

2009 Nevada Highway Cost Allocation Study

COMPILATION REPORT

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Prepared for
Nevada Department of Transportation
Carson City, Nevada



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2009 NEVADA HIGHWAY COST ALLOCATION STUDY

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Final Report	March 17, 2009
Tax Policy Options Analysis	June 8, 2009
Sensitivity Analysis Report	June 15, 2009

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Executive Summary

This report presents the findings of the 2009 Nevada Highway Cost Allocation Study (HCAS), which examines the equity of Nevada’s highway user tax structure. An HCAS is a study that is designed to determine the fair share of costs that each road user class should pay for the construction, operation, maintenance, and related costs of highways, roads, and bridges in a state. By comparing highway user payments to cost responsibilities estimated within the HCAS, the 2009 Nevada HCAS seeks to answer such questions as:

- How do broad highway user classes, differentiated based on vehicle type and weight category, compare with each other in terms of paying their share of highway costs? How much is each class under- or overpaying?
- How could existing tax rates be changed to bring about a closer match between payments and cost responsibilities for each vehicle class?

In addition to addressing these questions, the 2009 Nevada HCAS and the Federal Highway Administration (FHWA) State HCAS Model, which was refined for this study, can be used to examine the impact on equity of making adjustments to the current tax and fee structure, such as: a) adjusting current tax or fee rates, b) substituting a new set of vehicle miles of travel (VMT) fees for part of the current user charges, or c) the re-introduction of a weight-mile tax with appropriate adjustments to other taxes and fees.

Tables S.2 and S.3 present the results of the equity analysis comparing cost responsibilities computed for each vehicle class to attributed revenues. The vehicle classes examined in this report are presented in Table S.1. Table S.4 and Figure S.2 examine equity from the standpoint of registered gross weight (RGW) classes.

Table S.1. 2009 Nevada HCAS Vehicle Types

Vehicle Class	Acronym	Description
1	Auto	Automobiles, vans, light trucks with 2-axles and 4 tires and motorcycles
2	Bus	Buses (all larger types)
3	SU2	Single unit 2-axle, 6-tire trucks
4	SU3+	Single unit trucks with 3 or more axles
5	CB3&4	Combination trucks with 3 or 4 axles
6	CB5	Combination trucks with 5 axles
7	CB6+	Combination trucks with 6 or more axles
8	DS5	Tractor-double semitrailer combinations with 5 axles
9	DS6	Tractor-double semitrailer combinations with 6 axles
10	DS7+	Tractor-double semitrailer combinations with 7 or more axles
11	TRPL	Tractor-triple semitrailer or truck-double semitrailer combinations

The findings of this analysis are expressed in terms of equity ratios. The equity ratio compares the share of highway user revenues paid by a user group to the share of cost responsibility imposed by that group. Cost responsibility in this study represents the share of highway expenditures and preservation backlog costs for which each vehicle class is responsible. See Section 3.1 for a more thorough discussion of cost allocation procedures. A user group that meets 110 percent of its cost responsibility would be assigned an equity ratio of 1.1. Equity ratios above 1.0 are assigned to user groups that are paying more than their cost responsible share while payments from user groups assigned equity ratios of less than 1.0 fall short of the costs imposed by the group. An adjusted equity ratio accounts for differences between total revenues attributed and total costs allocated to all vehicle classes. If highway user payments exceed total cost responsibility, the equity ratios for each vehicle class would be adjusted downward so that total shares of allocated costs equal total shares of revenues and the overall equity ratio for all users equals 1.0. For example, if total highway user revenues exceeded total cost responsibilities by 50 percent, each unadjusted equity ratio would be divided by 1.5 to get the adjusted equity ratio. This procedure is necessary for examining equity in tax structures with highway user revenues collected for non-road purposes, as is done in Nevada with the vehicle sales tax and ad-valorem governmental service tax (GST), or when non-user sources (e.g., general fund revenues) are used to pay for part of the highway program.

Table S.2 presents vehicle miles, state revenue, and state cost responsibility for each vehicle class considered in this study. In all cases throughout this report, these values represent the average of the 2009 Nevada HCAS study time horizon, which runs from 2009 through 2016. Based on the findings presented in Table S.2, revenues from passenger vehicles exceed the cost responsibility calculated for that class by 137 percent. The adjusted equity ratio for passenger vehicles is 1.57, representing an overpayment of 57 percent. The heavier vehicle classes, such as tractor-double semitrailer combinations, face significant shortfalls in terms of revenues vs. allocated costs, with unadjusted equity ratios reaching as low as .30. When all levels of government (federal, state, and local) are included in the analysis (Table S.3), the unadjusted equity ratio for passenger vehicles falls to 1.46 while the unadjusted equity ratios for heavy trucks are reported in the 0.25 to 0.73 range.

Tables S.2 and S.3 also demonstrate that at the state-level, annual highway user payments are forecast to exceed state highway-related cost responsibilities by 51 percent (\$424.2 million annually) over the study time horizon. Figure S.1 demonstrates the magnitude of the diversion of highway user payments for non-road purposes. As shown, average annual state highway user tax payments during the HCAS study time horizon are forecast to reach \$1.3 billion. The average annual cost responsibility for all vehicle classes is estimated at \$834.6 million. That amount includes \$186.8 million in preservation backlog costs and \$30.3 million in property taxes and general funds deposited in the State Highway Fund. Further, \$21.8 million in average annual bond proceeds is included in the cost responsibility calculation. After netting out these elements, that leaves \$595.8 million in state highway user taxes used annually on highways in Nevada. Subtracting the state highway user payments used on highways from total payments leaves \$663.0 million in state highway user payments being used to fund other general government functions, including education, corrections, and human services. This diversion is counterbalanced at the local level where annual expenditures are forecast to exceed highway user payments by \$428.2 million.

State Revenues		
State Highway User Tax Payments		\$1,258,789
State Cost Responsibility Components		
State Highway User Taxes Used on Highway	\$595,804	
Preservation Backlog Cost	\$186,774	
Non-Highway User Funds Deposited in State Highway Fund	\$30,271	
Expenditures of Bond Proceeds	\$21,750	
State Cost Responsibility, All Vehicle Classes		\$834,599
State Highway User Taxes Diverted for Non-Highway Purposes	\$662,985	52.7%

Figure S.1. Average Annual Highway User Tax Payments and Cost Responsibility, FYs 2009-2016

Table S.4 presents vehicle miles, state revenue, and state cost responsibility by RGW class. For vehicles weighing 8,000 pounds or less, unadjusted equity ratios are 2.37, with adjusted equity ratios reaching 1.57. Equity ratios drop considerably as weights increase, reaching as low as 0.26 in unadjusted terms for the heaviest vehicles and 0.47 for vehicles weighing 75,001 to 80,000 pounds. This point is further illustrated in Figure S.2, which charts RGW class against unadjusted equity ratios. The figure clearly illustrates the negative relationship between increased weight and equity ratios. That is, unadjusted equity ratios fall consistently as registered gross weights increase. Nearly without exception, all vehicle classes below 62,000 pounds RGW register unadjusted equity ratios in excess of 1.0. Without exception, unadjusted equity ratios for all RGW classes above 62,000 pounds fall short of 1.0.

Table S.2. Annual Vehicle Miles, State Revenue, and State Level Cost Responsibility by Vehicle Class

Vehicle Class	Vehicle Miles (Millions)	State User Revenue (Thousands)	State Cost Responsibilities (Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psgr Veh	23,699	1,018,537	430,343	2.37	1.57
Bus	122	22,447	22,821	0.98	0.65
SU2	570	48,563	41,960	1.16	0.77
SU3+	123	22,036	20,165	1.09	0.72
CB3&4	105	11,730	12,481	0.94	0.62
CB5	950	107,015	219,869	0.49	0.32
CB6+	27	3,370	7,383	0.46	0.30
DS5	67	7,555	24,208	0.31	0.21
DS6	24	2,974	6,610	0.45	0.30
DS7+	68	8,704	29,492	0.30	0.20
TRPL ¹	46	5,859	19,267	0.30	0.20
Total	25,800	1,258,789	834,599	1.51	1.00

¹ The triples class is not used by NDOT in its annual reports of vehicle miles of travel. However, on the request of NDOT, the research team was able to add this vehicle configuration class to this report using very careful analysis of recent Nevada weigh-in-motion data.

Table S.3. Annual Vehicle Miles, Revenue, and Cost Responsibility by Vehicle Class - All Levels of Government

Vehicle Class	Vehicle Miles (Millions)	Highway User Revenue (\$Thousands)	Total Cost Responsibilities (\$Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psgr Veh	23,699	1,403,549	963,101	1.46	1.43
Bus	122	31,849	51,681	0.62	0.60
SU2	570	65,669	83,075	0.79	0.77
SU3+	123	33,707	40,027	0.84	0.82
CB3&4	105	18,978	26,055	0.73	0.71
CB5	950	177,901	408,920	0.44	0.43
CB6+	27	5,562	15,238	0.37	0.36
DS5	67	12,560	49,617	0.25	0.25
DS6	24	4,911	15,543	0.32	0.31
DS7+	68	14,497	52,374	0.28	0.27
TRPL	46	9,758	35,973	0.27	0.27
Total	25,800	1,778,942	1,741,606	1.02	1.00

Table S.4. Annual Vehicle Miles, State Revenue, and State Cost Responsibility by Registered Gross Weight (RGW) Class

RGW Class	Vehicle Miles (Millions)	State User Revenue (\$Thousands)	State Cost Responsibilities (\$Thousands)	Equity Ratios	
				Unadjusted	Adjusted
0-8,000	23,636	1,015,319	429,150	2.37	1.57
8,001-16,000	441	30,112	24,562	1.23	0.81
16,001-26,000	221	29,532	24,496	1.21	0.80
26,001-40,000	126	19,130	20,515	0.93	0.62
40,001-55,000	132	20,961	19,201	1.09	0.72
55,001-75,000	73	9,360	11,951	0.78	0.52
75,001-80,000	1,020	114,863	245,314	0.47	0.31
80,001-90,000	28	3,568	7,445	0.48	0.32
90,001-100,000	20	2,733	7,357	0.37	0.25
100,001-105,500	103	13,170	44,450	0.30	0.20
105,501-150,000	0	41	158	0.26	0.17
Total	25,800	1,258,789	834,599	1.51	1.00

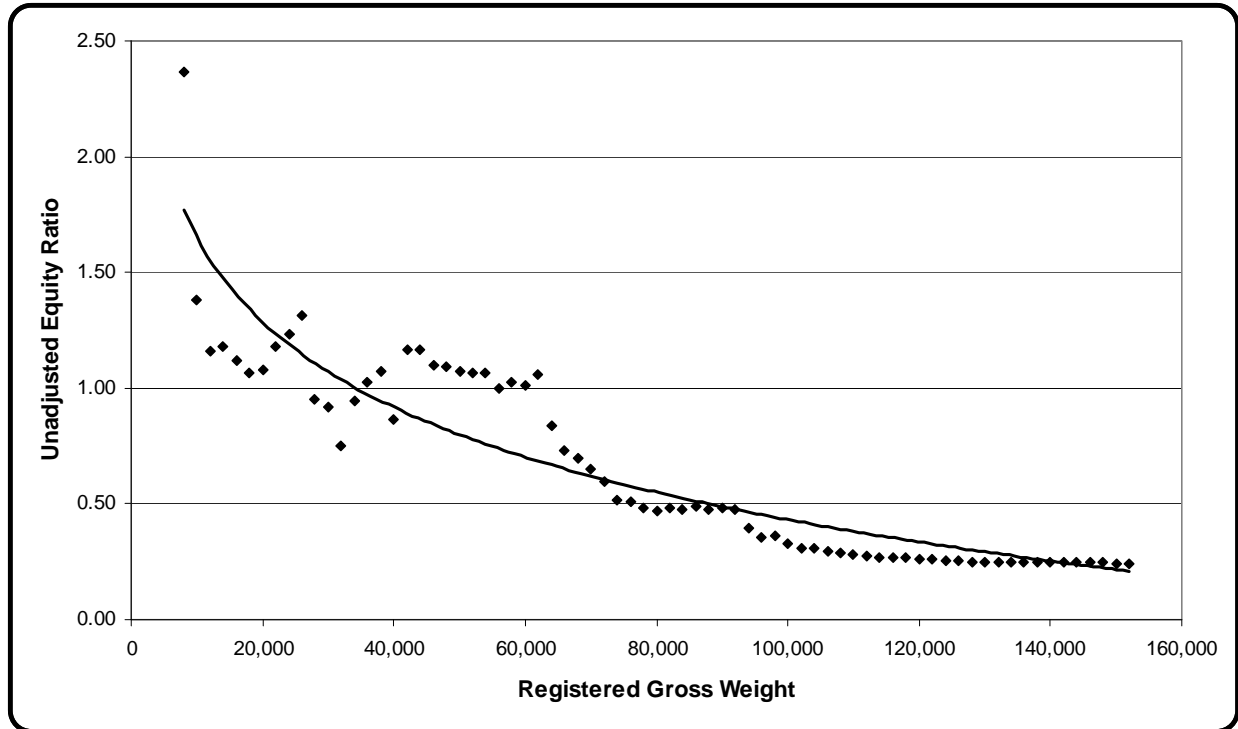


Figure S.2. State-Level Unadjusted Equity Ratios by Registered Gross Weight Class

Table S.5 compares state highway user revenue to cost responsibility for basic vehicles (vehicles with RGWs of 10,000 pounds or less) and heavy vehicles (vehicles with RGWs in excess of 10,000 pounds). As shown, payments from basic vehicles are estimated to exceed cost responsibility by 135 percent while the heavy vehicle class falls roughly 41 percent short of its cost responsibility. Using adjusted equity ratios, the basic vehicle overpayment lowers to 56 percent while the heavy truck class meets approximately 39 percent of its cost responsibility. To make payments from the heavy vehicle class equal its cost responsibility (unadjusted equity ratio of 1.0) would require an increase in annual payments of \$164.9 million. The annual increase for heavy vehicles required to modify the adjusted equity ratio until it reached 1.0 would exceed \$700.4 million.

Table S.5. Annual Revenue and Cost Responsibility for Basic and Heavy Vehicle (Nevada State Highway User Revenues and Cost Responsibilities Only)

Vehicle Class	State User Revenue (Thousands)	State Cost Responsibilities (Thousands)	Equity Ratios	
			Unadjusted	Adjusted
Basic Vehicles	1,025,995	436,871	2.35	1.56
Heavy Vehicles	232,794	397,728	0.59	0.39
Total	1,258,789	834,599	1.51	1.00

When compared to the 1999 Nevada HCAS, the heavy vehicle share of cost responsibility grew from 39.1 percent to 47.7 percent, reflecting a) several improvements in the accuracy of newer cost allocation procedures, most notably the National Pavement Cost Model (NAPCOM) developed by FHWA, b) use of more accurate weigh-in-motion (WIM) data on the operating weights of all vehicle classes (including use of ranges of operating weights instead of averages), c) a shift of emphasis in the highway program to a higher proportion of expenditures being required for rehabilitation and resurfacing of pavements and bridges, and d) the inclusion of the substantial future costs of the backlog of pavement and bridge preservation projects.

In the 1999 Nevada HCAS, heavy trucks were forecast to pay 27.4 percent. The 2009 Nevada HCAS attributes 18.5 percent to heavy trucks. The difference between the current study and the 1999 Nevada HCAS is almost entirely driven by the inclusion of vehicle sales taxes used for general government purposes and GST fees, which are nearly entirely paid by basic vehicles. In previous HCASs, only funds used on Nevada highways were included in the revenue attribution process. Excluding all sales taxes, title and GST fees would raise the heavy vehicle revenue share to 30.1 percent. See Section 1.2 for a more thorough examination of previous Nevada HCASs.

Historically, the results of HCASs conducted in other states have varied widely with heavy truck responsibility reaching as low as 18.9 percent in the 1987 California HCAS and as high as 64.5 percent in the 1979 Florida HCAS. The majority of the state HCASs conducted to date have allocated between 30 percent and 55 percent of the costs to the heavy truck class. The heavy truck share varies due to a number of factors, including the scope and type of expenditures included in the HCAS, the definition of the heavy truck class, the methods used in the study, and the types of expenditures examined.

Section 1.3 of this report presents the results of 22 HCASs conducted from 1982 to 2007 with respect to the equity ratios for the heavy truck class (Table 1.3). The definition of the heavy truck class is differentiated among states but generally includes all vehicles weighing in excess of a certain weight threshold (e.g., 10,000 pounds) or is identified based on vehicle characteristics (e.g., all vehicle configurations having more than two axles). The heavy truck vehicle class typically includes buses, single-unit trucks, and combination trucks. Of the 22 studies referenced in Section 1.3, 19 found that payments from the heavy truck class fell short of cost responsibility. Thus, the findings of the 2009 Nevada HCAS are generally consistent with the findings of HCASs conducted in most other states.

These findings suggest that the current tax structure does not accurately reflect the additional damage caused to Nevada roadways by heavier vehicles. A large part of this inequity is due to the fact that the rate structure is not effectively graduated to reflect the nearly exponential relationship between axle weight and pavement damage. In Nevada, per-mile state highway user revenues grow slightly as weights increase but not in a manner sufficient to reflect the cost responsibilities of the heavier vehicle classes. Within the heavy vehicle class, highway user payments from some light single-unit truck vehicle classes exceed cost responsibility while payments from heavier combination trucks are falling well short of cost responsibility.

