Maine and Vermont Interstate Highway Heavy Truck Pilot Program

6 Month Report

Introduction

Section 194 of the 2010 Department of Transportation Appropriations Act provided for a 1 year heavy truck pilot programs in both Maine and Vermont. The pilot programs allow the States of Maine and Vermont to apply State laws and regulations on the Interstate System in those States replacing the current federal weight limits with State weight limits. This allows trucks with a gross vehicle weight above 80,000 pounds and tandem axle weight above 34,000 pounds on each State's Interstate System. The pilot program also exempts the States from following the Federal Bridge Formula B mandated by Section 127 of Title 23, United States Code.

Specifically the law provides:

> Section 194(a) In General – Section 127(a)(11) of title 23, United States Code, is amended by striking "that portion of the Maine Turnpike designated Route 95 and 495, and that portion of Interstate Route 95 from the southern terminus of the Maine Turnpike to the New Hampshire State line, laws (including regulations)" and inserting "all portions of the Interstate Highway System in the State, laws (including regulations)".
>
> (b) Period of Effectiveness – The amendment made by subsection (a) shall be in effect during the 1-year period beginning on the date of enactment of this Act.
>
> (c) Reversion – Effective as of the date that is 366 days after the date of enactment of this Act, section 127(a)(11) of title 23, United States Code, is amended by striking "all portions of the Interstate Highway System in the State, laws (including regulations)" and inserting "that portion of the Maine Turnpike designated Route 95 and 495, and that portion of Interstate Route 95 from the southern terminus of the Maine Turnpike to the New Hampshire State line, laws (including regulations)".
>
> (d) Vermont Pilot Program – Section 127(a) of title 23, United States Code, is amended by adding at the end the following:
>
>> (13) Vermont Pilot Program –

"(A) In General – With respect to the Interstate Routes 89, 91 and 93 in the State of Vermont, laws (including regulations) of that State concerning vehicle weight limitations apply to the State highways other than the Interstate system shall be applicable in lieu of the requirements of this subsection".

(e) Period of Effectiveness for the Vermont Pilot Program – The amendment made by subsection (d) shall be in effect during the 1-year period beginning on the date of enactment of this Act.

(f) Reversion for the Vermont Pilot Program – Effective as of the date that is 366 days after the date of enactment of this Act, Section 127(a) of title 23, United States Code, is amended by striking paragraph (13).

(g) Report on the Vermont Pilot Program – Not later than 2 years after the date of enactment of this paragraph, the Secretary shall complete and submit to Congress a report on the effects of the pilot program under this paragraph on highway safety, bridge and road durability, commerce, truck volumes, and energy use within the State of Vermont.

The House and Senate Committees on Appropriations added:

> Section 194 modifies a provision proposed by the Senate to establish a 1-year pilot program related to truck weight in the States of Maine and Vermont. The conferees direct the Secretary to report to the House and Senate Committees on Appropriations no later than 6 months after the start of the pilot program on the impact to date of the pilot program on bridge safety and weight impacts.

Both States are implementing the pilot program by extending their State truck weight laws to the Interstate System as allowed by these pilot programs. Maine now allows tractor semi-trailers up to 100,000 pounds gross vehicle weight on 6-axles and tandem axle weights up to a maximum of 46,000 pounds for many commodities on the non-tolled Interstate Highways (tolled interstate and a portion of free Interstate between the southerly terminus of the Maine Turnpike and the New Hampshire border was already exempt). Maine did not choose to allow other non-Federally compliant State truck weights onto the Interstate System. Vermont allows all trucks legal on their State highway system onto their Interstate highways including up to a maximum gross vehicle weight of 99,000 pounds on 6-axles, and trucks with tandem axles weighing up to a maximum of 36,000 pounds plus a 10 percent tolerance, which reaches 36,900 pounds.

For the 6 month study the Secretary organized a team including the Federal Highway Administration (FHWA), Federal Motor Carrier Safety Administration (FMCSA), Maine Department of Transportation (Maine DOT), Maine State Police, Maine Bureau of Motor Vehicles, Vermont Agency of Transportation (Vermont AoT) and Vermont Department of Motor Vehicles (Vermont DMV). Given the short time frame of the study, the team utilized existing infrastructure data, engineering principles, and previously developed models. There was insufficient time to acquire empirical data for this study as it takes years before there would be measurable impacts on the pavements and bridges.

Federal regulations govern the weight and size of commercial vehicles and the number of trailers that a power unit may tow on the National Network for Large Trucks, including all Interstate Highways. These regulations have important economic implications because trucking costs and productivity are influenced by truck size and weight regulations. The broader consequences of allowing heavier trucks on Vermont and Maine's Interstate system; including safety, economic and environmental implications, is not part of this 6-month report, but will be explored in the Vermont one-year report. Size and weight regulations also impact highway construction and maintenance requirements, as well as highway safety. The truck sizes and weights are important to both Maine and Vermont where over 85 percent of the freight transported within or through the state utilize trucks. Forest products and other heavy commodities are important parts of Maine and Vermont's economies.[1]

This analysis focuses on the bridge safety and weight impacts of higher weight vehicles on the Maine and Vermont Interstate Highways. It does not consider any benefits, or pitfalls of moving existing heavy trucks from the State highway system to the Interstate highways. Federal regulations do not control the size of trucks off the National Network for Large trucks and the truck weight limits off the Interstate Highways. The National Network is described in Appendix A of Title 23, Part 658 of the Code of Federal Regulations.

Study Purpose – The purpose of this study is to report "to the House and Senate Committees on Appropriations no later than 6 months after the start of the pilot program on the impact to date of the pilot program on bridge safety and weight impacts."

This study focuses on the impacts of allowing the heavier trucks onto the Interstate routes where prior to H.R. 3288 the trucks were not allowed.

Information is also provided concerning revised state pilot implementation; previous relevant truck size and weight studies, state specific truck configurations for the pilot period, and results of the bridges and pavements most critically affected by the higher weight trucks.

Methodology – This study specifically examines: Vermont Interstate 89, 91 and 93 Highways (I-189 is excluded in Vermont) and the nontolled portion of Maine I-95(also excluded is a portion of the free Interstate between the southerly terminus of the Maine Turnpike and the New Hampshire border that was already exempt)..

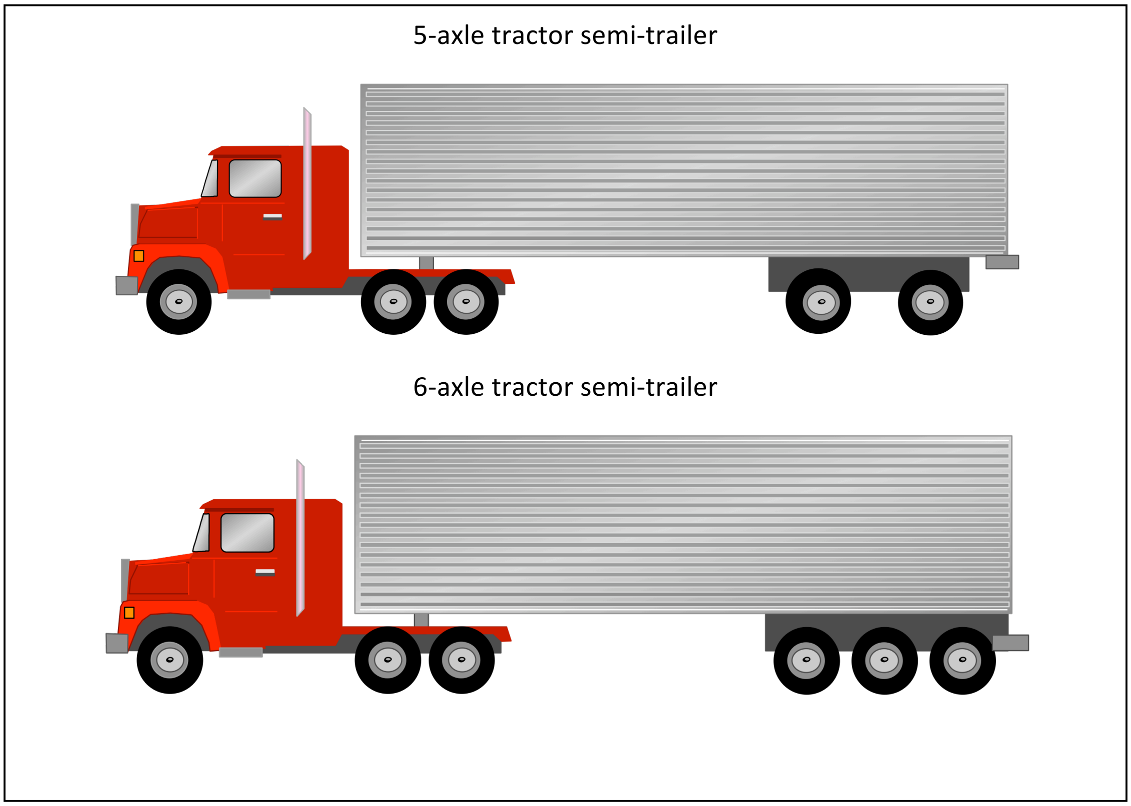
Context of Truck Size and Weight Limits

State and Federal law regulate the truck size and weight allowances on Maine and Vermont highways. Prior to the pilot, Maine allowed a maximum weight on non-interstate and tolled roads of 100,000 pounds on a 6-axle tractor semi-trailer. Vermont allowed maximum weight on non-interstate roads of 99,000 pounds on a 6-axle tractor semi-trailer. Unless covered by a specific

1 Source http://ops.fhwa.dot.gov/freight/resources/frt_solutions/index.htm

exemption, the maximum weight for a tractor semi-trailer on the Interstate and Defense Highway System is 80,000 pounds. Exhibit 1 shows typical 5-axle and 6-axle tractor semi-trailers.

