. For this purpose, the Cornell team has developed the enclosed "Permit Vehicle Usage Survey" questionnaire to collect firsthand information from you, the user.

Your company was selected on the basis of a random sample of weight-permit vehicles that was provided from the applications filed with the New York State Department of Transportation. The information requested in this questionnaire will be kept in strict confidence and will only be used for statistical analysis purposes. Some questions in the survey (axle loadings, state/county road mileage, etc.) seek information that is not readily available, but we hope you'll provide your best estimate in these instances.

Sincerely,

Douglas A. Hughes

Douglas A. Hughes

NEW YORK STATE MOTOR TRUCK ASSOCIATION, INC.
1234 Western Avenue
Albany, New York 12203