There are several options elected officials may wish to consider to increase the revenues attributed to heavy vehicles in order to bring about a closer match with their cost responsibilities. The most obvious options would include increased registration fees and / or diesel taxes. In addition, a weight distance tax could be considered. The weight distance tax, which is a graduated fee based on the weight of the vehicle and the distance it travels in Nevada, is not currently imposed in Nevada.

Acronyms and Abbreviations

ADT	Average Daily Traffic
AMT	Axle Miles of Travel
DMV	Department of Motor Vehicles
DOT	Department of Transportation
DPS	Department of Public Safety
ESAL	Equivalent Single Axle Load
FHWA	Federal Highway Administration
FY	Fiscal Year
GST	Governmental Services Tax
GVW	Gross Vehicle Weight
HCAS	Highway Cost Allocation Study
HPMS	Highway Performance Monitoring System
HVUT	Heavy Vehicle Use Tax
LEF	Load Equivalency Factor
LOS	Level of Service
MPG	Miles per Gallon
NAPCOM	National Pavement Cost Model
NCHRP	National Cooperative Highway Research Program
NDOT	Nevada Department of Transportation
NHS	National Highway System
PCE	Passenger Car Equivalent
RGW	Registered Gross Weight
SERC	State Emergency Response Commission
STIP	Statewide Transportation Improvement Program
TIUS	Truck Inventory and Use Survey
TRB	Transportation Research Board
US	United States
US DOT	United States Department of Transportation
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles of Travel
WIM	Weigh in Motion

Glossary

Ad Valorem Tax. A tax based on the assessed value of real or personal property.

Arterial. A road or highway used primarily for through traffic.

Attributable Costs. Costs that are a function of vehicle size, weight, or other operating characteristics and therefore can be attributed to vehicle classes based on those characteristics.

Average Daily Traffic. The average number of vehicles passing a given point or using a given highway per day.

Average Daily Truck Traffic. The average number of trucks passing a given point or using a given highway per day.

Axle Miles of Travel. Vehicle miles of travel multiplied by number of axles. Since trucks, on average, have roughly twice as many axles as cars (i.e., four versus two), their share of the total axle miles of travel on any given highway system will be about double their share of the vehicle miles of travel on that system.

Axle Weight or Axle Load. The gross load carried by an axle.

Collector. A road that connects local roads with arterial roads.

Common Costs. Expenditures that are independent of vehicle size, weight, or other operating characteristics and so cannot be attributed to any specific class of vehicles. These expenditures must therefore be treated as a common responsibility of all vehicle classes and are most typically assigned to all classes on the basis of a relative measure of use such as VMT.

Cost Allocation. The analytical process of determining the cost responsibility of highway system users.

Cost Occasioned Approach. An approach that determines responsibility for highway expenditures/costs based on the costs occasioned or caused by each vehicle class. Such an approach is not based solely on relative use, nor does it attempt to quantify the benefits received by different classes of road users.

Cost Responsibility. The principle that those who use the public roads should pay for them and, more specifically, that payments from road users should be in proportion to the road costs for which they are responsible. The proportionate share of highway costs legitimately assignable to a given vehicle class user group.

Cost-Based Approach. An approach in which the dollars allocated to the vehicle classes are measures of the costs imposed during the study period, rather than expenditures made during the study period. The difference between the cost-based and expenditure-based approaches is most evident when considering large investments in long-lived structures and when deferred maintenance moves the costs associated with one period's use into another period.

Dead Load. The load on a bridge when it is empty.

Debt Financing. Funding current activities by issuing debt to be repaid in the future.

Debt Service. Funds used for the repayment of previously incurred debt (both principal and interest.)

Deck. The roadway or surface of a bridge.

Depreciation. The amount of decrease in value of a physical asset due to ageing in a time period.

Efficiency. The degree to which potential benefits are realized for a given expenditure.

Efficient Pricing. Setting prices for the use of highway facilities so that each vehicle pays the costs it imposes at the time and place it is traveling. Efficient pricing promotes the most efficient use of existing facilities and generates the right amount of revenue to build the most efficient system and perform the optimal amount of maintenance.

Equity. Generally interpreted as the state of being just, impartial, or fair. Horizontal equity refers to the fair treatment of individuals with similar circumstances. Vertical equity refers to the fair treatment of individuals in different circumstances.

Equity Ratio. The ratio of the share of revenues paid by a highway user group to the share of costs imposed by that group. A user group that meets 110 percent of its cost responsibility would be assigned an equity ratio of 1.1. Equity ratios above 1.0 are assigned to user groups who are paying more than their cost responsible share while payments from user groups assigned equity ratios of less than 1.0 fall short of the costs imposed by the group.

Equivalent Single Axle Load. The pavement stress imposed by a single axle with an 18,000-pound axle load. ESAL-Miles are equivalent single-axle loads times miles traveled. Research has concluded that the relationship between axle weight and ESALs is an approximate third or fourth-power exponential relationship; ESALs therefore rise rapidly with increases in axle weight.

Excise Tax. A tax levied on the production or sale of a specific item such as gasoline, diesel fuel, or vehicles.

Federal Highway Funds. Funds collected from federal highway user fees and distributed to states by FHWA for spending on transportation projects by state and local governments.

Functional Classification. The classification of roads according to their general use, character, or relative importance. Definitions are provided by FHWA for Rural Interstate, Rural Other Principal Arterial, Rural Minor Arterial, Rural Major Collector, Rural Minor Collector, Rural Local, Urban Interstate, Urban Other Expressway, Urban Other Principal Arterial, Urban Minor Arterial, Urban Collector, and Urban Local.

Gross Vehicle Weight. The loaded weight for a vehicle.

Highway Cost Allocation Study. A study that estimates and compares the costs imposed and the revenues paid by different classes of vehicles over some time period.

Highway Performance Monitoring System. FHWA collects and reports data about a sample of road segments in every state in a common format.

Highway User. A person responsible for the operation of a motor vehicle in use on highways, roads, and streets. In the case of passenger vehicles, the users are the people in the vehicles. In the case of goods-transporting trucks, the user is the entity transporting the goods.

Incremental Cost. The additional costs associated with building a facility to handle an additional, heavier (or larger) class of vehicle.

Incremental Method. A method of assigning responsibility for highway costs by comparing the costs of constructing and maintaining facilities for the lightest class of vehicles only and for each increment of larger and heavier vehicles. Under this method, vehicles share the incremental cost of a facility designed to accommodate that class as well as the cost of each lower increment.

Light (or Basic) Vehicles. The lightest vehicle class, usually including passenger cars, vans, and pickups.

Live Load. The additional load on a structure by traffic (beyond the dead load imposed by holding itself up).

Load-Related Costs. Costs that vary with the load imposed by traffic on a facility.

Marginal Cost. The increase in total cost that results from producing one additional unit of output. With respect to highway use, the marginal cost is the increase in total highway costs that results from one additional vehicle trip. Economic efficiency is achieved when the price charged to the user is equal to the marginal cost.

National Highway System. A set of highways throughout the United States that have been designated as National Highways by the federal government. FHWA sets design and maintenance standards and provides funding for national highways, but the highways are owned by the states.

National Pavement Cost Model. A model of pavement costs that incorporates the wear-and-tear costs imposed by vehicle traffic of different weights and configurations as well as deterioration from age and environmental factors, taking into account the soil type, road base depth, pavement material, pavement thickness, and climate zone.

Non-Divisible Load. Non-divisible loads are large pieces of equipment or materials that cannot be feasibly divided into smaller individual shipments. All states issue special permits for nondivisible loads that would otherwise violate state and federal gross vehicle weight, axle weight, and bridge formula limits.

Operating Weight. The actual weight of a vehicle at a particular time

Overhead Costs. Costs that vary in proportion to the overall level of construction and maintenance activities but are not directly associated with specific projects.

Passenger Car Equivalent. A measure of road space effectively occupied by a vehicle of a given type under given terrain, vehicle mix, road type, and congestion conditions. The reference unit is the standard passenger car operating under the conditions on the road category in question.

Registered Weight. The weight that determines the registration fee paid by a single-unit truck or a tractor. For a tractor, it is typically the highest of that vehicle's declared weights.

Revenue Attribution. The process of associating revenue amounts with the classes of vehicles that produce the revenues.

Right of Way. The strip of land, property, or interest therein, over which a highway or roadway is built.

Seismic Retrofit. Work on an existing structure intended to increase its resistance to earthquakes.

Social (or Indirect) Costs. Costs that highway users impose on other users or on non-users. Costs typically included in this category are those associated with noise, air and water pollution, traffic congestion, and injury and property damage due to traffic accidents.

Span. A section of a bridge.

State Highway System. Roads under the jurisdiction of state agencies.

Statewide Transportation Improvement Program. Each state, following guidelines in federal law, produces and regularly updates a list of intended future transportation improvements.

Truck. A general term denoting a motor vehicle designed for the transportation of goods. The term includes single-unit trucks and truck combinations.

User Charge. A fee, tax, or charge that is imposed on facility users as a condition of usage.

User Revenues. Highway revenues raised through the imposition of user charges or fees.

Vehicle Class. Any grouping of vehicles having similar characteristics for cost allocation, taxation, or other purposes. The number of vehicle classes used in a cost responsibility (allocation) study will depend on the needs, purpose, and resources of the study. Potential distinguishing characteristics include weight, size, number of axles, type of fuel, time of operation, and place of operation.

Vehicle Miles of Travel. The sum over vehicles of the number of miles each vehicle travels within a time period.

Vehicle Registration Fees. Fees charged for being allowed to operate a vehicle on public roads.

Weight-Distance Tax. A graduated fee based on the weight of a vehicle and the miles it travels.

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1.0 Introduction

This report presents the findings of the 2009 Nevada Highway Cost Allocation Study (HCAS), which examines the equity of Nevada's highway user tax structure. The report compares federal, state, and local revenues to cost responsibilities for a number of vehicle classes differentiated based on type (e.g., passenger vehicle, single-unit truck, bus) and registered gross weight (RGW). This report contains the following sections:

- 1.0 Introduction. This section presents an overview of the purpose and scope of this study, and a review of previous Nevada HCASs and HCASs conducted in other states.
- 2.0 Data Elements. This section documents the revenue, expenditure, and travel data used to support the analyses presented in this report.
- 3.0 Cost Allocation. This section presents cost allocation procedures and the estimated cost responsibilities by detailed vehicle classes.
- 4.0 Revenue Attribution. This section provides an overview of the procedures used in attributing highway user payments to vehicle classes and presents revenue attribution results.
- 5.0 Equity Analysis. This section compares the revenues paid to cost responsibility and in so doing develops equity ratios for each vehicle class.

This report also contains a list of references, acronyms, and a glossary.

1.1 Purpose and Scope

An HCAS is a study that is designed to determine the fair share of costs that each road user class should pay for the construction, operation, maintenance, and related costs of highways, roads, and bridges in a state. By comparing highway user payments to cost responsibilities estimated within the HCAS, the 2009 Nevada HCAS examines the equity in Nevada's highway user tax system. Thus, the 2009 Nevada HCAS seeks to answer such questions as:

- How do broad highway user classes, differentiated based on vehicle configuration and weight category, compare with each other in terms of paying their share of highway costs? How much is each class under- or overpaying?
- How could existing tax rates be changed to bring about a closer match between payments and cost responsibilities for each vehicle class?

In addition to addressing these questions, the 2009 Nevada HCAS and the Federal Highway Administration (FHWA) State HCAS Model, which was refined for this study, can be used to examine the impacts on equity of making adjustments to the current tax and fee structure in Nevada, of developing alternative tax and fee schedules such as vehicle miles of travel (VMT) fees, or of re-introducing a weight-mile tax.

The 2009 Nevada HCAS uses a small number of key parameters:

- Definition of vehicle classes. The 12 vehicle classes established by the Highway Performance Monitoring System (HPMS) were contracted into 11 classes by combining four-wheel light trucks with passenger cars and combining single-unit three axle and single-unit four axle vehicles together into a single vehicle class. In addition, the seven or more axle multi-trailer class was broken down into two subclasses (doubles and triples) based on detailed analysis of recent Nevada weigh-in-motion data, thus creating an 11th vehicle configuration. Vehicle classes are further differentiated in the FHWA State HCAS Model based on weight in 2,000-pound increments above 8,000 pounds.
- Functional class of road system. Travel and expenditures data are broken down according to the following standard highway functional classes:
 - Rural
 - Interstate
 - Other Principal Arterials
 - Minor Arterials
 - Major Collectors
 - Minor Collectors
 - Local
 - Urban
 - Interstate
 - Other Freeways and Expressways
 - Other Principal Arterials
 - Minor Arterials
 - Collectors
 - Local.
- Study time period. This study uses the eight-year time period beginning in 2009 and ending in 2016.
- Levels of government examined. The analysis presented in this report includes analysis of all levels of government (i.e., federal, state, and local).

1.2 Previous Nevada Highway Cost Allocation Studies

Nevada HCASs were completed in 1984, 1986, 1988, 1990, 1992, 1994, and 1999. Historically, Nevada HCASs have used the modified incremental approach to assigning responsibility for highway costs to vehicle classes. The modified incremental approach allocates a base component of the costs of constructing and maintaining facilities to all vehicle classes and incrementally allocates costs for each additional design element required to accommodate wider and heavier vehicles to specific vehicle classes. Under this method, the heaviest vehicles incur the incremental cost of a facility designed to accommodate that class and share the cost of each lower increment.

In 1994, the Nevada Department of Transportation (NDOT) commissioned an outside audit of its HCAS (Sydec 1994). The audit was conducted in response to questions and comments by stakeholders,

and included a thorough review and assessment of the procedures and analyses used by NDOT in the first four Nevada HCASs, resulting in recommendations for refinements, including those relating to:

- Scope of programs
- Scope of revenue, registration, and related data covered
- Use of more than two vehicle classes analyzed in past Nevada studies
- Analysis limited to revenues and expenditures from the State Highway Fund
- Excessive gas tax revenue being credited to trucks.

While most of the recommendations relating to these issues were addressed in the 1999 Nevada HCAS, the study continued to classify vehicles according to broad weight categories (basic vehicles weighing 10,000 pounds or less and heavy vehicles weighing in excess of 10,000 pounds) and identified the total value of diverted highway user funds (e.g., federal highway user funds used to support mass transit programs and ad-valorem taxes passed through to counties) but did not allocate them. The recommendations of the 1994 audit regarding these issues were implemented in the 2009 Nevada HCAS.

Table 1.1 presents the findings of the past Nevada HCASs as they relate to highway user fee contributions vs. cost responsibility. In each of the previous Nevada HCASs, basic vehicles were found to be more than meeting their cost responsibility while the heavy vehicle class was found to be underpaying. In 1989, Nevada replaced its weight-distance tax with a diesel tax and increased registration fees. As shown in Table 1.1, since that time the heavy truck shortfall has expanded significantly, reaching \$133.7 million in the 1999 Nevada HCAS.

Table 1.1. History of Highway User Fee Contributions vs. Responsibility in Nevada

Study Year	Vehicle Class	Contribution (\$Millions)	Percent Contribution	Responsibility (\$Millions)	Percent Responsibility	Equitable Increase Required (\$Millions)
1999	Basic	\$502.8	72.6%	\$421.5	60.9%	\$0
	Heavy	\$189.4	27.4%	\$270.7	39.1%	\$133.7
1994	Basic	\$383.5	74.4%	\$302.2	58.7%	\$0
	Heavy	\$131.7	25.6%	\$212.9	41.3%	\$138.5
1992	Basic	\$282.9	68.6%	\$246.6	59.8%	\$0
	Heavy	\$129.2	31.4%	\$165.5	40.2%	\$60.6
1990	Basic	\$209.2	62.4%	\$206.9	61.7%	\$0
	Heavy	\$125.9	37.6%	\$128.2	38.3%	\$3.7
1988	Basic	\$186.5	59.4%	\$185.9	59.2%	\$0
	Heavy	\$127.5	40.6%	\$128.2	40.8%	\$1.2
1986	Basic	\$148.0	65.5%	\$143.8	63.6%	\$0
	Heavy	\$78.0	34.5%	\$82.2	36.4%	\$6.6
1984	Basic	\$275.0	71.2%	\$275.0	64.0%	\$0
	Heavy	\$111.1	28.8%	\$154.6	36.0%	\$43.5

Source: Nevada Department of Transportation (1999)

1.3 Results in Other States

The first HCAS was performed in Oregon in 1937. Since that time, at least 84 additional HCASs have been performed in 30 states. The results and basic methods used in these states are summarized in Table 1.2. The data were originally based on information presented in the *2005 Oregon Highway Cost Allocation Study* (EcoNW 2005) but were updated in the National Cooperative Highway Research Program (NCHRP) Synthesis Report #378, *State Highway Cost Allocation Studies* (Balducci and Stowers 2008). In total, 85 HCASs are known to have been performed in the United States.