Exhibit 1. 5-axle and 6-axle tractor semi-trailer configurations



Truck Size and Weight on the Interstate Highway System

States were the first to enact truck size and weight regulations. In 1913, Maine, Massachusetts, Pennsylvania and Washington became the first states to limit truck weights in an effort to protect highway pavements and bridges.

The Federal government became involved in truck size and weight regulations in 1956 when truck axle weight, vehicle gross weight and vehicle width limits were established for the Interstate System. They were based on the recommended limits from the American Association of State Highway Officials (the predecessor to the American Association of State Highway and Transportation Officials (AASHTO)). The Federal-Aid Highway Act of 1956 placed limits on the weight of vehicles operating on the Interstate System to protect the substantial Federal investment in its construction. The limits were 18,000 pounds for single axles, and 32,000 pounds for tandem axles. The allowable gross weight of each vehicle was determined as the sum of the allowable axle weights up to a maximum allowable gross vehicle weight of 73,280 pounds.

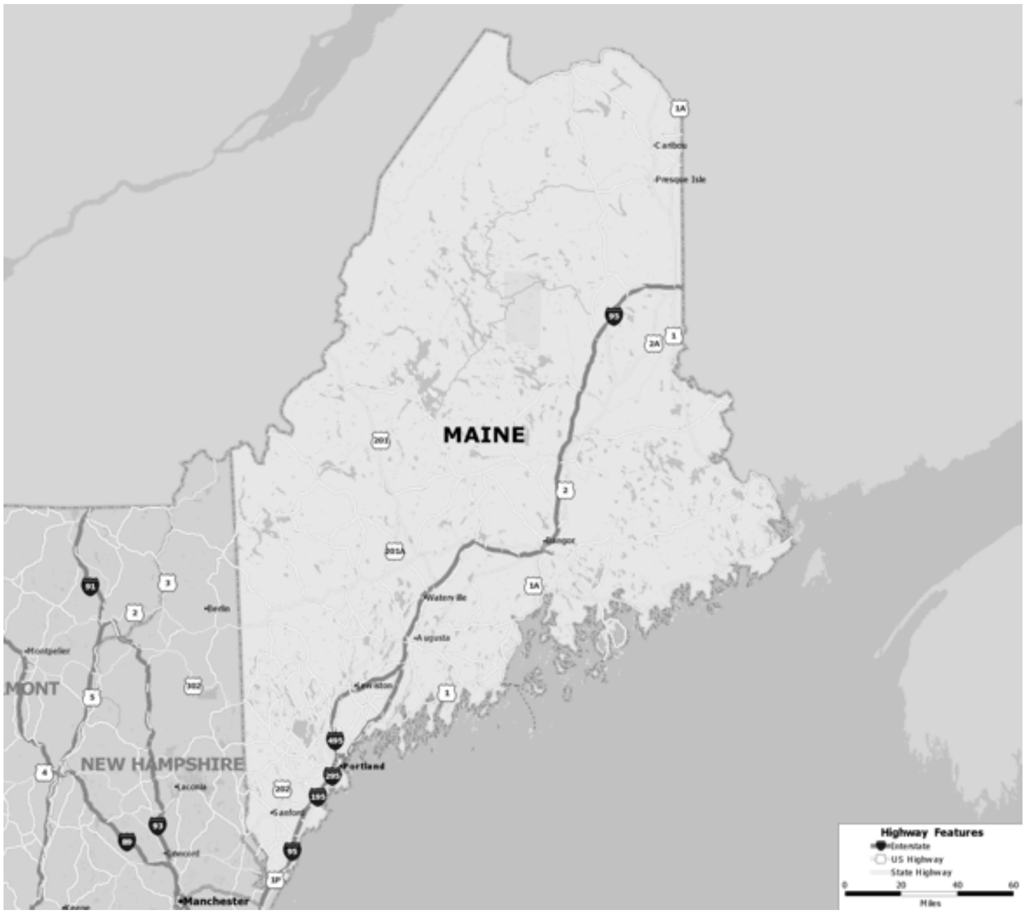
In 1975, Congress raised the weight limits and codified Bridge Formula B into law to ensure that divisible vehicle loads are distributed so as to avoid excessive overstressing of bridges. The Federal-Aid Highway Amendments of 1974 also increased the allowable maximums on the Interstate System to 20,000 pounds for single axles, 34,000 pounds on tandem axles, and 80,000 pounds for the gross weight. The maximum weight is limited to 80,000 pounds under Bridge Formula B because the formula takes into account the distance between and within each axle group for a 5-axle tractor semi-trailer pulling a 48 or 53 foot trailer.

All truck size and weight legislation, including the Federal-Aid Highway Act of 1956, contain provisions that allowed States to retain vehicle size and weight limits exceeding the Federal limits if the State's weight laws or regulations were in effect in 1956. This ability to retain the prior size and weight regulation is called 'grandfather' provisions. Most States that have grandfather provisions utilize the Federal exemptions because the transportation savings afforded to their industries are important to their State economies.

The Federal government does not exercise jurisdiction over truck weight limits on non-Interstate roads. Each State is able to set size and weight limits it deems appropriate on non-Interstate roads, either through commodity exceptions/permits or overall higher limits. In addition States issue permits for the movement of non-divisible loads on both the State and Interstate roadways.

Truck Size and Weight on the Maine State and Interstate Highway System

Exhibit 2. Maine Interstate Highway



Prior to H.B. 3288 The Maine State law allowed a maximum weight for tractor semi-trailer combinations on non-interstate of 100,000 pounds on a 6-axle tractor semi-trailer. On the Interstate, Maine followed the Federal weight limits set out in the Federal-Aid Highway Amendments of 1974. Maine State law (29-A §2355) set out Bridge Formula B for maximum weights on the Interstate and 80,000 pounds as the maximum gross vehicle weight. In addition Maine has two limited statutory exceptions of the Federal TS&W regulations on their Interstate. There is a waiver for shipments of jet fuel on I-95 between Augusta and Bangor to supply the Air National Guard Base at Bangor International Airport during periods of national emergency (the only waiver authority granted to the USDOT/FHWA). The second exception came in 1998, when the Transportation Equity Act for the 21st Century (TEA-21) allowed "with respect to that portion of the Maine Turnpike designated Interstate Route 95 and 495 and that portion of Interstate Route 95 from the southern terminus of the Maine Turnpike to the New Hampshire State line, laws (including regulations) of the State of Maine concerning vehicle weight limitations that were in effect on October 1, 1995 and are applicable to the State highways other than the Interstate System…" This last exception connected the southern end of the Maine

Turnpike, which is not subject to Federal size and weight regulations, with the New Hampshire boarder.[2]

Exhibit 3 shows the registration activity over 80,000 pound in the State of Maine for 2006 – 2010. Registrations have remained fairly steady over the past 5 years and have declined somewhat for 2010.

Exhibit 3. Maine Truck Registrations over 80,000 pounds* (as of January 1, each year)					
	YEAR				
	2006	***2007***	***2008***	***2009***	***2010***
Registered Weight					
80,001 to 90,000	710	673	567	550	489
90,001 to 94,000	7	9	8	10	12
94,001 to 100,000	3018	3271	3293	3427	3345
Total	3735	3953	3868	3987	3846

* Maine charges an annual registration fee of $1,234 for trucks with registered weights greater than 94,001 but less than 100,000 pounds. Fees must be expended for the enforcement of truck weight regulations.

In addition to the above Bridge Formula B axle weights for all commodities, Maine also allows a 10 percent axle weight tolerance for vehicles hauling specific commodities (29-A §2357).

This tolerance allows 24,200 pounds on a single axle; 46,000 pounds on a tandem axle; and 54,000 pounds on a tri-axle. Regardless of any allowance on the individual axle group weight, Maine requires 6-axle tractor semi-trailers may only have a maximum gross vehicle weight of 100,000 pounds.

The tridem and tri-axles limits for the 6-axle combination exceed the Federal Bridge Formula. In general for the 6-axle tractor semi-trailer weight on a tandem axle may not exceed 41,000 pounds and the tri-axle may not exceed 50,000 pounds (for certain commodities there is a 10% weight allowance on the axle weight but the gross vehicle weight is strictly limited to 100,000 pounds). The Federal Bridge Formula limit is 34,000 pounds for a tandem and 44,000 pounds for a tridem.

Exhibit 4. Prior to H.R. 3288: Truck Size and Weight Limits in Maine and Federal Interstate (pounds)Axle Configuration	Maine*		Federal Interstate
	State Roads	State Roads, Certain Commodities***	
Single Axle Limit	22,400	24,200	20,000

2 In 1998, the Transportation Equity Act for the 21st Century (TEA-21) provided an exemption for the 80,000 pound weight limit on I-95 in New Hampshire, thereby allowing up to 99,000 pounds gross vehicle weight on that highway.

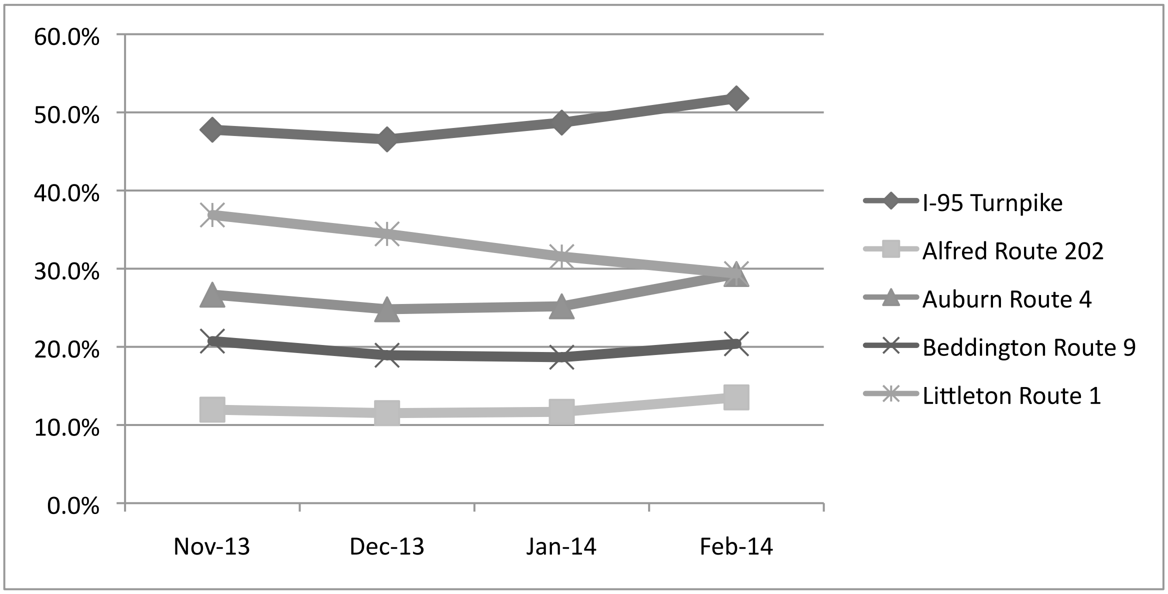
Tandem Axle Limit	38,000	46,000	34,000
Tri-axle weight limit	48,000	54,000	n/a
on a 4-axle combination**		64,000	
Gross Vehicle Weight			
5-axle combination	80,000	88,000	80,000
6-axle combination****	100,000	100,000	80,000

* Maine State road limits also apply to that portion of the Maine Turnpike designated Interstate Route 95 and 495 and that portion of Interstate Route 95 form the southern terminus of the Maine Turnpike to the New Hampshire State line. 23 U.S.C. §127(a)(11).
** § 2357(2)D. - On the tri-axle unit of a 4-axle single-unit vehicle hauling forest products
*** § 2357(1)A. a vehicle loaded entirely with building materials that absorb moisture during delivery originating and terminating within the State, bark, sawdust, firewood, sawed lumber, dimension lumber, pulpwood, wood chips, logs soil, unconsolidated rock material including limestone, bolts, farm produce, road salt, manufacturer's concrete products, solid waste or incinerator ash;
B. Dump trucks or transit-mix concrete trucks, carrying highway construction materials;
C. A vehicle loaded with a majority of products requiring refrigeration whether by ice or mechanical equipment; or
D. A vehicle loaded with raw ore from the mine or quarry to a place of processing.
**** For the 6-axle tractor semi-trailer allowed a gross vehicle weight of 100,000 pounds, the weight on tandem may not exceed 41,000 pounds and the tri-axle may not exceed 50,000 pounds.

Post H.R. 3288 the Consolidated Appropriations Act, 2010 (H.R. 3288) §194(a) would have allowed all truck weights, axle spreads and commodity exemptions as specified in Maine Law Chapter 21, Subchapter I on all Maine Interstate Highway but the Maine legislature amended Chapter 21 with Section 2355. The amendment states "not withstanding any other provision of this subchapter to the contrary, for as long as the provision of 23 United States Code, Section 127(a)(11) affording an exemption from the federal vehicle weight limitations for vehicles operating on all portions of the interstate system are in effect, a 6-axle combination vehicle consisting of a 3-axle truck tractor with a tri-axle semitrailer having a maximum gross vehicle weight of 100,000 pounds may be operated on any portion of the interstate system, consistent with this subchapter as it applies to the Maine Turnpike designated Interstate 95, subject to provisions of section 2354. For purposes of this section, 'interstate system' has the same meaning as in Title 23, section 1903, subsection 3." (Section 1. 29-A MRSA § 2355-A) The change is retroactive to December 16, 2009.

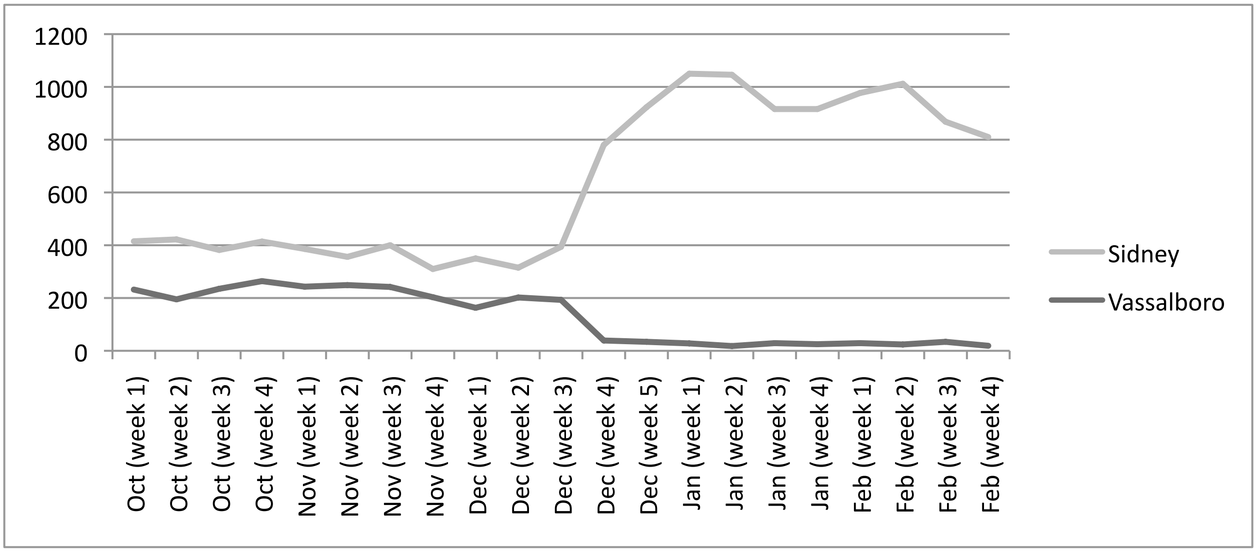
Maine Weight-in-Motion. Weight-in-motion data show gross vehicle weight and axle weights for trucks passing the weight-in-motion stations. This gives a snap shot of the trucks operating in Maine for November, 2009 – February, 2010. The data show relatively high utilization rates for trucks over 80,000 pounds but less than 120,000 pounds. It is interesting that the percent of trucks in that weight category has not decreased on the I-95 Turnpike following the implementation of the pilot program (the non-tolled Interstate runs parallel to the Maine Turnpike).

Exhibit 5 Maine - Percent of Total Trucks More than 80,000 pounds and less than 120,000 pounds



Truck classification sites count the number of trucks passing in each direction by the number of axles and size. Truck classification sites do not weigh the vehicles. Exhibit 6 shows truck count data for the six axle tractor semitrailer for Sidney and Vassalboro, Maine. These two locations are roughly parallel. Sidney is located on Interstate 95 and Vassalboro is located on State Route 201. One can see a decrease in the number of 6-axle tractor semitrailers on the State route and a much larger increase in the number of 6-axle tractor semitrailers on the Interstate highway.