Table 1.2 identifies each state that has performed an HCAS (Column 1) and the years in which the studies were completed (Column 2). Based on the data presented in Column 3, the incremental and federal methods have been the principal methods used historically in the United States. These methods collectively fall under the umbrella of the cost-occasioned approach, which determines cost responsibility based on the costs occasioned by various highway user classes. The cost-occasioned approach attempts to allocate cost responsibility based on the costs imposed on the highway network by each class of highway users, as opposed to allocating costs simply based on relative use.

In Table 1.2, Column 4 presents the heavy truck responsibility found in each study. Historically, HCAS results have varied widely with heavy truck responsibility reaching as low as 18.9 percent in the 1987 California HCAS and as high as 64.5 percent in the 1979 Florida HCAS. The heavy truck share varies due to a number of factors, including the scope and type of expenditures included in the HCAS, the definition of the heavy truck class (the heavy truck class is generally defined by some weight threshold or vehicle configuration), the methods used in the study, and the types of expenditures examined.

The fifth column in Table 1.2 identifies the key allocators used in the state HCASs conducted to date. The allocator, or measure used to allocate costs to highway user classes, is generally tied to either travel (e.g., VMT), the space vehicles take up on roads (e.g., passenger car equivalents [PCEs]), vehicle loads (e.g., equivalent single axle loads [ESALs]) or a combination of these measures (e.g., ESAL-miles, ton-miles, axle-miles, and PCE-VMT).

Table 1.2. State Highway Cost Allocation Study Methods and Results

State	HCAS Years Completed	Method	% Heavy Vehicle Cost Responsibility	Key Allocators	Types of Revenues Examined
Arizona	1993, 1999, 2000, 2001, 2002, 2005	Federal	31.4% (1999)	VMT, Axle-Load, Gross weight	State, federal and local funds combined
Arkansas	1978	Incremental / Cost Function			
California	1987, 1997	Federal and Incremental	18.9%	ESAL-Miles	State, federal and local funds analyzed separately
Colorado	1981, 1988	Federal	37%	VMT, Truck-VMT, ESALs, Ton-Miles	
Delaware	1992, 1993	Federal and Incremental	20.33%	VMT, PCE-miles, ESALs, Axle-Miles, Registrations	State and federal funds combined only
Florida	1979	Incremental	64.5%	VMT, ESALs, Axle-Miles, Registrations	State and federal
Georgia	1979, 1982	Incremental	51.2% (1979)	VMT, GVW, ESALs, Axle Miles Traveled (AMT)	State and federal
Idaho	1987, 1994, 2002	Prospective Cost-Occasioned	37.29%	VMT	State, federal and local funds combined
Indiana	1984, 1988, 1989, 2000	Incremental / Consumption	53.2%	ESAL	State, federal and local
Iowa	1983, 1984	Federal	48.94%	ESAL, Ton-miles, AMT, PCE, VMT	
Kansas	1978, 1985	Hybrid	41.85%	Number of vehicles, VMT, AMT, Ton-miles, PCE-VMT, ESAL-miles	State funds
Kentucky	1992, 1994, 1996, 1998, 2000	Federal	54.92%	VMT, ESAL-VMT, PCE-VMT, Axle-Miles	State and federal funds combined
Maine	1956, 1961, 1982, 1989	Hybrid / Expenditure Allocation	35.6%	VMT, ESALs, PCE, Delphi, TMT, Standard Vehicle Equivalent	State and federal funds

Table 1.2. (contd)

State	HCAS Years Completed	Method	% Heavy Vehicle Cost Responsibility	Key Allocators	Types of Revenues Examined
Maryland	1989				State and local funds
Minnesota	1990	Federal and incremental	19.2%	VMT, Truck-VMT	
Mississippi	1980	Incremental	36%	VMT, Truck-VMT	
Missouri	1984, 1987, 1990	Federal		Vehicle size, Vehicle weight, VMT	
Montana	1992, 1999	Federal	33%	VMT, ESAL-MT, AMT	
Nevada	1984, 1985, 1988, 1990, 1992, 1994, 1999	Modified Incremental	39.3%	ESALs, VMT, Axle-miles, Ton-miles	State, federal and local separately and combined
New Mexico	1972				
North Carolina	1983	Federal		PCE, ESALs, VMT, Weight axle-miles	State and federal funds
Ohio	1982	Federal / Incremental		VMT	
Oregon	1937, 1947, 1963, 1974, 1980, 1984, 1986, 1990, 1992, 1994, 1999, 2001, 2003, 2005, 2007	Cost occasioned with NAPCOM for pavement costs (since 1999)	34.1%	Congested PCE, VMT, Uphill PCE, Truck-VMT, Basic Vehicle VMT,	State, federal and local combined for cost allocation purposes but state only for revenue attribution purposes
Pennsylvania	1989, 1990	Federal / Cost Occasioned			
Texas	1984, 1985, 1994, 2002				
Vermont	1990, 1993, 2006	Federal	25.7%	VMT, ADT, ESAL	State and federal funds
Virginia	1991, 1992	Federal	21.7%	ESALs, VMT, ADT	State and federal funds combined
Washington	1977	Incremental			
Wisconsin	1982, 1992	Federal (1982)	31.7%	ESAL, VMT, PCE, Ton-miles	State and federal funds combined
Wyoming	1981, 1999	FHWA State HCAS model	55.8%	VMT, Vehicle size, Horsepower, Weight	

Source: Balducci and Stowers (2008)

Table 1.3 presents the results of 22 HCASs conducted from 1982 to 2007 with respect to the equity ratios for the heavy truck class. As noted previously, the definition of the heavy truck class is differentiated among states but generally includes all vehicles weighing in excess of a certain weight threshold (e.g., 10,000 pounds) or is identified based on vehicle characteristics (e.g., all vehicles with more than two axles). The heavy vehicle class typically includes buses, single-unit trucks, and combination trucks. The equity ratio is measured as the revenues attributed to the highway user class divided by its cost responsibility. An equity ratio of less than 1.0 would indicate that payments from the highway user class have fallen short of its cost responsibility, while an equity ratio in excess of 1.0 would indicate that tax payments exceed cost responsibility.

Of the 22 studies referenced in Table 1.3, 19 found that payments from the heavy truck class fell short of cost responsibility. In three states (Delaware, Montana, and Oregon), heavy truck payments were equal to or greater than their cost responsibilities. A large part of the explanation of the results is tied to the differences in the state tax structures. Note, for example, that one of the three states (Oregon) in the over 1.0 equity ratio category had weight-distance taxes at the time of the study, and another (Delaware) collected a high proportion of its heavy truck revenues from out-of-state based trailers.

Table 1.3. State HCAS Findings on Equity of Tax Structure for Heavy Vehicles (1982-2007)

Equity Ratio for Heavy Vehicles	State and Year of Study
<0.60	Maryland (1982), Colorado (1988), Georgia (1991), Texas (1994), Nevada (1999), Vermont (2006)
0.60-0.80	Connecticut (1982), Missouri (1984), Indiana (1988), Minnesota (1990)
0.80-1.00	Wisconsin (1982), North Carolina (1983), Kansas (1985), California (1987), Maine (1989), Pennsylvania (1990), Arizona (1999), Kentucky (2000), Idaho (2002)
>1.00	Delaware (1992), Montana (1992), Oregon (2007)

Source: Balducci and Stowers (2008)

2.0 Data Elements

This section presents an overview of the data used within the 2009 Nevada HCAS. To conduct the cost allocation and revenue attribution analyses, the study relies on forecasts of three major types of data:

- Revenue Data. Receipts from highway users from Nevada's tax and fee structure principally comprised of registration fees, ad-valorem (Governmental Service Tax [GST] fees) taxes, motor fuel taxes, driver's license fees, and vehicle sales taxes.
- Expenditure Data. Expenditure data for the construction, preservation, maintenance, and administration of highway programs in Nevada. The data also include expenditures by the Department of Motor Vehicles (DMV) and Department of Public Safety (DPS).
- Travel Data. Total VMT and VMT distributions by 11 vehicle classes and 12 road classifications.

This section presents forecasts developed for this study. With the exception of the travel forecasts, the data presented covers the average of the eight-year (2009-2016) study time horizon.

2.1 Revenue Data

The research team received detailed revenue data from NDOT for the 2007-2009 time period and revenue forecasts for all highway fund revenues through 2016. The revenues analyzed in this study include all highway user taxes and fees collected at the federal, state, and local levels in Nevada, including those deposited in the State Highway Fund and those used to fund activities unrelated to highways. In Nevada, highway user fees are principally comprised of registration fees, ad-valorem taxes (GST fees), motor fuel taxes, driver's license fees, and vehicle sales taxes. Rates for these taxes are presented in Table 2.1.

Table 2.1. Transportation Tax Rates in Nevada

<u>Federal</u>	
Federal Gasoline Tax	18.4 cents per gallon
Federal Special Fuels Tax	24.4 cents per gallon
Heavy Vehicle Use Tax	Below 55,000 lbs., no tax. From 55,000-75,000 lbs. \$100 plus \$22 per 1,000 lbs. over 55,000 lbs. Over 75,000 lbs., \$550.
Trucks and Trailer Sales Tax	12 percent of a retailer's sales price for tractors and trucks over 33,000 lbs. GVW and trailers over 26,000 lbs. GVW.
Tire Tax	0-40 pounds No Tax Over 40 pounds to 70 pounds 15¢ per pound in excess of 40 Over 70 pounds to 90 pounds \$4.50 plus 30¢ per pound in excess of 70 Over 90 pounds \$10.50 plus 50¢ per pound in excess of 90
<u>State</u>	
State Gasoline Tax	18.455 cents per gallon
State Special Fuel Tax	27.75 cents per gallon
State Registration Fee	\$ 33.00 per year for automobiles \$ 39.00 per year for motorcycles \$ 27.00 per year for travel trailers \$ 33.00 per year for trucks, truck tractors and buses weighing less than 6,000 pounds GVW \$ 38.00 per year for trucks, truck tractors and buses weighing 6,000-8,499 pounds GVW \$ 48.00 per year for trucks, truck tractors and buses weighing 8,500-10,000 pounds GVW \$ 12.00 per 1,000 lbs. for units between 10,001 and 26,000 lbs. GVW \$ 17.00 per 1,000 lbs for motor carrier units between 26,001 and 80,000 lbs. GVW (maximum fee is \$1,360)
Annual Permit Fees	\$ 60.00 per 1,000 lbs. for motor carrier units exceeding 80,000 lbs. for reducible-load units between 80,00 and 129,000 lbs. GVW (maximum fee is \$2,940)
Overlength vehicles	\$ 10.00 for overlength vehicles (longer than 70') carrying reducible loads not exceeding 80,000 lbs. GVW
Governmental Services Tax (Ad Valorem)	4% of a vehicle's depreciated assessed valuation
Driver's License Fees (Renewed Every Four Years)	\$ 22.00 for operating passenger cars \$ 17.00 for persons 65 or older \$ 5.00 for motorcycles \$ 87.00 commercial vehicle driver's license
Title Fees	\$ 28.25 for all vehicles
<u>Local</u>	
County Mandatory Tax (Applied in All Counties)	6.35 cents per gallon
Local Option Gasoline Tax	Ranges by county from 4-11.2 cents per gallon
GST Fee Supplemental (Ad Valorem)	1% of a vehicle's depreciated assessed value
Source: Nevada Department of Transportation (2009a) and Federal Highway Administration (2007).	

NDOT long-range forecasts of state highway funds were used to project the FYs 2007-2009 revenue data out to the end of the study time period (FY 2016). Once forecast, revenues were assigned to the categories used in the 1999 Nevada HCAS to allow for comparison between studies. Estimated revenues for the average of the FYs 2009-2016 time period are presented in Tables 2.2-2.4.

Table 2.2 presents forecasts of federal revenues attributable to highway users in Nevada. These estimates are based on data prepared by FHWA and presented in its annual publication, *Highway Statistics* (FHWA 2007). Estimates prepared by FHWA were forecast forward using State Highway Fund revenue rates of growth or decline experienced during FYs 2008 and 2009 and Nevada State Highway Fund forecasts out to FY 2016 prepared by NDOT. Motor fuel taxes comprise the vast majority of the federal highway user taxes collected in Nevada (\$273.6 million or 87.4 percent). The heavy vehicle use tax (HVUT), trucks and trailers tax, and tire tax, which collectively comprise \$39.3 million or 12.6 percent of total federal highway user revenues, are all paid by heavy vehicles in Nevada. This forecast includes highway user fees deposited in the Mass Transit Account of the Federal Highway Trust Fund.

Table 2.2. Federal Highway User Revenues in Nevada (Average Annual, FYs 2009-2016 Period)

User Fee	Revenues (\$)
Gasoline Tax	185,820,774
Special Fuels Tax	87,762,348
Heavy Vehicle Use Tax	7,528,987
Trucks and Trailers Tax	27,794,315
Tire Tax	<u>3,992,879</u>
Total Federal	312,899,304

Table 2.3 presents forecasts of state revenues attributable to highway users in Nevada. The revenues included in the 1999 Nevada HCAS were only those used on public highways whereas this study includes all highway user revenues collected regardless of their use. Thus, the 2009 Nevada HCAS includes \$270.9 million in GST revenue that is passed through to counties and used for both road and non-road purposes. The GST is an ad-valorem tax assessed on the depreciated value of the motor vehicle. The forecast also includes vehicle sales taxes, which are used for general governmental purposes. In total, state revenues are forecast at \$1.3 billion. The largest revenue sources are the vehicle sales tax (\$461.2 million), GST fee (\$270.9 million), gasoline tax (\$211.7 million), registration fee (154.8 million), and special fuels tax (\$107.1 million). The forecasts of some user fees (e.g., fuel taxes, registration fees, and sales taxes) reflect current trends reported by NDOT and DMV, which show recent declines in collections.

Table 2.3. State Highway User Revenues in Nevada (Average Annual, FYs 2009-2016 Time Period)

User Fee	Revenues (\$)
Gasoline Tax	211,698,324
Special Fuels Tax	107,117,992
Regular Registration	124,306,619
Driver's Licenses and Permits	15,064,575
Commercial Driver's Licenses and Permits	1,644,752
Governmental Services Tax	270,920,675
Motor Carrier Fees	7,753,682
Motor Carrier Registration	30,460,375
HazMat Fees	3,986,412
Vehicle Records Fees	11,563,314
Emissions Certificates	8,621,633
Vehicle Sales Tax	461,210,063
Rental Car Surcharge	3,531,816
Miscellaneous Fees	<u>908,939</u>
Total State	1,258,789,171

Local revenues attributable to highway users in Nevada are presented in Table 2.4. These revenues include the county mandatory and option gasoline tax (\$161.9 million) and the local GST fee component (\$45.4 million). In total, local highway user revenues in Nevada were forecast at \$207.3 million.

Table 2.4. Forecast Local Highway User Revenues in Nevada (Average Annual, FYs 2009-2016 Period)

User Fee	Revenues (\$)
Gasoline Tax	161,883,148
Government Services Tax (Ad Valorem)	<u>45,370,579</u>
Total Local	207,253,727

2.2 Expenditure Data

Expenditure data were obtained from NDOT and examined according to the following cost categories:

- New Pavements
- Rehab Pavements
- New Bridge
- Replacement Bridge
- Repair Bridge
- Grading
- Other Construction
- Maintenance
- Administration and Other Expenditures.

Most of these data are forecasts of most likely expenditures by each level of government (federal, state, and local) over the next eight years based on recent trends and anticipated revenues. Expenditure data were also obtained from the Statewide Transportation Improvement Program (STIP).

In addition to expenditure data, another basic input is the cost of the backlog of deferred pavement and bridge work that has been increasing as tabulated in NDOT's draft 2009 Preservation Report. These add up to \$718.4 million, including \$567.7 million for pavement and \$150.7 million for bridge rehabilitation, replacement, and repair (NDOT 2009b). NDOT's 2009 Preservation Report includes estimates of annual investment levels required to eliminate the preservation backlog by the end of 2020. Annual expenditure levels for each year falling within the 2009 Nevada HCAS time horizon (2009-2016) were used to establish average annual preservation cost values of \$169.3 million for pavement and \$150.7 million for bridges. These estimates include the impact of \$130 million in federal stimulus funds invested in preservation projects over the eight-year study time horizon.

2.3 Travel Data

The basic assumptions and procedures used in developing the projections of VMT by vehicle class and functional class of highway shown in Table 2.5 are as follows:

- We accepted an NDOT projection of 25.8 billion for overall Nevada VMT for 2012-2013, as shown in Table 2.5. This projection is based on a long-term correlation between Nevada population and statewide VMT (8,170 annual miles per person) and a recent official Nevada population forecast through our study's projection period.
- Supporting this projection, we analyzed trends for 2003 through 2007, the most recent five years for which complete data are available, and found that urban VMT has been growing at a steady average rate of 650 million per year, but that rural VMT has been declining at a steady average rate of 72 million per year. When we ran these trends through our project period, we arrived at a figure that was very close to (1.7 percent less than) the NDOT forecast. We were inclined to think it likely that the rural rate of decline would tend to level off over this projection period so we accepted the slightly higher NDOT projection of VMT.
- We used these steady trends in urban growth and rural decline to project the percentage split between urban and rural for our projection period.
- We then used (a) the 2007 splits for VMT by detailed functional classes, and (b) a weighted average of percentage splits for VMT for the last five years for each functional class to obtain the breakdowns of projected VMT for both urban and rural by functional class shown in the table.
- Finally, we used a careful analysis of recent Nevada weight-in-motion (WIM) data to split the largest vehicle configuration class (seven or more axle multi-trailer combinations) into two vehicle configurations – seven or more axle double and triple trailer combinations. This additional analysis was necessary because Nevada's VMT is generally atypical when compared with many other states because it allows triple trailer combinations. Additionally, since California does not allow triple trailers, staging areas near California are used to form the triple combinations eastbound that can travel through Utah. Westbound the reverse is true so the triples are disassembled for travel in California. These staging operations cause many triple combinations to use local urban roads.