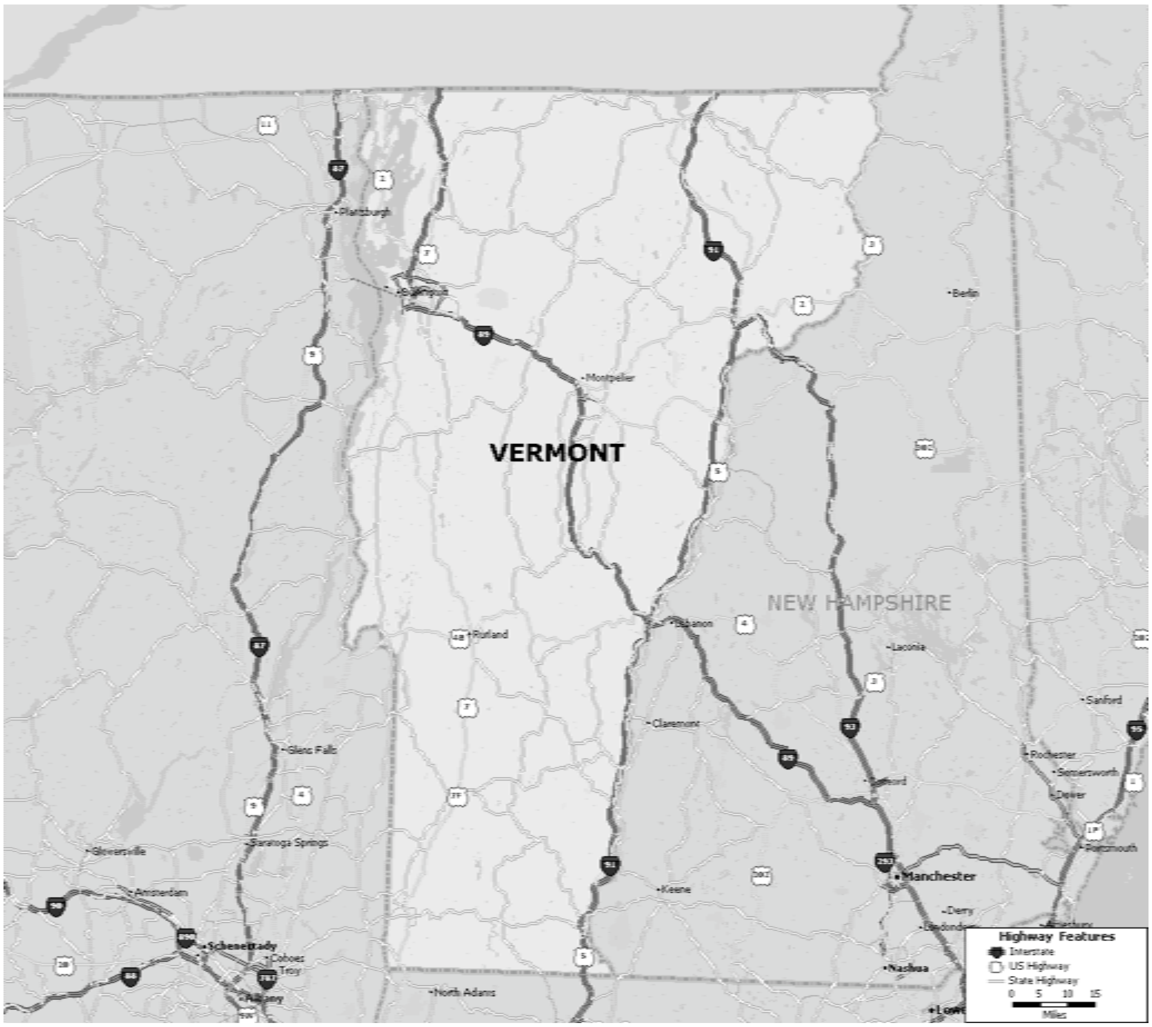
Exhibit 6. Six-Axle Tractor Semi-Trailer North Bound Truck Counts at I-95 Sidney and Route 201 Vassalboro, Maine



The weigh-in-motion and classification count data is not sufficient for bridge safety or pavement analysis. The data provides a single snapshot of both a shift from the state highway and an additional increase in 6-axle tractor semitrailers on the Interstate.

Truck Size and Weight on the Vermont State and Interstate Highway System

Exhibit 7. Vermont Interstate Highway



Prior to H.B. 3288 the Vermont State law mirrored the Federal law on the Interstate system, allowing single axle loads of 20,000 pounds and tandem axle loads of 34,000 pounds. Vermont had a Grandfather provision allowing permits for hauling unprocessed milk up to a maximum gross weight of 90,000 pounds on a 5-axle truck tractor, semi-trailer combination or truck trailer combination on the Interstate Highway.

On State highways, Vermont wrote permits for truck tractor, semi-trailer combination with six or more load bearing axles a maximum gross vehicle weight of 99,000 pounds for those specially equipped for hauling unprocessed milk, unprocessed forest or unprocessed quarry products.

Vermont also allowed a 1,000 pound weight tolerance for the 90,000 pound 6-axle tractor semi-trailer.

Exhibit 8. Prior to H.R. 3288: Vermont Vehicle Weight Regulations and Fees

	State Roads (pounds)	State Roads, Certain Commodities (pounds)*	Interstate (pounds)
Single Axle Limit	22,400**		20,000
Tandem Axle Limit	36,000**		34,000
Tri-Axle Limit	46,000**		n/a
Truck Limits			n/a
3-axle with tri-axle (registered weight of 55,000)	55,000***		
4-axle truck with tri-axle (registered weight of 60,000)	69,000***		
5 axle combination (registered weight of 80,000)	90,000***	99,000	80,000 (90,000 permitted unprocessed milk truck)****
6 axle combination	99,000		80,000

* Unprocessed forest products including whole trees, parts thereof, logs, wood chips, sawdust, shavings and bark mulch, unprocessed quarry products and unprocessed milk.

** 10 percent weight tolerance is allowed

*** 5 percent weight tolerance is allowed

****Sec. 23 V.S.A. § 1392 (13) 90,000 pounds is allowed on both State Highways and Interstate Highways when the load consists solely of unprocessed milk products.

Notes: (1) the permit fee for hauling unprocessed milk is $10.00 if registered at 90,000 or $285 if registered at 80,000; the fee is $310 for general commodities or unprocessed forest products if registered for 90,000 pounds; the permit fee is $500/year if hauling unprocessed milk, unprocessed forest or unprocessed quarry products if registered at 99,000 pounds.

Post H.R. 3288 The pilot program is in effect for 366 days following enactment of H.R. 3288 on December 17, 2009. The statute requests a report at the end of 2 years "on highway safety, bridge and road durability, commerce, truck volumes, and energy use within the State of Vermont" (H.R. 3288 §194 (g)). The 2-year report is in addition to this 6 month report requested by the House and Senate Committees on Appropriations.

Unlike the Maine provisions in H.R. 3288, the Vermont provisions identify specific Interstate highways. The legislation did not include Interstate 189 which is a spur off Interstate 89 connecting to U.S. Route 7 in a principally industrial area of Burlington. That 1.488 mile section of Vermont Interstate is not part of the pilot study. The discussion below focuses on the other Interstate routes where H.R. 3288 allows heavier trucks for the 1 year pilot.

Shortly after passage of H.R. 3288, Vermont passed S.93 which removed the commodity limitations on all permit vehicles allowing all State truck size and weight limits onto the Interstate with no commodity limitations. This includes: 3-axle trucks a gross vehicle weight of 55,000 pounds; 4-axle trucks a gross vehicle weight of 69,000 pounds; 5-axle trucks a gross vehicle weight of 90,000 pounds and 6-axle trucks a gross vehicle weight of 99,000 pounds.

The number of permits issued by Vermont has increased from their historical permitting numbers. The number of trucks permitted for 90,000 – 99,000 pounds maximum gross vehicle weight was 1,019 for all of 2009 but is already 810 for the first 10 weeks of 2010. According to Vermont officials, this does not follow the typical pattern increased permitting activity typically begins with spring construction cycle. The Vermont officials attribute this difference to the provision opening the permits to general commodities rather than just unprocessed milk, unprocessed quarry goods and forest products.

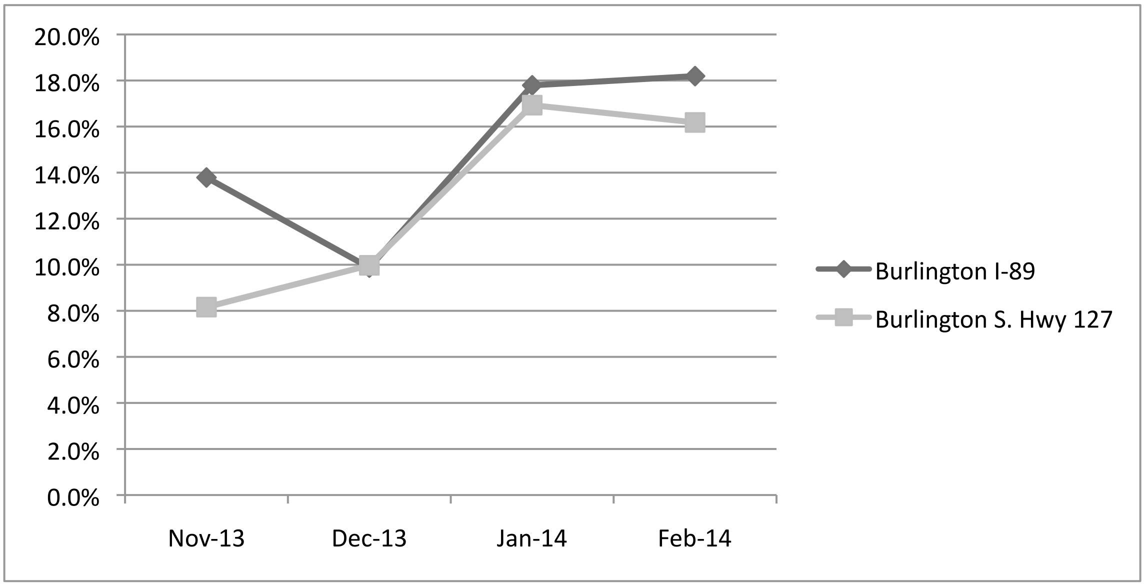
Exhibit 9: Number of Vermont Special Excess Weight Permits by Year

Type of Permit for All Products	2007	2008	2009	January 1 – March 17 2010
Registered for 55,000 lbs permitted to 60,000 must have 3 axles	1,079	1,012	918	131
Registered for 60,000 lbs permitted to 69,000 must have 4 axles	1,201	1,190	1,152	225
Registered for 90,000 lbs permitted to 99,000 must have 6 or more axles	1,003	1,041	1,019	810

Vermont Weight-in-Motion data show gross vehicle and axle weights for trucks passing the weight-in-motion stations. This gives a snap shot of the trucks operating in Vermont for November, 2009 – February, 2010.

A preliminary analysis of weight-in-motion data from Vermont does not show changes in the weight of trucks following implementation of the pilot program. The Burlington I-89 and the State Hwy 127 weigh-in-motion stations are located near each other in Burlington. The Burlington station on I-89 sees roughly 10 times the traffic as State Highway 127. FHWA and Vermont AoT are currently expanding weigh-in-motion sensors on I-91 and I-93 of the Vermont Interstate system to more fully estimate the pilot program impacts for pavements and bridges.

Exhibit 10 Vermont - Percent of Total Trucks More than 80,000 pounds and less than 120,000 pounds



Previous Truck Size and Weight Studies have examined the implications of changing truck size and weight policy at a State or National level. The regional studies include an examination of changing the law in Maine and New Hampshire's Interstate weight increase in 2005. Two prominent examinations of U.S. truck size and weight policy were conducted, one by the U.S. Department of Transportation and the other by the Transportation Research Board. The studies highlight the difficulties in properly assessing the impact of truck weight on bridges. The studies take very different views on replacement of deficient bridges. The USDOT Comprehensive Truck Size and Weight Study estimates full replacement (even thought USDOT does not believe all overstressed bridges would have to be replaced in practice) while the State analyses recommend further analysis and do not estimate the cost to replace or strengthen existing structures. Below is a brief summary of these studies.

Comprehensive Truck Size and Weight Study, (United States Department of Transportation, 2000) – This study employed state-of-the-art methods for assessing potential impacts of truck size and weight alternatives. The study examined safety, productively, infrastructure (pavements, bridges, and geometrics), traffic congestion, environmental impacts (primarily air quality and noise), and impacts on railroads. A major part of the study involved developing and testing analytical tools to estimate the potential diversion of traffic from one type of truck to another and between rail and truck if truck size and weight limits were changed.

This study made several significant improvements over previous studies by implicitly modeling inventory and logistics costs, roadway geometry, pavement, bridge and traffic operations. Like previous studies, this study analyzed several specific truck size and weight scenarios. While most scenarios assumed some increase in truck size and weight limits two scenarios assumed reductions in allowable weights or dimensions.

In order to estimate bridge-related costs the study assumed replacement for bridges showing overstress for the proposed vehicles, even though in practice, depending on the degree of overstress, the volume of vehicles expected to utilize the bridge and the type of bridge, States might postpone replacement for a number of years or perhaps be able to strengthen the bridge rather than replace it. This simplifying assumption was necessary due to the size and complexity of analyzing each individual bridge structure.

Transportation Research Board Special Issue 225, Truck Weight Limits (1990) – The study focused on four issues: (1) elimination of existing grandfather provisions; (2) alternative methods for determining gross vehicle weight and axle loadings; (3) adequacy and alternatives to the current Federal Bridge Formula; and (4) treatment of specialized hauling vehicles, garbage trucks, dump trucks and other trucks with short wheelbases that have difficulty complying with the current Federal Bridge Formula.

The Board made five recommendations: (1) there should be a new bridge formula; (2) Congress should enact a special permit program to allow States to examine changes in truck sizes and weights with oversight from a board authorized to grant/remove permits; (3) Congress should not restrict any current grandfather rights but should prevent future expansion of these claims; (4) a portion of overweight permit fees should be used to increase enforcement of truck weight laws; and (5) pilot programs to allow State to pursue opportunities for standardizing limits and permit practices at the regional level.

Wisconsin Truck Size and Weight Study (Wisconsin Department of Transportation, 2009) – This study examines four potential vehicles: 6-axle 90,000 pound tractor semi-trailer; 7-axle 97,000 pound tractor semi-trailer; 7-axle 80,000 pound single unit truck and 8-axle 108,000 pound tractor with double trailers. In addition, the study examines 2 vehicles currently allowed only on Wisconsin State highways: 6-axle 98,000 pound tractor semi-trailer and straight truck-trailer. Each of these configurations is examined for impacts to transport cost, safety, congestion, pavements, and bridges. The study finds positive net benefits for operating the following trucks on both State and Interstate Highways - the 6-axle 90,000 pound tractor semi-trailer; 7-axle 97,000 pound tractor semi-trailer; and the 6-axle 98,000 pound tractor semi-trailer. The net benefits do not consider the cost of State and local bridge replacement of deficient bridges.

New Hampshire Weight Limit Impact Study for I-89 and I-93 (New Hampshire Department of Transportation, 2006) – In 1998, the Transportation Equity Act for the 21st Century (TEA-21) provided an exception for the 80,000 pound weight limit on I-95 in New Hampshire, allowing a 6-axle tractor semi-trailer up to 99,000 pounds gross vehicle weight on that highway. Permission to extend the I-95 vehicle weights to I-89 and I-93 was granted in the 2005 Omnibus Appropriations Bill [Conference Report 108-792 (H.R. 4818)]. The maximum gross vehicle weights on New Hampshire Interstates are 37,400 pounds on a 2-axle single unit truck; 65,000 pounds on a 3-axle single unit truck; 73,000 pounds on a 4-axle single unit truck; 84,000 pounds on a 5-axle tractor semi-trailer; and 99,000 pounds on a 6-axle tractor semi-trailer. New Hampshire allows a 5 percent weight tolerance bringing the actual limit to 88,200 on a 5-axle tractor semi-trailer and 103,950 on a 6-axle tractor semi-trailer.

The study provides a complete examination of the enforcement system, truck route selection, pavements and shipper benefits. The study does not include bridge costs beyond maintaining and monitoring. The 231 bridges are recommended for additional evaluation but no cost is estimated for their replacement or rehabilitation.

Study of Impacts Caused By Exempting Currently Non-Exempt Maine Interstate Highways from Federal Truck Weights (Maine Department of Transportation, 2004) – This study analyzed the safety consequences, infrastructure costs and related social and economic impacts resulting from an exemption to all non-exempt Interstate Highways in Maine. The study finds net savings to the State by allowing 100,000 pound trucks on Interstate where they could not travel at the time of the study.

Infrastructure Analysis (Weight Impacts on Bridge Safety and Pavements)

Introduction

There are three aspects of truck weight that are interdependent and interact with the highway infrastructure – axle weight (loading), axle spacing, and gross vehicle weight. These aspects play out differently on pavements and bridges.

Bridges. For bridges, to deterimine their load carrying capability, one must consider the weight of the bridge, i.e. the dead load, and the axle loads and spacings between axles for the vehicles that will travel across the bridge. This is in addition to its axle group weights. The Federal Bridge Formula B (codified in 23 CFR §127 and currently enforced on the Interstate system, where it's not specifically exempt) takes into account both the number of axles and axle spreads, which are one of several factors used to determine allowable gross vehicle weight to maintain bridge safety. Axle weights are more significant to short span bridges (those with spans shorter than the truck wheel base) and gross vehicle weight is more significant to medium and long span bridges (those with spans longer than the truck wheel base).

Pavements. The weight of the axle or axle group, such as tandems (a group of 2 axles) or tridems (a group of 3 axles), is the most important for understanding pavement impacts. Axle groups distribute the vehicle's load on the pavement. In general the more axles, the greater the weight distribution and that allows a greater weight to be carried by the vehicle while holding constant the pavement damage. This principal holds as long as the weight is properly spread across the axles so as not to concentrate the weight on any axle or axle group. For example, a 9 to 10 foot spread between two axles results in no apparent interaction of one axle with the other and each axle is considered a separate loading for pavement impact analysis or design purposes. Conversely, the closer the axles in a group are, the greater the weight they may carry without increasing pavement deterioration beyond that occasioned by a single axle, dependent on the number of axles in the group. This benefit to pavements of adding axles to a group decreases rapidly beyond 4-axles.

Bridges

Bridges are critical to the safe and efficient movement of people and freight on the Nation's highways. Bridge safety and serviceability are directly related to the maximum permitted truck gross vehicle weight, axle weight, configuration, and quantity of other heavy trucks allowed in the traffic stream. Any changes to the heavy truck maximum gross vehicle weight limits, unless the bridge is built and maintained to accommodate the additional weight, will affect the available levels of safety and serviceability. Bridges must maintain the minimum safety as established by the American Association of State Highway Transportation Officials Load and Resistance Factor Design Specifications (AASHTO LRFD) and it's Manual for Bridge Evaluation (AASHTO MBE). This section summarizes the methodology and results of bridge safety assessment as it relates to the pilot program in Maine and Vermont.

Load Rating

Load rating is the process of quantifying the live load carrying capacity of existing bridges. In accordance with the MBE, load rating can be done using three different methods, Allowable Stress Rating (ASR), Load Factor Rating (LRF) and Load and Resistance Factor Rating (LRFR). LRFR is the most recent method and is recognized by FHWA as the preferred method for load rating of existing bridges. and is the required method for bridges built after October 1, 2010.

Bridge load ratings are performed for different purposes, using different truck models and configurations, and different levels of safety. Some of the purposes of load rating include National Bridge Inventory (NBI) reporting, assessing the need for strengthening load restriction, or assessing the ability to carry overload permit trucks.

Load rating, depending on its purpose, can be done at one or more of three distinct levels, each of which utilizes different truck models. These three levels are the 1) design load rating, 2) legal load rating, and 3) permit load rating. The results of each rating level serve a specific purpose, and guide the need for further bridge evaluations. For example, the design (or inventory) load rating can serve as a first-level assessment of bridges based on a combination of a notional (or fictitious) truck and lane loading. It provides a measure of current bridge performance against the performance of newly designed bridges. Evaluation at a second, lower-reliability level (or operating) can also be done to determine the maximum notional design load a structure can carry.