Table 2.5. Vehicle Miles of Travel on Nevada’s Highways and Streets (Average Annual for 2012 – 2013 Time Period) – Thousands of Miles

Functional Class	Pass. Cars	Buses	Single-Unit Trucks		Single-Trailer Combinations			Multi-Trailer Combinations				
			2 axle, 6 tire	3 axles or more	4 axles or less	5 axle	6 axles or more	5 axles or less	6 axles	7 axles or more (doubles)	7 axles or more (triples)	
Interstate – U	4,067,563	20,071	72,773	27,821	15,529	208,017	6,027	15,529	3,266	10,328	6,952	
Other Freeway and Expressway – U	2,249,313	7,564	35,774	9,847	9,562	48,443	2,220	3,742	1,713	6,208	4,179	
Other Principal Arterials – U	3,215,742	19,227	55,721	13,547	12,690	47,809	2,389	4,666	2,186	4,230	2,847	
Minor Arterials – U	5,332,927	26,362	95,239	24,729	21,127	40,138	3,564	7,018	4,047	8,521	5,736	
Collectors – U	1,679,193	7,093	30,112	2,710	4,244	2,053	219	2,122	1,211	489	329	
Local Roads – U	3,128,322	12,449	95,989	18,018	1,310	15,070	983	328	328	1,958	1,318	
Total Urban	19,673,059	92,766	385,607	96,672	64,462	361,530	15,403	33,404	12,751	31,736	21,362	
Interstate – R	1,340,365	12,673	72,790	9,524	17,232	386,338	5,549	18,845	7,048	20,561	13,840	
Other Principal Arterials – R	1,227,780	7,727	62,143	8,382	15,365	138,976	3,883	10,299	3,099	7,960	5,358	
Minor Arterials – R	443,128	2,780	18,833	4,750	3,619	33,625	966	2,354	491	2,806	1,889	
Major Collectors – R	416,135	1,973	12,258	2,675	3,753	20,772	885	1,768	497	2,844	1,915	
Minor Collectors - R	149,905	127	1,965	356	301	1,666	134	134	72	674	454	
Local Roads - R	448,291	3,691	16,536	767	527	6,806	-	383	144	1,289	868	
Total Rural	4,025,605	28,971	184,525	26,454	40,797	588,183	11,418	33,783	11,351	36,135	24,323	
Total All Road Systems	23,698,664	121,737	570,132	123,126	105,259	949,713	26,821	67,187	24,101	67,871	45,685	

3.0 Cost Allocation

This section allocates the construction, preservation, maintenance and other expenditures by level of government to the various vehicle classes. Section 3.1 presents an overview of the procedures used in the cost allocation process. Section 3.2 presents the results of the cost allocation analysis.

3.1 Cost Allocation Procedures

The cost responsibility for each vehicle class was estimated using the FHWA State HCAS Model as a framework, updated to reflect Nevada's highway system and the vehicles using the system.

3.1.1 Pavements

Our most important updates focused on vehicle characteristics. We used a large amount of weigh-in-motion data collected by Nevada DOT during 2005-2006 and reported to FHWA as part of an ongoing traffic monitoring program. We subjected slightly over nine million individual observations to the study team's previously developed evaluation and editing algorithm and found that slightly over eight million passed the edit tests and seemed valid. These observations have been used in the refinements to the HCAS model inputs.

The weight observations provided excellent distributions of vehicle operating weights for the 11 vehicle classes, as well as detailed information on axle weights—two vital components needed for accurate allocation of pavement, bridge, and other highway costs.

The research team also relied on a very recent run of the National Pavement Cost Model (NAPCOM), using 2007 highway section data reported by Nevada DOT to FHWA under the HPMS. NAPCOM, one of the most important HCAS innovations developed by FHWA, estimates how much pavement deterioration in a given state results from each type and weight of axle. Thus, the pavement cost responsibility component of this study is a significant improvement over the work done in all previous Nevada HCASs, reflecting the current better understanding of how NDOT pavement design, pavement condition, weather, soils, motor vehicle axle weights, and chemical deterioration of pavements interact with each other in Nevada.

3.1.2 Bridges

The bridge cost allocation procedures used in this study are based on research and methods developed by FHWA for the 1982 and 1997 Federal HCASs. Three types of bridge expenditures were considered: new bridges, bridge replacement, and bridge rehabilitation.

New bridge costs are allocated based on an incremental analysis of the costs of constructing bridges using different design loadings. These loadings are based on hypothetical vehicles, for which stresses in the load-bearing members of bridges are calculated and compared with permissible stress levels. As loadings become heavier, the size of bridge members (and, consequently, bridge costs) must be increased to remain within permissible stress levels. All vehicles share the cost of the first increment (i.e., that

associated with the lightest design loadings). Only heavier vehicles share the cost of subsequent increments. The determination of which vehicles share the costs of which increments depends upon a comparison of the stresses produced by the vehicles with those produced by the design loadings used in the incremental analysis.

Bridge replacement costs are allocated based on estimates of the percentage of these costs that are incurred because the load-bearing capacity of existing bridges is deficient. Those costs due to deficient load-bearing capacity are allocated to vehicles that operate at weights over the load-bearing capacities of the replaced bridges. The percentage of bridge replacement costs that are incurred as a result of deficient load-bearing capacities was estimated using FHWA's Bridge Sufficiency Rating Formula.¹ Under the Bridge Sufficiency Rating Formula, bridges lose points if their load-bearing capacity is inadequate or if they have other non-load-related problems such as scouring around piers or being too narrow for current traffic levels. For bridges to be replaced, points lost due to inadequate load-bearing capacity are expressed as a fraction of total points lost to determine the share of bridge replacement costs to be allocated to vehicles that operate at weights over the load-bearing capacities of the bridges to be replaced.

Bridge rehabilitation costs are allocated based on estimates of the fraction of these costs associated with different types of bridge rehabilitation projects and the extent to which expenditures for each type of project are load-related. The allocation was based on information from FHWA's Bridge Needs and Investment Process. The primary input required is an analysis of a representative sample of bridge repair projects to determine the overall percentage of such projected costs that are expected to be load-related as opposed to non-load related costs. This split, broken down by functional class of street and highway, is then used to determine the split between costs that should be allocated by vehicle mile of travel broken down by weight category and the costs that should be allocated only by vehicle miles of travel for each vehicle class.

3.1.3 Maintenance

State highway maintenance cost allocation procedures are based on very detailed reporting by NDOT maintenance crews for thousands of projects completed over the course of 2004-2008, the most recent complete years for which such data were available. The first main task was to assign each of the dozens of different types of projects to one of seven cost allocation categories:

- Travel related – maintenance costs that relate only to the amount of traffic, independent of weight
- Wear-related flexible pavements – maintenance costs for asphalt pavements that are based on axle weights, as measured by equivalent single-axle loads (ESALs) or local equivalency factors (LEFs)
- Wear-related rigid pavements – same for concrete pavements
- Axle-related surface wear – maintenance costs that are independent of weight but are dependent on the number of axles
- Truck-related – truck facilities – costs of maintenance for truck-only facilities, such as weigh stations
- Light vehicle-related facilities – costs for facilities used only by light vehicles, such as lanes or routes from which trucks are prohibited

¹ This formula is described in Appendix A of FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*.

- Rest areas – facilities where portions are truck-only and portions are for light vehicles only.

The second main task was to sum up the totals of all costs for each of these seven types, broken down by functional class of highway.

The appropriate allocators are then used for each of these seven classes to obtain maintenance costs by allocator for each functional class, which are then translated into cost responsibility by vehicle class based on each class's use of each functional class of highway.

3.1.4 Preservation

Estimates of the backlog of preservation costs have been updated in a February 2009 draft preservation report (NDOT 2009b). This report estimated the current pavement preservation backlog at \$567.7 million and the bridge preservation backlog at \$150.7 million, for a total of \$718.4 million.

The cost responsibility for the pavement backlog was estimated using the same allocators as were used for pavement repair. The cost responsibility for the bridge backlog was estimated using the same allocators as were used for bridge replacement and bridge repair. A more detailed breakdown of these by functional class was based on a limited breakdown by major functional class in the preservation report and on more detailed breakdowns by specific functional class developed as part of the construction cost allocation.

3.1.5 Federal Stimulus

NDOT currently plans to divide the total stimulus funding for Nevada highways (\$201 million) into two categories: reduction of preservation backlog (\$130 million), and other short-term improvement priorities on the National Highway System (NHS) and urban portions of the State Transportation Improvement Program (STIP Urban).

With guidance from NDOT staff we assumed that the preservation portion of the stimulus improvements would be divided proportionally between pavement and bridge improvements estimated in the 2009 draft preservation report, and that the other high-priority improvement projects would be programmed in the same proportion as are currently programmed projects in the capital improvement projects on the NHS and STIP Urban. The allocation factors used for these funds were the same as those used in the preservation and capital improvement programs.

3.1.6 Department of Motor Vehicles

Detailed review of DMV's budget for its various program categories reveals that: a) essentially all of its costs are highway-related, and b) only the Motor Carrier program is uniquely related to heavier vehicles. Accordingly, we have allocated about 4.5 percent of projected DMV expenditures solely to heavy vehicles based on their share of travel on Nevada highways. The rest of DMV expenditures have been allocated to all vehicle classes based on their shares of travel on Nevada highways.

3.1.7 Department of Public Safety

Detailed review of DPS's budget for its various program categories reveals that a) essentially all of its costs are highway-related, and b) only the State Emergency Response Commission (SERC) is uniquely related in significant part to heavy vehicles. We estimate that about half of SERC's costs should be considered the cost responsibility of heavy vehicles, in large part because emergency responses to incidents caused by heavy vehicles more often involved fatalities and serious injuries, major property damage and clean-up efforts, and more time and costs for police direction and emergency vehicles.

Accordingly, we have allocated half of DPS's projected expenditures for SERC, or about 1 percent of total DPS expenditures, to heavy vehicles based on their share of overall travel on Nevada highways. The rest of DPS expenditures have been allocated to all vehicle classes based on their shares of travel on Nevada highways.

3.1.8 Administration

Essentially all NDOT expenditures except capital and maintenance expenditures are support or management services for these two large components of NDOT programs. They include such things as payroll, computer services, equipment services, field and headquarters offices, executive offices, the transportation board, and various other units of state government that serve the highways.

Accordingly, all of these costs have been allocated as an overhead on the sum of the costs of capital and maintenance programs of NDOT – i.e., cost responsibility has been allocated among all vehicle classes in the same proportion as the sum of the costs of these two major components of NDOT programs.

3.1.9 Bonds

The costs of projected bond expenditures for both capital expenditures and debt service have been allocated in the same manner as the costs of other capital expenditures on the Urban Interstate system where the bond-financed projects are located.

3.1.10 Local Expenditures

Local expenditures were stratified according to the following seven expenditure categories:

- Capital outlay
- Maintenance
- Traffic control operations
- Snow and ice removal
- General administration
- Highway law enforcement and safety
- Bond obligations / debt service.

Expenditures by category were forecast out to 2016 based on growth rates used by NDOT to project State Highway Fund revenues. This study uses the average of the expenditures over the 2009-2016 time horizon, which totaled \$635.5 million.

Capital outlay, traffic control operations, general administration and bond obligations were allocated across functional highway systems and construction category using NDOT estimated breakdowns for local expenditures. Maintenance and snow and ice removal were allocated across functional highway systems using the detailed maintenance breakdowns obtained from NDOT maintenance expenditure worksheets. They were allocated as a travel-related maintenance cost. Highway law enforcement and safety expenditures were allocated as a police traffic management cost.

3.2 Cost Allocation Results

Table 3.1 summarizes the result of the allocation of all costs by vehicle class, taking into account all the factors affecting cost responsibility, such as those listed in the preceding section. Vehicle classes are defined in Section 4.1 of this report. As shown, the cost allocation methods used in the 2009 Nevada HCAS resulted in \$430.3 million or 51.6 percent of all costs being allocated to passenger vehicles weighing 8,000 pounds or less. Fewer than half of the costs (\$404.3 million or 48.4 percent) have been allocated to vehicles weighing in excess of 8,000 pounds.

Table 3.1. Summary of State Highway Fund Cost Allocation Results (\$Thousands Annually)

Vehicle Class	New Pavements	Rehab Pavements	New Bridge	Replacement Bridge	Repair Bridge	Grading	Other Construction	Total Construction	Maintenance	Admin & Other ^(a)	Total
Psg. Veh	6,523	83,515	8,018	12,334	17,109	13,262	52,416	193,177	74,693	162,474	430,343
Bus	2,722	10,491	505	1,137	699	862	481	16,899	1,837	4,085	22,821
SU2	3,951	18,736	806	1,325	1,438	2,527	1,715	30,497	5,594	5,869	41,960
SU3+	2,565	10,569	434	796	605	989	574	16,533	1,368	2,264	20,165
CB3&4	1,177	5,687	319	554	521	796	447	9,501	1,121	1,858	12,481
CB5	24,346	102,174	7,078	16,657	7,151	11,015	6,858	175,278	23,021	21,571	219,869
CB6+	664	3,255	301	817	265	355	174	5,831	459	1,092	7,383
DS5	2,804	9,751	1,266	4,138	872	846	470	20,148	1,538	2,522	24,208
DS6	474	2,536	269	834	268	227	142	4,749	410	1,451	6,610
DS7+	2,907	16,600	774	2,314	724	926	476	24,722	2,746	2,025	29,492
TRPL	1,723	9,709	722	2,318	574	679	328	16,053	1,787	1,426	19,267
Total	49,855	273,023	20,492	43,225	30,227	32,485	64,081	513,388	114,574	206,636	834,599

(a) "Administrative & Other" category includes \$88.3 million in DMV expenditures, \$72.2 million in DPS expenditures, \$41.0 million in administrative and support services expenditures, and \$5.1 million in transfers to other funds.

Table 3.2 breaks down the findings of the cost allocation analysis by vehicle class and level of government. As shown, \$93.3 million and \$439.5 million of all federal and local expenditures were allocated to passenger vehicles, respectively. The passenger vehicle cost responsibility is proportionally higher on the local systems due to the higher share of VMT the class represents on urban and local roads. In total, \$963.1 million or 55.3 percent of all costs were allocated to passenger vehicles.

Table 3.2. Cost Responsibility by Vehicle Class and Level of Government (\$Thousands)

Vehicle Class	State	Federal	Local	Total
Psgr Veh	430,343	93,278	439,480	963,101
Bus	22,821	7,065	21,794	51,681
SU2	41,960	13,068	28,047	83,075
SU3+	20,165	7,310	12,552	40,027
CB3&4	12,481	4,386	9,188	26,055
CB5	219,869	111,003	78,048	408,920
CB6+	7,383	2,967	4,888	15,238
DS5	24,208	10,777	14,632	49,617
DS6	6,610	2,419	6,514	15,543
DS7+	29,492	11,345	11,536	52,374
TRPL	19,267	7,886	8,820	35,973
Total	834,599	271,506	635,501	1,741,606

4.0 Revenue Attribution

The revenue attribution process involves the splitting of revenue forecast for a future time period, in this case the average of FYs 2009-2016, among vehicle classes and weight groups. In this process, revenues are attributed to vehicle classes separately for each tax and fee. Section 4.1 presents an overview of the procedures used in the revenue attribution process. Section 4.2 presents the results of the revenue attribution analysis.

The output of the revenue attribution process, which is an assignment of revenues collected by vehicle class, serves as the numerator in the equity ratio calculation. The equity ratio is the share of revenues paid by a highway user group to the share of costs imposed by that group. A user group that meets 110 percent of its cost responsibility would be assigned an equity ratio of 1.1. Equity ratios above 1.0 are assigned to user groups who are paying more than their cost responsible share while payments from user groups assigned equity ratios of less than 1.0 fall short of the costs imposed by the group.

4.1 Revenue Attribution Procedures

The revenue attribution procedures assigned federal, state, and local user revenues to the vehicle classes detailed in Table 4.1 and to RGW classes in 2,000-pound increments above 8,000 pounds. For reporting purposes, however, these RGW classes have been contracted into 11 classes.

Table 4.1. 2009 Nevada HCAS Vehicle Types

Vehicle Class	Acronym	Description
1	Auto	Automobiles, vans, light trucks with 2-axles and 4 tires and motorcycles
2	Bus	Buses (all larger types)
3	SU2	Single unit 2-axle, 6-tire trucks
4	SU3+	Single unit trucks with 3 or more axles
5	CB3&4	Combination trucks with 3 or 4 axles
6	CB5	Combination trucks with 5 axles
7	CB6+	Combination trucks with 6 or more axles
8	DS5	Tractor-double semitrailer combinations with 5 axles
9	DS6	Tractor-double semitrailer combinations with 6 axles
10	DS7+	Tractor-double semitrailer combinations with 7 or more axles
11	TRPL	Tractor-triple semitrailer or truck-double semitrailer combinations

In conducting the revenue attribution process, the research team supplemented NDOT travel and miles per gallon (MPG) data with data collected from other states and national databases, such as the Vehicle Inventory and Use Survey (VIUS). With assistance from representatives of NDOT, the research team also replaced several elements of the default data contained within the FHWA State HCAS model

with Nevada-specific inputs. The various sources of data examined for this study, combined with the default data already contained within the HCAS model, enabled the estimation of numerous vehicle characteristics for each detailed vehicle class, including:

- Average miles of travel per vehicle broken down by configuration and registered weight
- Percentage of mileage outside of Nevada broken down by configuration and registered weight
- Annual mileage per vehicle broken down by configuration and registered weight
- Gallons per mile broken down by configuration and registered weight
- Number of vehicles registered broken down by configuration and registered weight.

The travel, MPG, registration, and other data were input into the HCAS model, thus enabling the attribution for each tax from each vehicle configuration and registered weight class. The following procedures were used when developing estimates of revenues for the primary taxes from each vehicle class:

- Fuel tax revenues (gasoline and special fuels) were attributed based on estimates of VMT on Nevada highways and gallons per mile for each vehicle class.
- Registration fees were attributed based on the number of vehicles registered in each vehicle class.
- GST fees and vehicle sales taxes were attributed based on the number of vehicles registered in each vehicle class and default data on prices and depreciation schedules for vehicles in each RGW class.

Total collections for the average of FYs 2009 through 2016 were then applied as controls to the estimates derived from the revenue attribution procedures. This step ensured that total revenues attributed to all vehicle classes were equal to the forecast revenue totals for each level of government.

4.2 Revenue Attribution Results

This section summarizes the output of the revenue attribution process. Tables appearing in this section present total and per-mile state, federal, and local revenues paid by each vehicle and RGW class considered in this study. State highway user payments by type of tax are also presented for each vehicle and RGW class.

Table 4.2 presents the total and per-mile state, federal, and local revenues attributed to each vehicle class considered within this study. When only state highway user fees are included, passenger vehicle operators are paying 4.3 cents per mile. When all levels of government are considered, the per-mile fee for passenger vehicles rises to 5.9 cents. Per-mile state user fees increase gradually, reaching 12.8 cents per mile for tractor-double semitrailer combinations with 7 or more axles (DS7+) and triple trailer combinations. When taxes paid to all levels of government are considered, per-mile payments for the DS7+ and TRPL vehicle categories reach 21.4 cents.

Table 4.3 presents the total and per-mile state, federal, and local revenues by RGW class. Based on the data presented in Table 4.3, one preliminary finding of this study is that the current tax structure does not accurately reflect the additional damage caused to Nevada roadways by heavier vehicles. That is, the

Table 4.2. Total and Per-Mile State, Federal, and Local Revenues Attributed to Each Vehicle Class (Average Annual, FYs 2009-2016)

Vehicle Configuration	Vehicle Miles (Millions)	State		Federal		Local		Total	
		Revenue (\$Thousands)	Per Mile (Cents)	Revenue (\$Thousands)	Per Mile (Cents)	Revenue (\$Thousands)	Per Mile (Cents)	Revenue (\$Thousands)	Per Mile (Cents)
Psgr Veh	23,699	1,018,537	4.3	186,124	0.8	198,888	0.8	1,403,549	5.9
Bus	122	22,447	18.4	7,679	6.3	1,723	1.4	31,849	26.2
SU2	570	48,563	8.5	11,428	2.0	5,679	1.0	65,669	11.5
SU3+	123	22,036	17.9	11,417	9.3	254	0.2	33,707	27.4
CB3&4	105	11,730	11.1	7,119	6.8	129	0.1	18,978	18.0
CB5	950	107,015	11.3	70,432	7.4	453	0.0	177,901	18.7
CB 6+	27	3,370	12.6	2,177	8.1	16	0.1	5,562	20.7
DS5	67	7,555	11.2	4,972	7.4	32	0.0	12,560	18.7
DS6	24	2,974	12.3	1,924	8.0	14	0.1	4,911	20.4
DS7+	68	8,704	12.8	5,753	8.5	39	0.1	14,497	21.4
TRPL	46	5,859	12.8	3,873	8.5	27	0.1	9,758	21.4
Total	25,800	1,258,789		312,899		207,254		1,778,942	

Table 4.3. Total and Per Mile State, Federal, and Local Revenues by Registered Gross Weight Class (Average Annual, FYs 2009-2016)

Registered Gross Weight (Pounds)	Vehicle Miles (Millions)	State		Federal		Local		Total	
		Revenue (\$Thousands)	Per Mile (Cents)	Revenue (\$Thousands)	Per Mile (Cents)	Revenue (\$Thousands)	Per Mile (Cents)	Revenue (\$Thousands)	Per Mile (Cents)
0-8,000	23,636	1,015,319	4.3	185,202	0.8	198,332	0.8	1,398,854	5.9
8,001-16,000	441	30,112	6.8	6,828	1.5	4,221	1.0	41,162	9.3
16,001-26,000	221	29,532	13.4	5,521	2.5	2,910	1.3	37,963	17.2
26,001-40,000	126	19,130	15.2	10,143	8.1	928	0.7	30,202	24.0
40,001-55,000	132	20,961	15.9	11,076	8.4	228	0.2	32,265	24.5
55,001-75,000	73	9,360	12.7	5,719	7.8	60	0.1	15,139	20.6
75,001-80,000	1,020	114,863	11.3	75,621	7.4	486	0.0	190,971	18.7
80,001-90,000	28	3,568	13.0	2,266	8.2	17	0.1	5,850	21.3
90,001-100,000	20	2,733	13.5	1,767	8.8	13	0.1	4,513	22.4
100,001-105,500	103	13,170	12.8	8,727	8.4	59	0.1	21,956	21.3
105,501-150,000	0	41	13.1	27	8.8	0	0.1	69	21.9
Total	25,800	1,258,789		312,899		207,254		1,778,942	

rate structure is not effectively graduated to reflect the nearly exponential relationship between axle weight and pavement damage. In Nevada, per-mile state highway user revenues grow slightly as weights increase but not in a manner sufficient to capture the cost responsibilities of the heavier vehicle classes. See Section 5.0 for the comparison of revenues paid to cost responsibilities for each vehicle class.

Tables 4.4 and 4.5 present estimated annual Nevada highway user revenues attributed to each vehicle and RGW class for each state highway user fee. These tables do not include federal or local highway user fees. The highway user revenues highlighted in Table 2.3 have been compressed into the seven categories examined in Tables 4.4 and 4.5. The vast majority of the revenues from operators of passenger vehicles are collected through vehicle sales tax and title fees (\$400.0 million), GST fees (\$253.2 million), gasoline taxes (\$204.6 million), and registration fees (\$114.1 million). The diesel or special fuels tax collections (\$107.1 million for all vehicle classes) are net after the tax revenue is redistributed among states through the International Fuel Tax Agreement. When comparing registration fees presented in these tables to levels forecast by NDOT, note that these values include revenues kept for DMV operations and other miscellaneous fees paid when registering a vehicle in Nevada, such as specialized plate fees. Further, these revenues include those collected from highway users but ultimately used for non-road purposes. In Nevada, the majority of revenues from heavy trucks are those tied to diesel taxes and motor carrier registration fees.

Table 4.6 breaks down annual state highway user revenues attributed to basic vehicles (vehicles weighing 10,000 pounds or less) and heavy vehicles (vehicles weighing more than 10,000 pounds) by user fee for the average of FYs 2009 through 2016. Basic vehicles are forecast to pay \$1.0 billion (81.5 percent) in state highway user revenues, while heavy vehicles are forecast to pay \$232.8 million (18.5 percent). In the 1999 Nevada HCAS, heavy trucks were forecast to pay 27.4 percent. The difference between the current study and the 1999 Nevada HCAS is almost entirely driven by the inclusion of vehicle sales taxes used for general government purposes and GST fees, which are nearly entirely paid by basic vehicles. In previous HCASs, only funds used on Nevada highways were included in the revenue attribution process. Excluding all sales taxes, title and GST fees would raise the heavy vehicle revenue share to 30.1 percent.

Table 4.7 presents highway user revenues attributed to basic and heavy vehicles for all levels of government. At the federal level, tire taxes, the HVUT, and truck and trailer fees enhance collections from heavy vehicles, which were attributed \$125.2 million per year in FYs 2009-2016 (40.0 percent) in Nevada. At the local level, basic vehicles generate the vast majority of the revenue (96.5 percent) through GST fees and gasoline taxes. When all levels of government are included in the analysis, \$365.3 million (20.5 percent) are attributed to heavy vehicles while \$1.4 billion (79.5 percent) are attributed to basic vehicles.

Table 4.4. Nevada State Highway User Revenue by Type of Tax and Vehicle Class, Average Annual of FYs 2009-2016 (\$Thousands)

Vehicle Configuration	Gasoline	Diesel & Other Fuel Tax	Registration Fees	GST Fees	Vehicle Sales Tax and Title Fees	Other Permits and Fees	Drivers' Licenses	Total
Psgr Veh	204,637	7,936	114,055	253,207	399,944	24,018	14,740	1,018,537
Bus	1,514	3,922	4,102	3,376	8,986	548	-	22,447
SU2	5,300	7,015	8,783	9,708	16,517	783	456	48,563
SU3+	127	7,440	4,888	939	7,255	962	424	22,036
CB3&4	88	5,774	1,663	372	2,870	823	141	11,730
CB5	29	59,930	16,434	2,574	19,876	7,422	750	107,015
CB 6+	0	1,721	617	91	705	210	25	3,370
DS5	2	4,234	1,156	182	1,403	525	53	7,555
DS6	0	1,539	532	79	612	188	22	2,974
DS7+	-	4,546	1,516	235	1,819	530	58	8,704
TRPL	-	3,060	1,020	159	1,224	357	39	5,859
Total	211,698	107,118	154,767	270,921	461,210	36,366	16,709	1,258,789

Table 4.5. Nevada State Highway User Revenue by Type of Tax and Registered Gross Weight Class, Average Annual of FYs 2009-2016 (\$Thousands)

Registered Gross Weight (Pounds)	Gasoline	Diesel & Other Fuel Tax	Registration Fees	GST Fees	Vehicle Sales Tax and Title Fees	Other Permits and Fees	Drivers' Licenses	Total
0-8,000	204,058	7,431	113,753	252,536	398,885	23,955	14,701	1,015,319
8,001-16,000	4,045	4,001	3,994	6,734	10,636	447	255	30,112
16,001-26,000	2,440	4,124	6,560	6,232	9,844	224	108	29,532
26,001-40,000	998	4,930	3,400	984	7,603	985	230	19,130
40,001-55,000	111	7,733	4,295	850	6,568	1,029	374	20,961
55,001-75,000	15	4,493	1,648	290	2,239	574	101	9,360
75,001-80,000	31	64,366	17,610	2,761	21,321	7,970	805	114,863
80,001-90,000	-	1,762	701	99	763	215	27	3,568
90,001-100,000	-	1,323	539	79	613	158	21	2,733
100,001-105,500	-	6,933	2,260	353	2,729	807	87	13,170
105,501-150,000	-	22	6	1	9	2	0	41
Total	211,698	107,118	154,767	270,921	461,210	36,366	16,709	1,258,789

Table 4.6. State Highway User Fee Payments by Vehicle Class, Average of FYs 2009-2016
(\$Thousands)

User Fee	Basic Vehicles	Heavy Vehicles	Total
Gasoline	205,633	6,065	211,698
Diesel & Other Fuel Tax	8,804	98,314	107,118
Registration Fees	114,876	39,891	154,767
GST Fees	254,987	15,934	270,921
Vehicle Sales Tax and Title Fees	402,756	58,454	461,210
Other Permits and Fees	24,131	12,235	36,366
Drivers' Licenses	14,809	1,901	16,709
Total	1,025,995	232,794	1,258,789
	81.5%	18.5%	

Table 4.7. Highway User Fee Payments by Vehicle Class and Level of Government, Average of FYs 2009-2016 (\$Thousands)

	State Revenues	(%)	Federal Revenues	(%)	Local Revenues	(%)	Total Revenues	(%)
Basic Vehicles	1,025,995	81.5	187,710	60.0	199,947	96.5	1,413,653	79.5
Heavy Vehicles	232,794	18.5	125,189	40.0	7,306	3.5	365,290	20.5
Total	1,258,789		312,899		207,254		1,778,942	

5.0 Equity Analysis

Tables 5.1-5.7 present the results of the equity analysis, which compares cost responsibilities estimated for each vehicle and RGW class to attributed revenues. The equity ratio is a concept that has already been discussed in this report (See Section 4.0) but this section introduces the concepts of adjusted and unadjusted equity ratios. An unadjusted equity ratio is the type described previously in this report, which is revenues divided by cost responsibility for each vehicle class. The adjusted equity ratio accounts for differences between revenues attributed and costs allocated to all vehicle classes. If total highway user payments exceed total cost responsibility, the equity ratios for each vehicle class would be adjusted downward so that the total shares of allocated costs equal total shares of revenues and the overall equity ratio equals 1.0. For example, if highway user revenues exceeded cost responsibilities by 50 percent, each unadjusted equity ratio would be divided by 1.5. This procedure is necessary for examining equity in tax structures with highway user revenues collected for non-road purposes, as is done in Nevada with the vehicle sales tax and ad-valorem GST fee, and when non-user sources (e.g., general fund revenues) are used to pay for part of the highway program.

Table 5.1 presents vehicle miles, state revenue, and state cost responsibility for each vehicle class considered in this study. Based on the findings presented in Table 5.1, revenues from passenger vehicles exceed the cost responsibility estimated for that class by 137 percent. The adjusted equity ratio for passenger vehicles is 1.57. The larger vehicle classes, such as tractor-double semitrailer combinations, face significant shortfalls in terms of revenues vs. allocated costs, with unadjusted equity ratios reaching as low as 0.30.

Tables 5.2 through 5.5 present vehicle miles, revenue, and cost responsibility for the federal, federal and state combined, local, and all levels of government combined, respectively. At the federal level, revenues exceed cost responsibility by 15 percent and the unadjusted equity ratio for passenger vehicles is 2.0 while the unadjusted equity ratios for heavy trucks exceed 1.0 in several vehicle classes. At the local level, revenues are equal to 33 percent of total expenditures due to the heavy reliance on local, non highway-user revenue sources. When all levels of government are included in the analysis (Table 5.5), the unadjusted equity ratio for passenger vehicles falls to 1.46 while the equity ratios for heavy trucks is reported in the 0.25 to 0.73 range.

Tables 5.1 demonstrates that at the state level, annual highway user payments are forecast to exceed state highway-related cost responsibilities by 51 percent (\$424.2 million) over the study time horizon. This diversion is counterbalanced at the local level where annual expenditures are forecast to exceed highway user payments by \$428.2 million (Table 5.4).

Table 5.6 presents vehicle miles, state revenue, and state cost responsibility by RGW class. For vehicles weighing 8,000 pounds or less, unadjusted equity ratios are 2.37 with adjusted equity ratios reaching 1.57. Equity ratios drop considerably as weights increase, reaching as low as .26 in unadjusted terms for the heaviest vehicles and 0.47 for vehicles weighing 75,001 to 80,000 pounds.

Table 5.7 compares state highway user revenue to cost responsibility for basic and heavy vehicles. As shown, payments from basic vehicles are estimated to exceed cost responsibility by 135 percent while payments from heavy vehicles fall roughly 41 percent short of their cost responsibility. Using adjusted

equity ratios, the basic vehicle overpayment lowers to 56 percent while the heavy truck class meets approximately 39 percent of its cost responsibility. To make payments from the heavy vehicle class equal its cost responsibility would require an increase in annual payments of \$164.9 million. The annual increase required to modify the adjusted equity ratio until it reached 1.0 would exceed \$700.4 million.