The design load rating serves as a screening process to identify bridges that should be evaluated further against national or local legal loads. Bridges that pass the design load rating at the inventory level have a satisfactory load rating for legal loads, which are permitted under the grandfather exclusion to federal weight laws. The design level ratings are used for NBI reporting. Bridges that do not pass the design level rating or bridges that carry loads heavier than the limits imposed by weight laws require further evaluation at the legal load rating level. The legal load rating level provides a safe-load capacity for a given legal truck configuration. At this level of rating, bridges are evaluated against structural failure, and selectively-applied serviceability performance criteria (restrictions on stress, deformation, and crack opening). Bridges with adequate safe load capacity rating for can safely withstand the rated truck repeatedly over the duration of a specified inspection cycle. Bridges with inadequate safe load capacity for a given truck need to be strengthened or load restricted. Therefore, if the maximum weight limit for heavy trucks is raised, as in the case of this pilot program, then bridges with inadequate safety reserve may not be able to safely support the new increased loading.

Ideally, the Maine and Vermont Interstate bridges would be load rated with LRFR, as described above, to assess their ability to safely carry the new pilot trucks. However, the LRFR requirements are very new and still optional, hence neither Maine nor Vermont have implemented LRFR, although Maine did use LRFR in the analysis of four bridges of concern. Therefore the rating data in the NBI are based on Load Factor Rating calculations and estimates rather than Load and Resistance Factor Rating. The FHWA screening model uses the LFR data to identify those bridges at risk of safety failure under the new loading. Detailed LRFR load rating analysis is then needed for those at-risk bridges to better assess their true truck carrying capability in the as-is condition.

Engineering Criteria

Bridge rating requires many assumptions and involves many unknowns and variables. For example, bridges are affected by the probability of side-by-side truck presence, illegally loaded trucks, truck speeds and surface roughness affecting the dynamic impact, lateral position of the trucks affecting the load distribution of trucks, accuracy of the structural analysis methods, assumed materials and section properties, reliability of visual inspection and field measurements. Therefore, safety margins are used to cover the various uncertainties that exist in the calculation of bridge design and rating.

The Load and Resistance Factor Design (LRFD) method applies statistically determined factors to bridge design parameters, using a series of load and resistance factors to account for variability in loads and material resistance. The specifications use statistical methods and probability theory to define the variations in loading and material properties and the likelihood that various load combinations will occur simultaneously.

The nationwide implementation of the AASHTO LRFD specification for bridges has resulted in the Load and Resistance Factor Rating (LRFR) system for bridge evaluation. Since October 1, 2007 the FHWA has adopted a policy that new bridges be designed using LRFD Specification. After October 1, 2010 FHWA has a policy that bridges designed with LRFD be load rated with LRFR. FHWA considers LRFR to be the preferred load rating methodology for existing bridges as well, but has not mandated existing bridges be rated using LRFR. FHWA does believe, that where bridge conditions or load allowances have changed, LRFR analysis for suspect bridges improves the understanding of the bridge's safety. Several States have transitioned to LRFR for existing bridges. Vermont and Maine have not made this transition. It is expected that LRFR analysis will be performed on several bridges in Vermont to better understand the impact of lifting the weight limit on the bridge capacity and safety margin. Maine performed LRFR analysis on 4 bridges identified of concern

Load rating and resistance factors provide a target level of safety (safety index), which is established so that there is a sufficiently small probability that a loading condition could exceed the structural resistance during the bridge's design life. Providing for a margin of safety is necessary to bridge design because:

- The materials used in construction are not always completely consistent in size, shape, and quality;
- The effects of weather and the environment are not always predictable;
- Highway users on occasion violate vehicle weight laws;
- Legally allowed loads may increase during the design life of a structure; and
- Overweight loading is allowed by permit.

Bridge Inventory and Operating Ratings

As explained in an earlier section of this report, the AASHTO MBE manual allows the use of three different methodologies for bridge load ratings. These are the Allowable Stress Rating (ASR), Load Factor Rating (LFR), and Load and Resistance Factor Rating (LRFR).

For ASR and LFR, two limits have been established by AASHTO for the rating of bridges: inventory and operating. The inventory rating is the limit at which any truck which produces stresses equal to or less than the stresses produced by the inventory rating vehicles can safely operate unlimited times on the bridge. The operating rating is the load level describing the maximum permissible live load to which the bridge should be subjected. Allowing unlimited numbers of vehicles to use the bridge at operating level may damage the bridge and shorten its life. Most all States will allow a vehicle that procudes stresses greater than those caused by the inventory rating vehicle, but is less than the operating rating vehicle to operate as an infrequent or permit vehicle. In general, no vehicles that produce stresses greater than the operating rating vehicle are allowed to cross the bridge except under carefully controlled conditions with special escort and after a thorough analysis. The operating rating is sometimes used as the limit for load posting of bridges due to the economic implications of restricting commercial traffic and the cost of bridge strengthening.

As States have the option (when using ASR or LFR) to use either level for posting purposes, both ratings have been used in past studies to assess the bridge impacts for evaluating truck size and weight policy scenarios. Use of the more conservative level (inventory rating) results in more bridges being identified as needing to be upgraded to accommodate increased weights or decreased lengths.[3] Following the reviews of the TRB Special Reports 225 and 227, the FHWA determined that the stress level representative of many State bridge posting practices was the inventory rating plus 25 percent.[4]

For LRFR, the inventory and operating limits have been defined differently from past practice in the MBE. They now indicate the level comparable to a newly designed bridge at two levels of safety, one that is identical to the level of safety of a new design, and the other at a reduced level of safety. Neither of the two rating limits is applicable to the pilot trucks in assessing the existing bridges. Instead, the legal load level rating is used to assess the safe carrying capacity of the bridges (for the given pilot truck configuration) along with the MBE legal load factors. If needed, a more refined level of analysis can be used to calibrate a refined live load factor to be used in the legal load rating safe load carrying capacity using site-specific traffic data. If the pilot trucks cannot pass the safe load carrying capacity rating with the calibrated legal load factor, site-specific reliability analysis can be conducted to determine the safety index using weight-in-motion data obtained from the affected highways. Additional weight-in-motion data will be collected and used in the Vermont two-year study. The legal load factors as used by the MBE or obtained from site-specific calibration would take into account the multiple presence probability of side-by-side heavy pilot trucks.

Bridge Conditions

Bridges are considered *structurally deficient* if significant load-carrying elements are in poor condition or worse due to deterioration and/or damage, or if the adequacy of the waterway opening provided by the bridge is insufficient to the point of causing bridge flooding that results in intolerable traffic interruptions. That a bridge is deficient does not imply that it is likely to collapse or that it is unsafe. A structurally deficient bridge is not necessarily deficient with respect to the weight of the truck traffic utilizing the bridge. With hands-on inspection, unsafe conditions may be identified; if the bridge is determined to be unsafe, the structure must be closed. A deficient bridge, when left open to traffic, typically requires significant maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies. To remain in service, structurally deficient bridges may have weight limits that restrict the gross weight of vehicles using the bridges to less than the maximum weight typically allowed by statute. To determine if a structurally deficient bridge should allow the pilot program trucks, States must examine the reason that a bridge is rated as structurally deficient.

Functional obsolescence is a function of the geometrics, waterway adequacy, and load-carrying capacity of the bridge in relation to the requirements of current design standards. While structural deficiencies are generally the result of deterioration of the conditions of the bridge components, functional obsolescence results from changing traffic and waterway demands on the structure. Facilities, including bridges, are designed to conform to the design standards in place at the time they are designed. Over time, improvements are made to the design requirements. As

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3 The TRB *Special Reports 225, Truck Weight Limits: Issues and Options* and *227, New Trucks for Greater Productivity and Less Road Wear: an Evaluation of the Turner Proposal* estimated the bridge costs of the TS&W changes under study based on the operating rating of 75 percent of yield stress, whereas reviewers of those reports found much higher bridge costs resulting from the use of the inventory rating of 55 percent of yield stress.

4 Comprehensive Truck Size and Weight Report, Volume II, Chapter 6, page VI-7.

an example, a bridge designed in the 1930s would have shoulder widths in conformance with the design standards of the 1930s, but current design standards are based on different criteria and require wider bridge shoulders to meet current safety standards. The difference between the required, current-day shoulder width and the 1930s' designed shoulder width represents a deficiency. The magnitude of these types of deficiencies determines whether a bridge is classified as functionally obsolete.

Bridge Analysis Results

For both the Maine and Vermont Interstate bridges, FHWA utilized the Bridge Analysis and Structural Improvement Software (BASIC) model as an initial screening tool. BASIC was developed as a policy-level bridge analysis tool. BASIC is not a rating program. It computes the maximum total force effects (moments) for the candidate trucks and for the NBI reported HS rating vehicle and then computes the ratio of each candidate truck's moment to the moment of the HS rating vehicle (either inventory or operating) for each bridge. It can consider dead load as well as live load because it contains estimates of bridge dead loads as a function of design type, construction material, span length and design rating. It outputs the candidate trucks' live and dead load moment and compares that to the inventory or operating rating. The results show the analyst which bridges may be a problem. If the ratio of the candidate truck to the rating vehicle is over 1.0, then it indicates the candidate truck stresses the bridge more than the rating vehicle. If this overstress is greater that some acceptable amount, it indicates the bridge should be investigated more rigorously to determine its load bearing capabilities. As such, BASIC does not perform bridge load ratings but rather serves as a scanning tool. BASIC determines the ratio of the total force effects (moments) using the evaluation truck to the total effect using the NBI prevalent truck. Although BASIC can handle the most prevalent bridge types, it cannot analyze suspension, movable, timber, and a few other unusual bridges. Despite these limitations, BASIC has proven to be a powerful tool to identify candidate problem bridges that require further in-depth analysis.