Table 5.1. Annual Vehicle Miles, State Revenue, and State Cost Responsibility by Vehicle Class

Vehicle Class	Vehicle Miles (Millions)	State User Revenue (Thousands)	State Cost Responsibilities (Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psgr Veh	23,699	1,018,537	430,343	2.37	1.57
Bus	122	22,447	22,821	0.98	0.65
SU2	570	48,563	41,960	1.16	0.77
SU3+	123	22,036	20,165	1.09	0.72
CB3&4	105	11,730	12,481	0.94	0.62
CB5	950	107,015	219,869	0.49	0.32
CB6+	27	3,370	7,383	0.46	0.30
DS5	67	7,555	24,208	0.31	0.21
DS6	24	2,974	6,610	0.45	0.30
DS7+	68	8,704	29,492	0.30	0.20
TRPL	46	5,859	19,267	0.30	0.20
Total	25,800	1,258,789	834,599	1.51	1.00

Table 5.2. Annual Vehicle Miles, Federal Revenue, and Federal Cost Responsibility by Vehicle Class

Vehicle Class	Vehicle Miles (Millions)	Federal User Revenue (Thousands)	Federal Cost Responsibilities (Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psgr Veh	23,699	186,124	93,278	2.00	1.73
Bus	122	7,679	7,065	1.09	0.94
SU2	570	11,428	13,068	0.87	0.76
SU3+	123	11,417	7,310	1.56	1.36
CB3&4	105	7,119	4,386	1.62	1.41
CB5	950	70,432	111,003	0.63	0.55
CB6+	27	2,177	2,967	0.73	0.64
DS5	67	4,972	10,777	0.46	0.40
DS6	24	1,924	2,419	0.80	0.69
DS7+	68	5,753	11,345	0.51	0.44
TRPL	46	3,873	7,886	0.49	0.43
Total	25,800	312,899	271,506	1.15	1.00

Table 5.3. Annual Vehicle Miles, Federal and State Revenue, and Federal and State Level Cost Responsibility Combined by Vehicle Class

Vehicle Class	Vehicle Miles (Millions)	Federal and State User Revenue (Thousands)	Federal and State Cost Responsibilities (Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psg'r Veh	23,699	1,204,661	523,621	2.30	1.62
Bus	122	30,126	29,887	1.01	0.71
SU2	570	59,991	55,029	1.09	0.77
SU3+	123	33,453	27,474	1.22	0.86
CB3&4	105	18,849	16,867	1.12	0.79
CB5	950	177,447	330,872	0.54	0.38
CB6+	27	5,547	10,350	0.54	0.38
DS5	67	12,528	34,985	0.36	0.25
DS6	24	4,898	9,029	0.54	0.38
DS7+	68	14,458	40,838	0.35	0.25
TRPL	46	9,732	27,153	0.36	0.25
Total	25,800	1,571,688	1,106,105	1.42	1.00

Table 5.4. Annual Vehicle Miles, Local Revenue, and Local Level Cost Responsibility by Vehicle Class

Vehicle Class	Vehicle Miles (Millions)	Local User Revenue (Thousands)	Local Cost Responsibilities (Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psg'r Veh	23,699	198,888	439,480	0.45	1.39
Bus	122	1,723	21,794	0.08	0.24
SU2	570	5,679	28,047	0.20	0.62
SU3+	123	254	12,552	0.02	0.06
CB3&4	105	129	9,188	0.01	0.04
CB5	950	453	78,048	0.01	0.02
CB6+	27	16	4,888	0.00	0.01
DS5	67	32	14,632	0.00	0.01
DS6	24	14	6,514	0.00	0.01
DS7+	68	39	11,536	0.00	0.01
TRPL	46	27	8,820	0.00	0.01
Total	25,800	207,254	635,501	0.33	1.00

Table 5.5. Annual Vehicle Miles, Revenue, and Cost Responsibility by Vehicle Class, All Levels of Government

Vehicle Class	Vehicle Miles (Millions)	Highway User Revenue (\$Thousands)	Total Cost Responsibilities (\$Thousands)	Equity Ratios	
				Unadjusted	Adjusted
Psgr Veh	23,699	1,403,549	963,101	1.46	1.43
Bus	122	31,849	51,681	0.62	0.60
SU2	570	65,669	83,075	0.79	0.77
SU3+	123	33,707	40,027	0.84	0.82
CB3&4	105	18,978	26,055	0.73	0.71
CB5	950	177,901	408,920	0.44	0.43
CB6+	27	5,562	15,238	0.37	0.36
DS5	67	12,560	49,617	0.25	0.25
DS6	24	4,911	15,543	0.32	0.31
DS7+	68	14,497	52,374	0.28	0.27
TRPL	46	9,758	35,973	0.27	0.27
Total	25,800	1,778,942	1,741,606	1.02	1.00

Table 5.6. Annual Vehicle Miles, State Revenue, and State Cost Responsibility by Registered Gross Weight (RGW) Class

RGW Class	Vehicle Miles (Millions)	State User Revenue (\$Thousands)	State Cost Responsibilities (\$Thousands)	Equity Ratios	
				Unadjusted	Adjusted
0-8,000	23,636	1,015,319	429,150	2.37	1.57
8,001-16,000	441	30,112	24,562	1.23	0.81
16,001-26,000	221	29,532	24,496	1.21	0.80
26,001-40,000	126	19,130	20,515	0.93	0.62
40,001-55,000	132	20,961	19,201	1.09	0.72
55,001-75,000	73	9,360	11,951	0.78	0.52
75,001-80,000	1,020	114,863	245,314	0.47	0.31
80,001-90,000	28	3,568	7,445	0.48	0.32
90,001-100,000	20	2,733	7,357	0.37	0.25
100,001-105,500	103	13,170	44,450	0.30	0.20
105,501-150,000	0	41	158	0.26	0.17
Total	25,800	1,258,789	834,599	1.51	1.00

Table 5.7. Annual Revenue and Cost Responsibility for Basic and Heavy Vehicles (Nevada State Highway User Revenues and Cost Responsibilities Only)

Vehicle Class	State User Revenue (Thousands)	State Cost Responsibilities (Thousands)	Equity Ratios	
			Unadjusted	Adjusted
Basic Vehicles	1,025,995	436,871	2.35	1.56
Heavy Vehicles	232,794	397,728	0.59	0.39
Total	1,258,789	834,599	1.51	1.00

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2009 Nevada Highway Cost Allocation Study

TAX POLICY OPTIONS ANALYSIS

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Prepared for
Nevada Department of Transportation
Carson City, Nevada

June 8, 2009



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Acronyms and Abbreviations

DOT	Department of Transportation
FHWA	Federal Highway Administration
GST	Governmental Services Tax
GVW	Gross Vehicle Weight
HCAS	Highway Cost Allocation Study
HPMS	Highway Performance Monitoring System
NDOT	Nevada Department of Transportation
RGW	Registered Gross Weight
VMT	Vehicle Miles of Travel

Glossary

Ad Valorem Tax. A tax based on the assessed value of real or personal property.

Cost Allocation. The analytical process of determining the cost responsibility of highway system users.

Cost Responsibility. The principle that those who use the public roads should pay for them and, more specifically, that payments from road users should be in proportion to the road costs for which they are responsible. The proportionate share of highway costs legitimately assignable to a given vehicle class or user group.

Equity. Generally interpreted as the state of being just, impartial, or fair. Horizontal equity refers to the fair treatment of individuals with similar circumstances. Vertical equity refers to the fair treatment of individuals in different circumstances.

Equity Ratio. The ratio of the share of revenues paid by a highway user group to the share of costs imposed by that group. A user group that meets 110 percent of its cost responsibility would be assigned an equity ratio of 1.1. Equity ratios above 1.0 are assigned to user groups who are paying more than their cost responsible share while payments from user groups assigned equity ratios of less than 1.0 fall short of the costs imposed by the group.

Gross Vehicle Weight. The loaded weight for a vehicle.

Highway Cost Allocation Study. A study that estimates and compares the costs imposed and the revenues paid by different classes of vehicles over some time period.

Highway Performance Monitoring System. FHWA collects and reports data about a sample of road segments in every state in a common format.

Highway User. A person responsible for the operation of a motor vehicle in use on highways, roads, and streets. In the case of passenger vehicles, the users are the people in the vehicles. In the case of goods-transporting trucks, the user is the entity transporting the goods.

Incremental Cost. The additional costs associated with building a facility to handle an additional, heavier (or larger) class of vehicle.

Light (or Basic) Vehicles. The lightest vehicle class, usually including passenger cars, vans, and pickups.

Registered Weight. The weight that determines the registration fee paid by a single-unit truck or a tractor. For a tractor, it is the highest weight at which the vehicle may operate.

Revenue Attribution. The process of associating revenue amounts with the classes of vehicles that produce the revenues.

Truck. A general term denoting a motor vehicle designed for the transportation of goods. The term includes single-unit trucks and truck combinations.

User Charge. A fee, tax, or charge that is imposed on facility users as a condition of usage.

User Revenues. Highway revenues raised through the imposition of user charges or fees.

Vehicle Class. Any grouping of vehicles having similar characteristics for cost allocation, taxation, or other purposes. The number of vehicle classes used in a cost responsibility (allocation) study will depend on the needs, purpose, and resources of the study. Potential distinguishing characteristics include weight, size, number of axles, type of fuel, time of operation, and place of operation.

Vehicle Miles of Travel. The sum of the number of miles each vehicle travels within a time period.

Vehicle Registration Fees. Fees charged for being allowed to operate a vehicle on public roads.

Weight-Distance Tax. A graduated fee based on the weight of a vehicle and the miles it travels.

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1.0 Introduction

This report is a supplement to the 2009 Nevada Highway Cost Allocation Study (HCAS). The 2009 Nevada HCAS examined the equity of Nevada's highway user tax structure. An HCAS is a study that is designed to determine the fair share of costs that each road user class should pay for the construction, operation, maintenance, and related costs of highways, roads, and bridges in a state. By comparing highway user payments to cost responsibilities estimated within the HCAS, the 2009 Nevada HCAS examines the equity in Nevada's highway user tax system. This report examines the impact of several tax policy options from an equity standpoint.

The findings of this analysis are expressed in terms of equity ratios. The equity ratio compares the share of highway user revenues paid by a group to the share of cost responsibility imposed by that group. Cost responsibility in the 2009 Nevada HCAS represents the share of highway expenditures and preservation backlog costs for which each vehicle class is responsible. See Section 3.1 of the 2009 Nevada HCAS Final Report for a more thorough discussion of cost allocation procedures (Balducci et al. 2009).

Equity ratios above 1.0 are assigned to user groups that are paying more than their cost responsible share while payments from user groups with equity ratios of less than 1.0 fall short of the costs imposed by the group. An adjusted equity ratio accounts for differences between total revenues attributed and total costs allocated to all vehicle classes. If highway user payments exceed total cost responsibility, the equity ratios for each vehicle class would be adjusted downward so that total shares of allocated costs equal total shares of revenues and the overall equity ratio for all users equals 1.0. For example, if total highway user revenues exceeded total cost responsibilities by 50 percent, each unadjusted equity ratio would be divided by 1.5 to get the adjusted equity ratio. This procedure is necessary for examining equity in tax structures with highway user revenues collected for non-road purposes, as is done in Nevada with the vehicle sales tax and ad-valorem governmental service tax (GST), or when non-user sources (e.g., general fund revenues) are used to pay for part of the highway program.

The equity findings for the examined policy options are presented by vehicle and registered gross weight (RGW) class. The 12 vehicle configurations established by the Highway Performance Monitoring System (HPMS) were contracted into 11 classes by combining four-wheel light trucks with passenger cars and combining single-unit three axle and single-unit four or more axle vehicles together into a single vehicle class. For this study, an 11th vehicle configuration was added: tractor-triple semitrailer (triples) were separated from the rest of the vehicle configuration class in which they were classified in the database (i.e., truck double semitrailer combinations with seven or more axles). Vehicle classes are further differentiated in the Federal Highway Administration (FHWA) State HCAS Model, which was used to support the calculations presented in this report, based on RGW in 2000-pound increments above 8,000 pounds. The vehicle classes examined in this report are presented in Table 1.

Table 1. 2009 Nevada HCAS Vehicle Types

Vehicle Class	Acronym	Description
1	Auto	Automobiles, vans, light trucks with 2-axles and 4 tires and motorcycles
2	Bus	Buses (all larger types)
3	SU2	Single unit 2-axle, 6-tire trucks
4	SU3+	Single unit trucks with 3 or more axles
5	CB3&4	Combination trucks with 3 or 4 axles
6	CB5	Combination trucks with 5 axles
7	CB6+	Combination trucks with 6 or more axles
8	DS5	Tractor-double semitrailer combinations with 5 axles
9	DS6	Tractor-double semitrailer combinations with 6 axles
10	DS7+	Tractor-double semitrailer combinations with 7 or more axles
11	TRPL	Tractor-triple semitrailer

This report contains the following sections:

- 1.0 Introduction. This section presents an overview of the purpose and scope of this analysis.
- 2.0 Policy Options Analysis. This section presents an overview and analysis of each policy option examined in this report.
- 3.0 Conclusions. This section presents the conclusions drawn from the policy options analysis.

This report also contains a list of references, acronyms, and a glossary.

2.0 Policy Options Analysis

This section presents an overview of several policy options for changing the existing transportation tax structure in the State of Nevada. These options include both those designed to modify the existing transportation tax structure (e.g., increase diesel tax rates, increase registration fees) and those with new transportation taxes and fees (e.g., weight-distance tax, vehicle miles of travel [VMT] fee). The alternative tax systems were designed to move the transportation tax system in Nevada towards a more equitable position. It is important to note, however, that these should only be considered options and should not be construed as proposals or legislative concepts. Furthermore, these alternatives are examined with one criterion in mind: equity. Thus, this analysis does not examine other important tax criteria such as revenue adequacy, political feasibility, evasion, avoidance, administrative/compliance costs, or economic efficiency. Analysis of these criteria is outside the scope of this study. Note also that the Nevada Department of Transportation (NDOT) has not endorsed these policy options.

2.1 Adjustments to Existing Tax Structure

This section presents the equity impacts of three proposed adjustments to the existing transportation tax structure in the State of Nevada:

- Policy Option 1: Increase the diesel tax by 12 cents per gallon
- Policy Option 2: Increase the diesel and gas tax rates by 6 cents per gallon
- Policy Option 3: Increase heavy truck registration fees by 50 percent, and increase gasoline taxes by 6 cents per gallon and diesel taxes by 12 cents per gallon.

The findings for each scenario are presented in Table 2. Under the existing tax structure, the unadjusted equity ratio for passenger vehicles is 2.37 while the adjusted equity ratio is 1.57. Equity ratios drop considerably as weights increase, reaching as low as 0.30 in unadjusted terms for the DS7+ and TRPL vehicle classes. Findings for each policy option are examined in the remainder of this section.

Under Policy Option 1, which is summarized in Table 3, the 12-cent diesel tax is forecast to generate an additional \$46.3 million in revenue annually over the study time horizon (2009-2016). The diesel tax increase results in additional payments attributed primarily to the bus and truck vehicle classes, bringing about a closer match with equity. For example, the CB5 vehicle class meets only 49 percent of its cost responsibility in unadjusted terms under the current system but would meet 61 percent under Policy Option 1. Because the diesel tax would also be paid by operators of single unit trucks, these classes would have an overpayment in unadjusted terms. In adjusted terms, all heavy vehicle classes continue to fall short in terms of meeting a cost responsible level of payment, though all achieve small gains toward becoming more cost responsible. For example, the adjusted equity ratio for the DS6 class grows from 0.30 to 0.36 under Policy Option 1.

Table 2. Equity Ratios by Vehicle Configuration for Current Nevada Highway User Tax System and Policy Options 1-3.

Vehicle Class	Current System		Policy Option 1		Policy Option 2		Policy Option3	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Unadjusted
Psgr Veh	2.37	1.57	2.37	1.52	2.52	1.56	2.53	1.52
Bus	0.98	0.65	1.05	0.67	1.03	0.64	1.11	0.67
SU2	1.16	0.77	1.22	0.78	1.23	0.76	1.27	0.76
SU3+	1.09	0.72	1.23	0.79	1.16	0.72	1.36	0.82
CB3&4	0.94	0.62	1.13	0.72	1.03	0.64	1.20	0.72
CB5	0.49	0.32	0.61	0.39	0.55	0.34	0.64	0.39
CB6+	0.46	0.30	0.57	0.36	0.52	0.32	0.61	0.37
DS5	0.31	0.21	0.39	0.25	0.35	0.22	0.41	0.25
DS6	0.45	0.30	0.56	0.36	0.51	0.31	0.60	0.36
DS7+	0.30	0.20	0.38	0.24	0.34	0.21	0.41	0.24
TRPL	0.30	0.20	0.39	0.25	0.35	0.22	0.42	0.25
Total	1.51	1.00	1.56	1.00	1.62	1.00	1.66	1.00

Table 3. Policy Option 1 Summary.

Component	Change from Existing	Affecting These Vehicles
Gasoline Tax	No change.	All
Diesel Tax	12¢ per gallon increase.	All
All Other Components	No change.	All

Policy Option 2, which is summarized in Table 4, would generate \$23.2 million in revenue annually through enhanced diesel tax payments and \$68.8 million in additional gasoline tax payments over the study time horizon. Thus, Policy Option 2 would generate \$92.0 million in additional motor fuel tax payments annually in Nevada from 2009 through 2016. In unadjusted terms, the equity ratio for each vehicle class would increase; however, because all vehicle classes would pay more under this option, impacts on adjusted equity ratios are negligible.

Table 4. Policy Option 2 Summary.

Component	Change from Existing	Affecting These Vehicles
Gasoline Tax	6¢ per gallon increase.	All
Diesel Tax	6¢ per gallon increase.	All
All Other Components	No change.	All

Policy Option 3, which is summarized in Table 5, generates the most additional revenue to the State Highway Fund (\$130.3 million annually) of the three options examined in this section. It generates \$68.8 million through the 6-cent gasoline tax increase, \$46.3 million through the 12-cent diesel tax increase, and \$15.2 million annually through the 50 percent increase in heavy truck registration fees. Due to the expanded diesel tax and registration fee component of this option, unadjusted equity ratios grow among larger vehicle classes. For example, the unadjusted equity ratio for the DS6 vehicle class grows from 0.45 under the current system to 0.60. Adjusted equity ratios under Policy Option 3 are close to those presented for Policy Option 1 because passenger vehicles also pay more under this option.

Table 5. Policy Option 3 Summary.

Component	Change from Existing	Affecting These Vehicles
Gasoline Tax	6¢ per gallon increase.	All
Diesel Tax	12¢ per gallon increase.	All
Registration Fee	50% Increase.	All vehicles weighing in excess of 26,000 lbs.
All Other Components	No change.	All

2.2 Alternative Tax Systems

This section presents the equity impacts of two alternative systems that include taxes or fees not currently charged by the State of Nevada:

- Policy Option 4: Implement a \$0.12 per mile registration fee on all vehicles registered in excess of 55,000 pounds.
- Policy Option 5: Ideally, a tax structure should be equitable among vehicle classes (e.g., passenger vehicles vs. combination trucks) and within vehicle classes (e.g., low- vs. high-mileage vehicles). This policy option involves a three-step progression towards a more equitable highway tax system:
 - a. Determine the increased revenues and rates required to bring the heavy truck class equity ratio to 1.0 by increasing the diesel fuel tax. Report the estimated revenues and rates resulting from the diesel fuel tax increase.
 - b. Fixed registration fees would be kept at current levels, sales and ad-valorem taxes would be eliminated, motor fuels taxes would be retained, and a weight-distance tax would be added for heavy vehicles registered in excess of 62,000 pounds in a manner designed to bring RGW classes' equity ratios closer to 1.0.
 - c. Fixed registration fees are maintained while the ad-valorem, vehicle sales, and motor fuels taxes are eliminated and a VMT fee is implemented in a manner designed to ensure that vehicle and RGW class equity ratios are near 1.0.

2.2.1 Policy Option 4: Nevada Implements a \$0.12 per Mile Registration Fee for Vehicles Registered in Excess of 55,000 Pounds

This fourth policy option is based on the assumption that the State of Nevada would impose a \$0.12 per mile registration fee, in addition to existing registration fees, on all vehicles registered in excess of 55,000 pounds. Table 6 presents a summary of Policy Option 4. Since the FHWA State HCAS model examines RGW classes in 2,000-pound increments, the enhanced registration fee was modeled to begin with RGWs of 56,000 pounds. When applied to all vehicles with RGWs in excess of 56,001 pounds, estimated revenues are \$148.1 million annually.

Table 6. Policy Option 4 Summary.

Component	Change from Existing	Affecting These Vehicles
Gasoline Tax	No change.	All
Diesel Tax	No change.	All
Registration Fee	\$0.12 per mile increase.	All vehicles weighing in excess of 55,000 lbs.
All Other Components	No change.	All

Table 7 compares the unadjusted equity ratios under Policy Option 4 to those reported in the 2009 Nevada HCAS Final Report. For vehicles registering at 56,000 pounds or less, unadjusted equity ratios would remain unchanged. Thus, the SU2, bus, and passenger vehicle equity ratios would be the same as they were under the base case. As shown, all single unit and most combination truck classes have equity ratios reaching up to and exceeding 1.0, which indicates that under Policy Option 4, revenues from the heavy truck classes are in many cases equaling or exceeding their cost responsibility on an unadjusted basis. Under Policy Option 4, the unadjusted equity ratios for the heaviest truck classes nearly double when compared to those reported in the 2009 Nevada HCAS. Adjusted equity ratios also increase significantly under Policy Option 4.

Table 7. State Level Cost Responsibility by Vehicle Configuration (Current System vs. Policy Option 4)

Vehicle Class	Current System		Policy Option 4	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Psgr Veh	2.37	1.57	2.37	1.40
Bus	0.98	0.65	0.98	0.58
SU2	1.16	0.77	1.16	0.69
SU3+	1.09	0.72	1.17	0.69
CB3&4	0.94	0.62	1.32	0.78
CB5	0.49	0.32	1.01	0.60
CB6+	0.46	0.30	0.89	0.53
DS5	0.31	0.21	0.65	0.38
DS6	0.45	0.30	0.89	0.53
DS7+	0.30	0.20	0.57	0.34
TRPL	0.30	0.20	0.59	0.35
Total	1.51	1.00	1.69	1.00

Figure 1 shows plots of unadjusted equity ratios as a function of RGW class and compares the results of the 2009 Nevada HCAS to the Policy Option 4 equity ratios, which include the impact of a \$0.12 per mile registration fee on all vehicles registered in excess of 56,000 pounds. The unadjusted equity ratios for vehicles registered at 58,000 pounds or more increase significantly under the \$0.12 per mile registration fee, up from 0.45 to 0.92. Thus, revenues from these vehicles would nearly equal their cost responsibility in unadjusted terms. The adjusted equity ratio for all vehicles registered at weights equal to or exceeding 58,000 pounds is 0.55, thus indicating a 45 percent shortfall. The revised equity ratios are a significant deviation from the results presented in the 2009 Nevada HCAS Final Report.

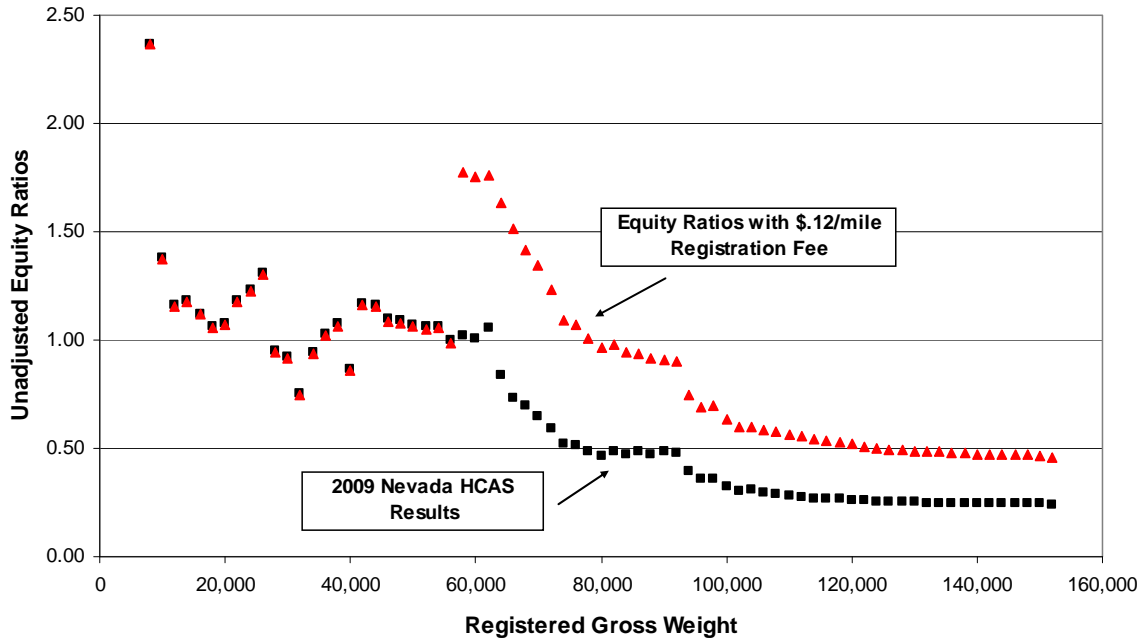


Figure 1. State-Level Unadjusted Equity Ratios by Registered Gross Weight Class (2009 Nevada HCAS vs. Policy Option 4)

The impact of a flat \$0.12 per mile registration fee on highway user payments is illustrated in Figure 2, which compares per-mile highway user revenues for each RGW class under Policy Option 4 to the existing tax system. As shown, the impact of the \$0.12 per mile registration fee is significant, with per-mile rates increasing by 73.4 percent for the 58,000 pound RGW class, from 16.0 cents per mile to 27.8 cents per mile. Because the new tax system would apply a flat fee per mile to all vehicles registered in excess of 55,000 pounds (implemented in this analysis as vehicles registered over 56,000 pounds), the per-mile rate jumps significantly when RGWs reach 58,000 pounds. For vehicles registered at 54,000 pounds RGW or more, the per-mile rate is 16.6 cents per mile. For the 58,000 pound RGW class, the per-mile rate reaches 27.8 cents per mile.

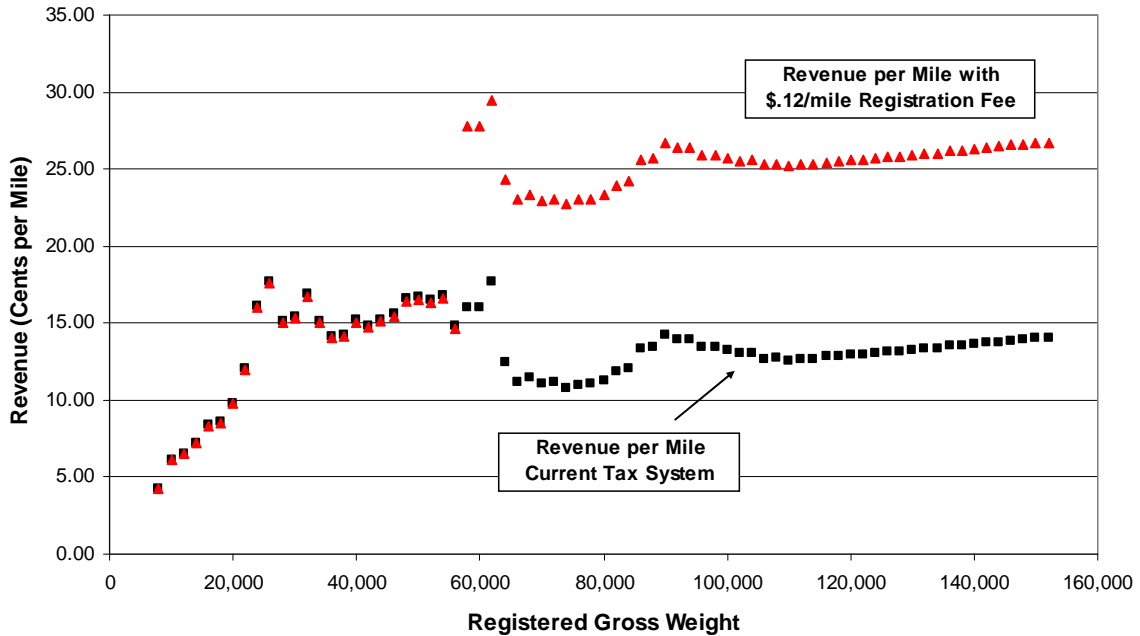


Figure 2. State-Level Per-Mile Highway User Payments by Registered Gross Weight Class (2009 Nevada HCAS vs. Policy Option 4)

2.2.2 Policy Option 5: Progression towards a More Equitable Highway Tax System

This policy option considers a three-step progression from the existing to a more equitable highway tax system. Overviews of each policy option are identified in Section 2.2.

2.2.2.1 Policy Option 5a: Diesel Taxes Adjusted Upward Until Heavy Vehicle Class Equity Ratio Equals 1.0.

Under Policy Option 5a, the research team determined the revenues and rates required to bring the heavy truck class (i.e., all vehicles registered over 10,000 pounds) equity ratio to 1.0 by increasing the diesel fuel tax. It is important to note that the diesel tax is a fairly blunt tool for implementing equity. Therefore, diesel tax rates could not be set to capture the relationship between axle weights and pavement damage (and other vehicle class cost responsibilities such as bridge costs) without setting a very complicated and impractical tax schedule with rates varied based on the RGW of the vehicle purchasing or using the fuel. Thus, this policy option assumes a single diesel tax rate, which results in overpayments within some heavy truck classes and underpayments in others. The first sub-option, which is referred to as Policy Option 5a1 involves an increase of the diesel tax to 70.5 cents per gallon, the amount required to bring the unadjusted equity ratio for the heavy vehicle class to 1.0. To bring about equity in adjusted terms, or to a level that accounts for the current overpayment from basic vehicles, the diesel tax would need to be raised to \$2.09 per gallon (Policy Option 5a2). Policy Option 5a1 would generate an additional \$164.9 million (average annual revenue during the 2009-2016 timeframe) while Policy Option 5a2 would generate an additional \$700.4 million annually. Policy Options 5a1 and 5a2 are summarized in Table 8.

Table 8. Policy Option 5a1 and 5a2 Summary.

Component	Change from Existing	Affecting These Vehicles
Gasoline Tax	No change.	All
Diesel Tax	42.75¢ per gallon increase (5a1) and 181.25¢ per gallon increase (5a2)	All
All Other Components	No change.	All

The findings of Policy Options 5a1 and 5a2 are presented in Table 9. As shown, these two options enhance equity significantly overall but result in significant overpayments in unadjusted terms for lighter single unit vehicles. As noted previously, unadjusted equity ratios compare total payments for each vehicle class to total cost responsibility without regard for overpayments or underpayments made by other vehicle classes. The adjusted equity ratios improve for all vehicle classes under Policy Option 5a1. For example, the adjusted equity ratio for the DS6 vehicle class grows from 0.30 to 0.48.

Under Policy Option 5a2, all vehicle classes would overpay significantly in unadjusted terms. In interpreting the results of this policy option, it means that highway user payments from the heavy vehicle classes exceed cost responsibility in a manner consistent with the levels of overpayment currently experienced by the basic vehicle class. In adjusted terms, the single unit and smaller combination vehicle classes would be overpaying while the equity ratios among the largest vehicle configurations (e.g., DS7+ and TRPL) would reach 0.61.

Table 9. Equity Ratios by Vehicle Class for Current Nevada Highway User Tax System and Policy Options 5a1 and 5a2.

Vehicle Class	Current System		Policy Option 5a1		Policy Option 5a2	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Psgr Veh	2.37	1.57	2.39	1.40	2.48	1.06
Bus	0.98	0.65	1.23	0.72	2.06	0.88
SU2	1.16	0.77	1.40	0.82	2.21	0.94
SU3+	1.09	0.72	1.63	0.95	3.41	1.45
CB3&4	0.94	0.62	1.63	0.96	3.90	1.66
CB5	0.49	0.32	0.91	0.53	2.28	0.97
CB6+	0.46	0.30	0.84	0.49	2.05	0.87
DS5	0.31	0.21	0.58	0.34	1.46	0.62
DS6	0.45	0.30	0.83	0.48	2.03	0.86
DS7+	0.30	0.20	0.57	0.33	1.40	0.60
TRPL	0.30	0.20	0.58	0.34	1.44	0.61
Total	1.51	1.00	1.71	1.00	2.35	1.00

2.2.2.2 Policy Option 5b: Elimination of Vehicle Sales and Ad-Valorem Taxes and Introduction of Weight-Distance Tax

Under Policy Option 5b, which is summarized in Table 10, the vehicle sales and ad-valorem taxes would be eliminated and a weight distance tax would be imposed on vehicles registered over 62,000 pounds. A weight-distance tax is a graduated fee based on the weight of a vehicle and the miles it travels in Nevada. There are currently four states in the U.S. that impose weight-distance taxes – Kentucky, New Mexico, New York, and Oregon. The weight-distance tax is a far more refined tool for implementing the findings of an HCAS and balancing equity in a tax structure. The vehicle sales and ad-valorem taxes would be eliminated in this scenario due to their negative impacts on equity. Note that this policy option represents the 2nd in a three-step progression towards a more equitable highway user tax structure in Nevada.

Table 10. Policy Option 5b Summary.

Component	Change from Existing	Affecting These Vehicles
Gasoline Tax	No change.	All
Diesel Tax	No change.	All
Vehicle Sales Tax	Eliminated.	All
GST Fee	Eliminated.	All
Weight-Distance Tax	Establishes a graduated weight-based tax from 2.6¢ per mile to 40.8¢ per mile.	Vehicles with RGWs from 62,000 to 152,000 pounds.
All Other Components	No change.	All

The weight distance tax rate schedule was designed to bring the adjusted equity ratios close to 1.0 while eliminating incentives to register a vehicle at a higher weight to avoid paying taxes. The following steps were taken to prepare the weight distance tax rate schedule:

1. Eliminate the ad-valorem and sales tax revenue
2. Calculate the adjusted heavy vehicle class revenue shortfall
3. Calculate the total shortfall only for vehicles registered at 62,000 or more (the breakeven point under this policy option)
4. Calculate the per-mile revenue shortfall by RGW class for vehicles registered over 62,000 pounds
5. Adjust the per-mile revenue shortfall by RGW class until the total shortfall for vehicles registered over 62,000 pounds equals the shortfall for the entire heavy vehicle class
6. Construct a polynomial regression line that fits the curve calculated by Step 5 (R squared value of .984)
7. Construct the polynomial equation and use it to calculate the proposed weight distance tax rates for each RGW class beginning with the 62,001-64,000 pound RGW class
8. Calculate the weight distance tax revenue from the proposed rates
9. Apply the control total (total heavy vehicle revenue shortfall) to the revenue from the proposed rates and adjust the weight distance tax rates until calculated revenue is equal to the control total.