Maine Bridges

Overview: The 2009 National Bridge Inventory (NBI) contains 175 open bridges for the Maine non-tolled Interstate Highway System.[5] Most bridges in Maine are continuous bridges. Ninety-six percent of the 175 bridges are steel and therefore have the potential for a reduced fatigue life. Nonetheless, the NBI shows that about half the bridges have fewer than 10,000 total vehicles per day. Therefore, "truck traffic volumes in Maine are very low compared to most States and bridges will need replacement or rehabilitation due to general deterioration before they approach their fatigue life."[6]

An examination of the NBI data shows that 36 bridges are functionally obsolete, and 6 are structurally deficient. Maine DOT examined those 6 bridges and found, "Four (of the structurally deficient bridges) have already been replaced or rehabilitated, and have already had their new NBI inspection. One will be repaired this year and the other one during the 2012-2013 construction season."[7]

5 This excludes the Maine Turnpike since that is not part of this pilot study. The number of bridges excludes small culverts. None of the Maine Interstate Bridges are posted for lower weights.
6 Chip Getchell, P.E., Maine DOT
7 Ibid

FHWA Screening Analysis: The results of the BASIC screening analysis on the Maine Interstate bridge inventory are shown in Exhibit 11. Despite limitations of BASIC and the NBI data, most all (83 percent) of the Maine bridge inventory could be analyzed. The inventory rating check indicates that the long wheelbase 100,000 pound 6-axle tractor semi-trailer produces at least 10% overstress, relative to the inventory rating, in almost 27 percent of the Maine interstate bridges, and produces overstresses of at least 20 percent in just over 7 percent of these bridges. The operating rating check indicates that the Maine's non-tolled Interstate bridges can accommodate the 100,000 pound 6-axle tractor semi-trailer, since the worst candidate truck produces no overstresses relative to the operating rating on any of the bridges.

Exhibit 11
Percent of bridges with apparent insufficient rating for the Long Base, 6-axle Truck based on screening analysis

	>5 percent over	**>10 percent over**	**>20 percent over**	**>30 percent over**	**>40 percent over**	**>50 percent over**
Inventory Rating	42%	27%	7%	0%	0%	0%
Operating Rating	0%	0%	0%	0%	0%	0%

Maine DOT Analysis: The BASIC analysis identified four bridges for which the 100,000 pound truck produced a negative moment ratio to the inventory rating exceeding 1. Maine DOT completed detailed LRFR analysis of these four steel bridges (see exhibit below) and concluded that Maine's non-tolled Interstate bridges "will safely carry the 6-axle tractor semi-trailer at 100,000 pounds with Maine's axle and spacing requirements", for the duration of the pilot.[8]

Maine Bridge Analysis - Stress Levels Relative to a Routine (non-permit) Load

Bridge Number	BASIC Moment Ratio Potential Overstress	LRFR Rating Factor Understress (Overstress)
5985	27.10%	-4.00%
6075	12.90%	5.00%
5999 North Bound	12.50%	3.00%
5999 South Bound	12.50%	3.00%

Vermont Bridges

Overview: The 2009 National Bridge Inventory contains 282 open and un-posted bridges (48 of which are culverts) on the Vermont Interstate Highway System.[9] Ninety-six percent of the 265 (98.5 percent) bridges are steel.[10] Unlike Maine, most bridges in Vermont are simply supported

8 Ibid
9 This excludes small culverts. None of the Maine Interstate Bridges are posted for lower weights. Eighty-three of the bridges are on the Maine Turnpike which already allows 100,000 pounds on six-axle tractor semi-trailers.
10 Excludes 48 Culverts

bridges, and 39 percent are continuously supported. Vermont is similar to Maine in that 67 percent of the bridges were built over 40 years ago.

Vermont's implementation of the pilot program is different than that chosen by Maine. Maine chose to only allow the 6-axle tractor semi-trailer with a long wheel base at 100,000 pounds onto the non-tolled Interstate. Vermont chose to allow all State permitted size and weights onto the Interstate system, and expanded their previous commodity specific size and weight provisions, to include all commodities.

An examination of the NBI data shows that 95 bridges are functionally obsolete and 21 are structurally deficient. Of the 21 structurally deficient bridges, 15 are in the work plan for varying stages of repair over the next 3 years and 6 of those bridges are not in the work plan because their deterioration is not affecting the load capacity.

FHWA Screening Analysis: The BASIC analysis of the Vermont Interstate bridges is different than that performed for the State of Maine. In Vermont, all truck configurations currently allowed on the State highways are now allowed onto the Interstate system. Therefore, the analysis considered several different truck configurations which may overstress the bridges. BASIC was able to analyze most all (94 percent) of their bridge inventory.

The results of the screening analysis are shown in Exhibit 12. It was found that the short wheel base, 6-axle truck for hauling milk, quarry, and forest products produces the highest stress levels in most bridges and the 90,000 pound very short wheel base 5 axle truck on only a few bridges. Relative to the inventory rating, Vermont's NBI records show almost 13 percent of the bridges are potentially overstressed at least 10 percent by at least one of the governing trucks (Exhibit 12). The data shows that no bridge is overstressed for the operating rating check, for occasional use of trucks complying with the State size and weight rules. The analysis shows similar overstresses for other short wheelbase trucks and the 99,000 pound 6-axle tractor semi-trailer.

Exhibit 12
Percent of bridges with apparent insufficient rating for Short Wheel Base, 6-axle Truck for Hauling Milk, Quarry and Forest Products based on screening analysis

	>5 percent over	**>10 percent over**	**>20 percent over**	**>30 percent over**	**>40 percent over**	**>50 percent over**
Inventory Rating	19%	13%	3%	1%	0%	0%
Operating Rating	0%	0%	0%	0%	0%	0%

Vermont AoT Analysis: Vermont recently completed a 12 month LFR screening analysis on all its Interstate bridges. In response to the preliminary screening analysis, Vermont AoT conducted more in-depth Load Factor Rating (LFR) analysis of bridges number 58, north and south, on I-89 just south of Burlington. These bridges expect to see an above average loading of heavy trucks, and were chosen because preliminary analysis identified them as potentially overstressed. The individual members of the bridges – stringers, riveted girders and floor beams – were each mathematically analyzed. Another distinctive feature of these bridges' construction is the use of A373 steel which has a lower yield strength than the steel typically required. This causes the bridge stringers to rate above an acceptable stress level. The purpose of the stringer is to support and transfer of load from the deck onto the floor beams and girders. Vermont AoT believes that, "even without the stringers, the floor beams and girders have adequate capacity to carry the loads." It is their engineering judgment that "as a unit, the bridges are showing no signs of fatigue weakening and (are) strong enough to support the increased loads." These bridges will be further analyzed and additional findings will be available in the follow-on Vermont report.

Summary and Conclusions

Cursory screening analysis has been conducted on the majority of the Interstate bridge inventory in Maine and Vermont by FHWA. Maine completed detailed LRFR analysis on four bridges that had been identified via a NBI screening as potentially overstressed by the pilot vehicles. Vermont ran a 5-axle LFR screening analysis on all of its Interstate bridges to assess the bridge safety as affected by the introduction of the pilot program allowing up to 99,000 pound trucks onto the Interstate system. The screening analyses have indicated that the level of safety on the bridges is reduced by the introduction of the pilot program. In some cases, the level of safety is still expected to remain above the minimum required by the AASHTO MBE Manual. However, in several cases, the pilot trucks may approach the operating limit, which is the maximum load established by the AASHTO Manual for Bridge Evaluation. The possibility of an overload on a number of bridges exists when heavy trucks are allowed into the traffic stream, uncontrolled. Overload could mean permanent damage to the bridge in the form of yielding or cracking, but not increased risk of sudden collapse so long as bridge conditions are carefully monitored. The refined level of safety can be quantified by LRFR using site-specific reliability analysis and weight-in-motion data obtained directly from the affected highways, which will be completed by the end of the two-year study.

These results highlight the need for further evaluation of those bridges and others that have yet to be analyzed, including more detailed resistance calculations, increased monitoring through weigh-in-motion data collection, and visual inspections. Active examination of those bridges continues at both of the State transportation agencies in concert with FHWA.

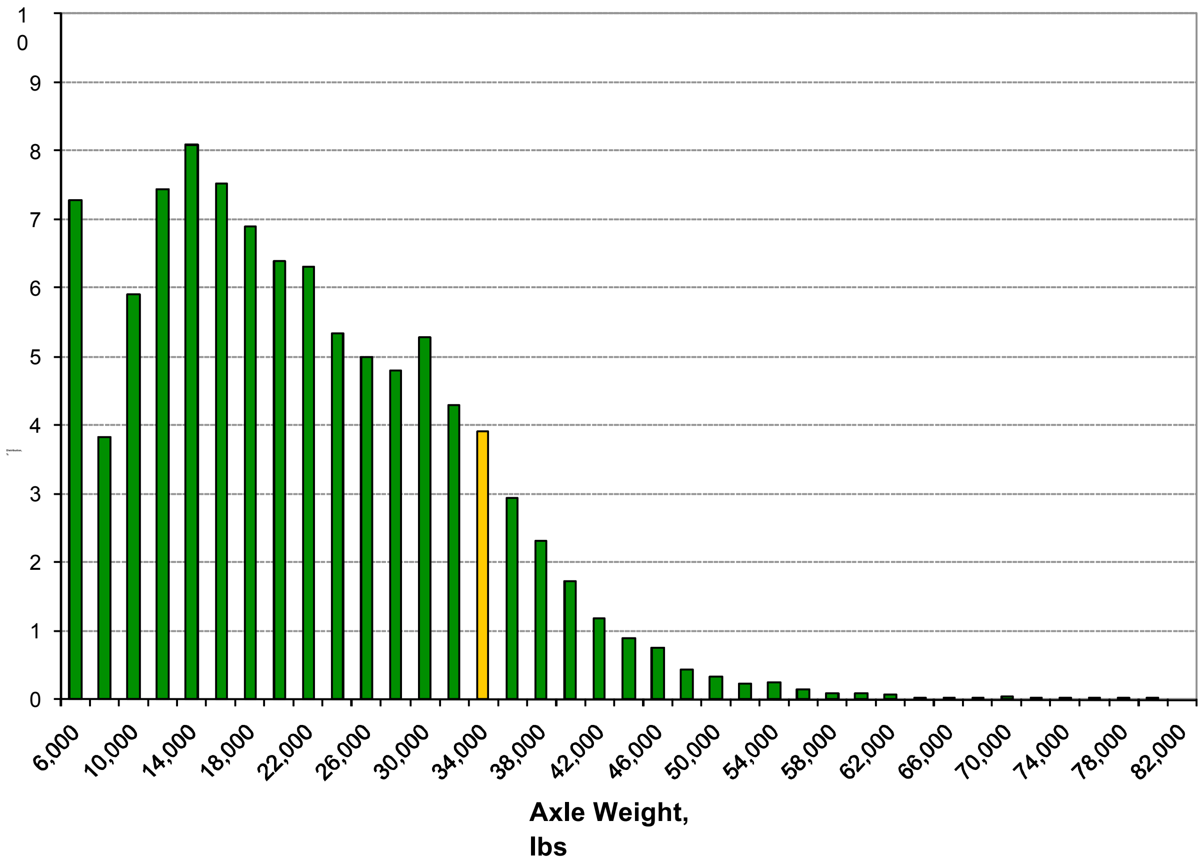
Pavements

The impact of raising the allowable gross-vehicle-weight and axle-load limits on pavements is difficult to quantify, because complex interactions of numerous factors govern pavement performance, including the intensity and mix of traffic, pavement design, paving material, type of soil, and climate. Pavements are also designed to last a long time (20 or more years), and visible signs of distress do not appear until close to the end of the pavement's design life. In general, once a pavement begins to show distresses, the pavement tends to deteriorate rapidly, unless steps are taken to save and preserve the pavement structure.

One of the major difficulties in assessing the impact of any changes in load limits is that the highways "see" a wide range of axle loads, from light, inconsequential loads to permitted non-divisible loads that exceed design loads. Exhibit 13 shows the national average axle load distribution for tandem axles of heavy, combination trucks (Class 9 and higher[11]) on Interstate highways. Note the lack of prominent peak at the current Federal Bridge Formula limit for tandem axles, 34,000 pounds. The graph indicates the majority of axles on Interstate highways are well below the current axle-load limit, but Exhibit 13 also shows significant frequency of very heavy axles. The intensity and frequency of over 34,000 pound axles has a very significant impacts on pavement performance; a relatively small number of extremely heavy axles moving permitted non-divisible loads can completely overshadow the effects of changes in axle load limits for divisible loads. The impact of changes in the load limits depend on how the axle-load distribution will change as a result of the changes in the prescribed load limits.

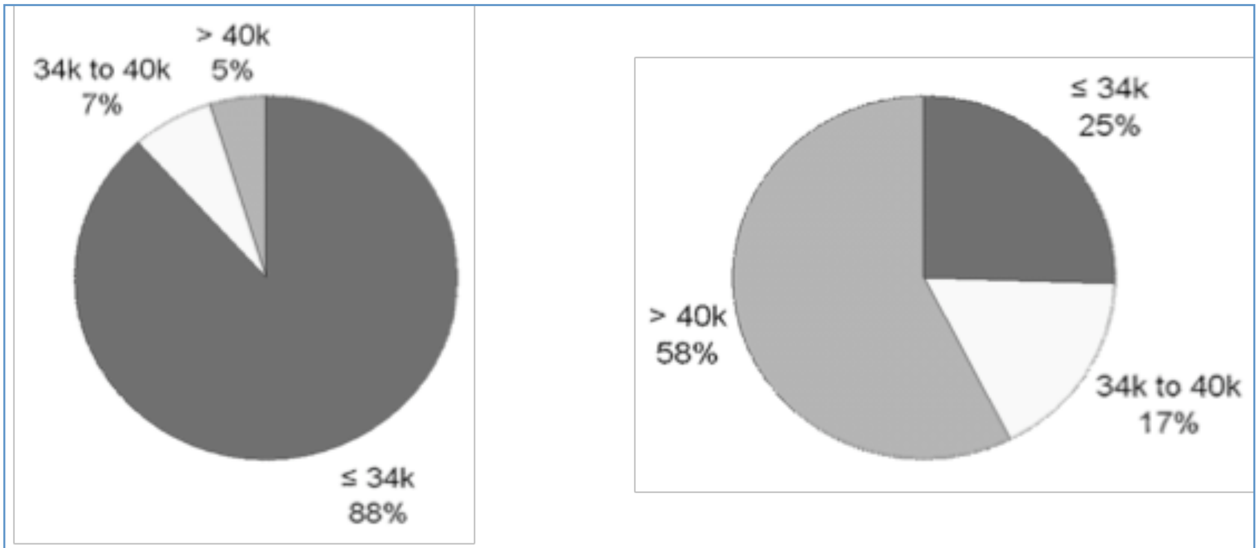
11 This includes 5-axle single-trailer trucks, six or more axle single trailer trucks, and trucks with multiple trailers.

Exhibit 13. National average axle load distribution for tandem axles of heavy, combination trucks (Class 9 and higher). Data source: Mechanistic-Empirical Pavement Design Guide (MEPDG).



For pavements, it is more important to control the axle-load limits than gross vehicle weight because pavement performance is very sensitive to the axle load limit. Exhibit 14 shows the damage contribution of the axle load distribution shown in Exhibit 13. Both the effects of load intensity and frequency are included. Exhibit 14 shows that nationally 88 percent of the tandem axles are at or below the current tandem-axle load limit of 34,000 pounds; 7 percent of the axles are between 34,000 to 40,000 pounds; and 5 percent are heavier than 40,000 pounds. However, the 5 percent of the heavy tandems cause 58 percent of the damage; whereas 88 percent of the axles that are at or below 34,000 pounds only cause 25 percent of the total damage. The moderately overweight, 34,000 to 40,000 pound group comprise 7 percent of the volume, but causes 17 percent of the damage.

Exhibit 14. Traffic distribution by tandem axle weight groups and corresponding damage distribution. Where k = 1,000 pounds.



(a) Traffic distribution **(b) Damage distribution**

The Maine-Vermont Pilot Program has the potential to increase pavement damage by increasing the frequency of tandem axles near and above the 40,000 pound range. Exhibit 14 shows that the tandem axles in the 34,000 to 40,000 pound range cause significant damage, and any shift of the tandem axles to this range from the less than or equal to 34,000 pound category could have negatively impact pavement performance. For example, a 4 percent shift (from less than or equal to 34,000 pound to 34,000 to 40,000 pound category) would mean a10 percent increase in damage. Any increase in the frequency of the greater than 40,000 pound tandem axles would have detrimental effect on pavement performance. To limit the damaging effects of the increased gross vehicle weight, it is important to control the axle loads. Any increase in the axle load directly translates to increased damage.

The most direct and objective means of assessing the effects of increased gross vehicle weight on pavement performance is to conduct a direct comparison of damage caused by the proposed truck configurations, relative to the current 80,000 pound, 5-axle tractor semi-trailer. This approach involves evaluating relative damage caused by the proposed truck configurations on constant payload basis. The associated damage can be assessed, and an additional pavement thickness can be calculated as increasing the pavement thickness can limit damage and retain the roadway's current performance level. The additional pavement cost could enter into a benefit-cost assessment of vehicles and a cost allocation analysis to determine who is paying the costs under the current or proposed fee structure. The cost of the additional pavement thickness is, then, the cost of accommodating the heavier trucks. A nominal increase in pavement thickness can compensate for a fairly significant increase in axle loads. This is also the most cost effective means of accommodating the heavier trucks: it is much more economical to provide the pavement structure that can handle the load, rather than allowing the heavier loads to cause premature pavement failures.

FHWA and Vermont AoT are currently expanding weigh-in-motion sensors on the Vermont Interstate system to more fully estimate the pilot program impacts for pavements.

Conclusion

This 6 month study examined "the impact to date of the pilot program on bridge safety and weights", and is limited by the available data and modeling techniques. To empirically measure and quantify the *impacts* on bridge safety and weight impacts) would take somewhere in the range of ten to fifteen years to measure the consequences directly since damage – except in the case of failed bridges – is not immediate. More detailed modeling analysis and an expansion of the empirical data will be utilized in the study of Vermont's full one year implementation.

Conclusions redacted