Using the approach outlined above generated the weight-distance tax schedule presented in Table 11. The weight distance tax rates are presented through 130,000 pounds but were calculated through 152,000 pounds RGW. The maximum weight-distance tax rate was set at 40.82 cents per mile for the 152,000 pound RGW class. The weight-distance tax rate for the 80,000-pound RGW class was set at 13.42 cents per mile to best achieve equity. Table 12 presents the results of Policy Option 5b. Under this policy option, unadjusted equity ratios for each vehicle class fall below 1.0 due to the elimination of the ad-valorem GST and the vehicle sales tax. This policy option is designed to bring the adjusted equity ratios nearer to 1.0. Figure 3 demonstrates the impact of the weight distance tax on equity ratios by comparing equity ratios calculated for the current tax system to those calculated for the system examined in Policy Option 5b. As shown, the weight distance tax system would greatly improve equity for the vehicle classes exceeding 62,000 pounds RGW.

Table 11. Policy Option 5b Weight-Distance Tax Rates by RGW Class

RGW Class	Weight Distance Tax Rate (Cents per Mile)
62,001-64,000	2.61
64,001-66,000	4.06
66,001-68,000	5.48
68,001-70,000	6.87
70,001-72,000	8.23
72,001-74,000	9.57
74,001-76,000	10.88
76,001-78,000	12.16
78,001-80,000	13.42
80,001-82,000	14.65
82,001-84,000	15.86
84,001-86,000	17.03
86,001-88,000	18.18
88,001-90,000	19.31
90,001-92,000	20.40
92,001-94,000	21.47
94,001-96,000	22.51
96,001-98,000	23.53
98,001-100,000	24.52
100,001-102,000	25.48
102,001-104,000	26.42
104,001-106,000	27.33
106,001-108,000	28.21
108,001-110,000	29.06
110,001-112,000	29.89
112,001-114,000	30.69
114,001-116,000	31.47
116,001-118,000	32.21
118,001-120,000	32.94
120,001-122,000	33.63
122,001-124,000	34.30
124,001-126,000	34.94
126,001-128,000	35.55
128,001-130,000	36.14

Table 12. Equity Ratios by Vehicle Class for Current Nevada Highway User Tax System and Policy Option 5b.

Vehicle Class	Current System		Policy Option 5b	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Psgr Veh	2.37	1.57	0.85	1.01
Bus	0.98	0.65	0.44	0.52
SU2	1.16	0.77	0.53	0.62
SU3+	1.09	0.72	0.68	0.81
CB3&4	0.94	0.62	0.81	0.96
CB5	0.49	0.32	0.96	1.14
CB6+	0.46	0.30	0.99	1.17
DS5	0.31	0.21	0.61	0.73
DS6	0.45	0.30	0.95	1.12
DS7+	0.30	0.20	0.85	1.01
TRPL	0.30	0.20	0.88	1.04
Total	1.51	1.00	0.84	1.00

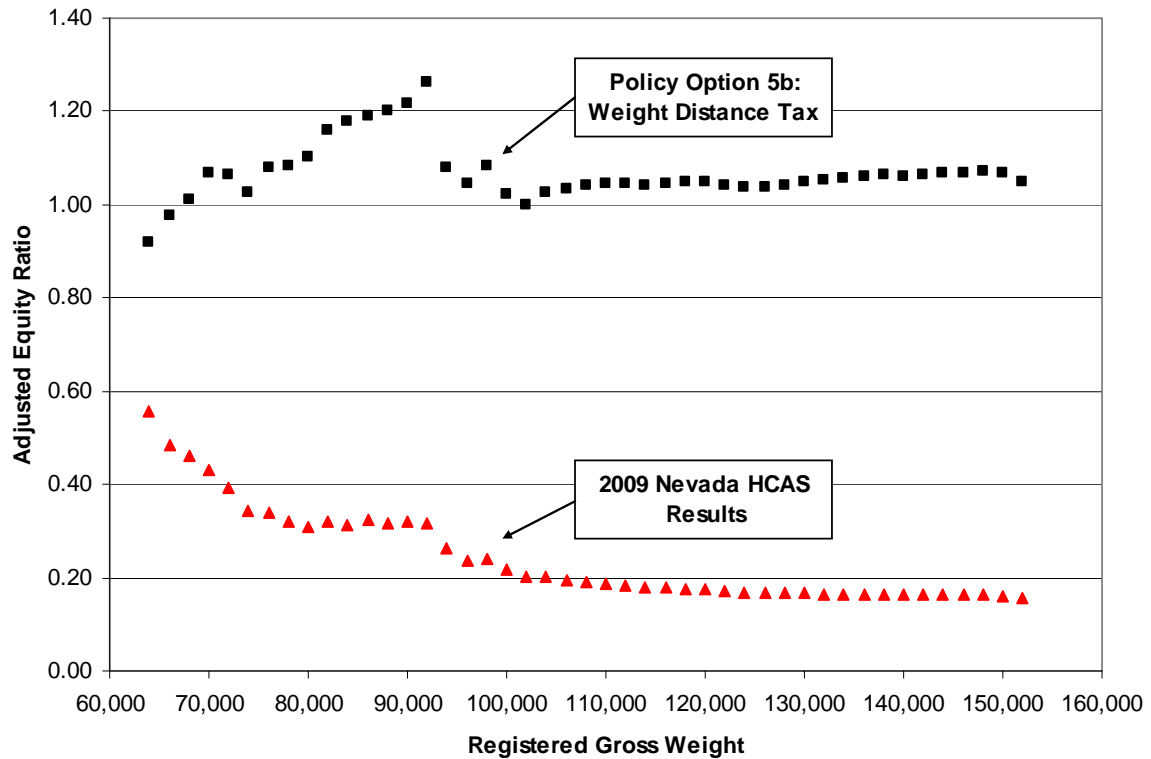


Figure 3. State-Level Adjusted Equity Ratios by Registered Gross Weight Class (2009 Nevada HCAS vs. Policy Option 5b)

2.2.2.3 Policy Option 5c: Eliminate Vehicle Sales, Ad-Valorem, and Motor Fuel Taxes, and Introduce Vehicle Miles of Travel Fee

Policy 5c represents the final step in the aforementioned three-step progression towards a more equitable highway tax system for the State of Nevada. Under Policy Option 5c, which is summarized in Table 13, fixed registration fees are maintained while the ad-valorem, vehicle sales, and motor fuels taxes are eliminated. A VMT fee is implemented in a manner designed to move vehicle and RGW class equity ratios near to 1.0. In Policy Option 5c, eliminating the motor fuel taxes, GST fee, and vehicle sales tax would reduce annual highway user payments by \$1.1 billion during the 2009-2016 timeframe. The VMT fee is forecast to generate \$626.8 million annually from 2009 to 2016. Thus, Policy Option 5c, while improving equity significantly, would reduce tax collections by \$424.2 million annually. This shortfall could be addressed, of course, by increasing the remaining taxes uniformly until the new tax structure reaches revenue neutrality with respect to the existing system.

Table 13. Policy Option 5c Summary.

Component	Change from Existing	Affecting These Vehicles
Registration Fees	No change.	All
Gasoline Tax	Eliminated.	All
Diesel Tax	Eliminated.	All
Vehicle Sales Tax	Eliminated.	All
GST Fee	Eliminated.	All
VMT Fee	Establishes a graduated weight-based VMT fee from 1.2¢ per mile to 54.5¢ per mile.	All
All Other Components	No change.	All

In constructing the VMT fee schedule, the research team modified the nine-step approach highlighted in Section 2.2.2.2 by eliminating gasoline and diesel taxes, focusing on unadjusted equity ratios, and extending the fee to all RGW classes, including passenger vehicles. Table 14 presents the VMT fee schedule constructed for this policy option. The VMT fee for the 0-8,000 pound RGW class is 1.2 cents per mile while the fee for the 80,000 pound RGW vehicle class is 20.9 cents per mile. The VMT fee reaches 54.5 cents per mile for the 152,000 pound RGW class.

Table 15 compares the equity ratios for each vehicle class to those estimated for the VMT fee-based system evaluated in Policy Option 5c. As shown, the system designed under Policy Option 5c is far more equitable than the current system, particularly in the higher weight groups. For example, the unadjusted equity ratio for the DS6 and DS7+ classes grows from 0.45 and 0.30 to 0.98 and 0.91, respectively. Thus, the heaviest vehicle classes are meeting more than 90 percent of their cost responsibility under this policy option. Figure 4 clearly demonstrates the upward shift in equity ratios under Policy Option 5c. Under the current system, the 80,000-pound RGW class is meeting 47 percent of its cost responsibility. Under Policy Option 5c, the 80,000-pound RGW class equity ratio grows to 0.98. The equity ratio for the 0-8000-pound RGW class is 1.02 under Policy Option 5c.

Table 14. Policy Option 5c Vehicle Miles of Travel Fee Rates per Mile.

RGW Class	VMT Fee Rate (Cents per Mile)
0-8,000	1.20
8,001-10,000	4.00
10,001-12,000	5.08
12,001-14,000	5.90
14,001-16,000	6.62
16,001-18,000	7.24
18,001-20,000	7.77
20,001-22,000	8.23
22,001-24,000	8.62
24,001-26,000	8.96
26,001-28,000	9.24
28,001-30,000	9.49
30,001-32,000	9.71
32,001-34,000	9.91
34,001-36,000	10.09
36,001-38,000	10.26
38,001-40,000	10.44
40,001-42,000	10.62
42,001-44,000	10.81
44,001-46,000	11.02
46,001-48,000	11.26
48,001-50,000	11.52
50,001-52,000	11.81
52,001-54,000	12.14
54,001-56,000	12.51
56,001-58,000	12.93
58,001-60,000	13.39
60,001-62,000	13.90
62,001-64,000	14.46
64,001-66,000	15.07
66,001-68,000	15.74
68,001-70,000	16.46
70,001-72,000	17.24
72,001-74,000	18.07
74,001-76,000	18.96
76,001-78,000	19.91
78,001-80,000	20.90
80,001-82,000	21.95

Table 14 (cont). Policy Option 5c Vehicle Miles of Travel Fee Rates per Mile.

RGW Class	VMT Fee Rate (Cents per Mile)
82,001-84,000	23.05
84,001-86,000	24.20
86,001-88,000	25.39
88,001-90,000	26.63
90,001-92,000	27.90
92,001-94,000	29.21
94,001-96,000	30.55
96,001-98,000	31.92
98,001-100,000	33.31
100,001-102,000	34.71
102,001-104,000	36.13
104,001-106,000	37.55
106,001-108,000	38.96
108,001-110,000	40.37
110,001-112,000	41.76
112,001-114,000	43.12
114,001-116,000	44.45
116,001-118,000	45.74
118,001-120,000	46.24
120,001-122,000	47.37
122,001-124,000	48.42
124,001-126,000	49.21
126,001-128,000	49.65
128,001-130,000	50.08
130,001-132,000	50.52
132,001-134,000	50.98
134,001-136,000	51.38
136,001-138,000	51.81
138,001-140,000	52.42
140,001-142,000	52.86
142,001-144,000	53.23
144,001-146,000	53.58
146,001-148,000	53.90
148,001-150,000	54.33
150,001-152,000	54.51

Table 15. Equity Ratios by Vehicle Class for Current Nevada Highway User Tax System and Policy Options 5c.

Vehicle Class	Current System		Policy Option 5c	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Psg. Veh	2.37	1.57	1.02	1.02
Bus	0.98	0.65	0.67	0.67
SU2	1.16	0.77	1.10	1.10
SU3+	1.09	0.72	1.02	1.02
CB3&4	0.94	0.62	1.28	1.28
CB5	0.49	0.32	1.01	1.01
CB6+	0.46	0.30	1.02	1.02
DS5	0.31	0.21	0.65	0.65
DS6	0.45	0.30	0.98	0.98
DS7+	0.30	0.20	0.91	0.91
TRPL	0.30	0.20	0.94	0.94
Total	1.51	1.00	1.00	1.00

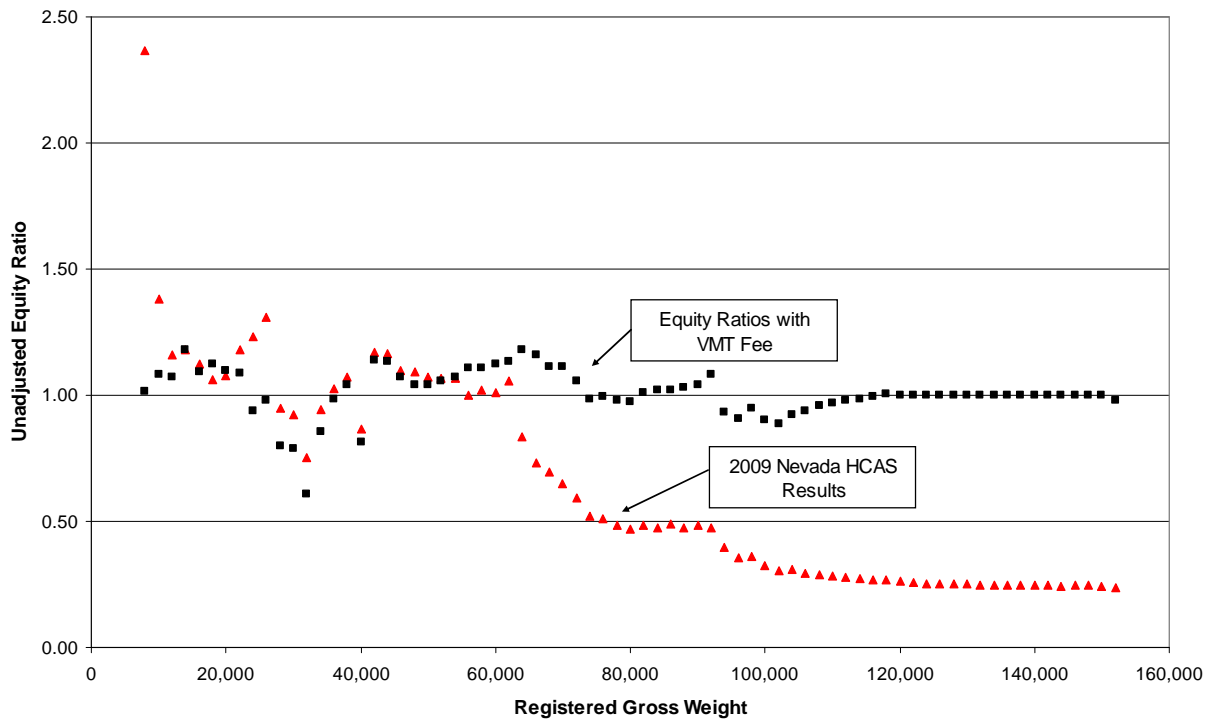


Figure 4. State-Level Unadjusted Equity Ratios by Registered Gross Weight Class (2009 Nevada HCAS vs. Policy Option 5c)

3.0 Conclusions

The 2009 Nevada HCAS revealed considerable inequity in the Nevada highway user tax system. Through the repeal of the weight-distance tax in 1989 and the expanded reliance on the ad-valorem GST fee and vehicle sales tax, neither of which are transferred into the State Highway Fund, the equity gap in the Nevada highway tax structure has grown larger over time. Today, payments from the basic vehicle class exceeds its cost responsibility by 137 percent while payments from the largest truck classes fall as far as 70 percent short of cost responsibility. This analysis examines the impact on equity resulting from rate adjustments made to the existing highway user tax system and alternative systems that include taxes and/or fees not currently imposed in the State of Nevada.

The results of the policy options analyses presented in this report demonstrate that the current tax structure is not well-designed to capture the additional damage caused to Nevada streets and highways by heavier vehicles. That is, the existing rate structure cannot be effectively graduated to reflect the exponential relationship between axle weights and pavement damage. In achieving equity, the focus is both on equity among various vehicle classes (e.g., passenger cars vs. combination truck configurations) and within vehicle classes (e.g., low- vs. high-mileage vehicles). The current tax structure is a fairly blunt tool for implementing equity because it cannot achieve equity both among and within vehicle classes. For example, the diesel tax required to achieve equity would result in significant overpayments from lighter single unit trucks (equity ratios of 1.40-1.63 in unadjusted terms) while the largest vehicle classes would continue to underpay (equity ratios of 0.57-0.83 in unadjusted terms).

The alternative highway user tax systems examined in this report (\$0.12 per mile heavy vehicle registration fee, weight-distance tax, and VMT fee) would greatly improve equity in Nevada's highway user tax structure. If combined with the repeal of the ad-valorem GST fee and vehicle sales tax, weight distance tax and VMT fee rates could be set to fully achieve equity both among and within vehicle classes. While these new tax systems would greatly improve equity, it is important to note that this analysis does not examine other important tax criteria such as revenue adequacy, political feasibility, evasion, avoidance, administrative/compliance costs, or economic efficiency. These other criteria should also be considered prior to implementing a new highway user tax or fee system, such as those developed under Policy Option 5.

4.0 References

Balducci, P., J. Stowers, R. Mingo, H. Cohen, and H. Wolff, *2009 Nevada Highway Cost Allocation Study*, Prepared for the Nevada Department of Transportation, Carson City, Nevada, March 2009.

2009 Nevada Highway Cost Allocation Study

SENSITIVITY ANALYSES REPORT

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Prepared for
Nevada Department of Transportation
Carson City, Nevada

June 15, 2009



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2009 Nevada Highway Cost Allocation Study

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Acronyms and Abbreviations

DMV	Department of Motor Vehicles
DOT	Department of Transportation
DPS	Department of Public Safety
FHWA	Federal Highway Administration
GST	Governmental Services Tax
HCAS	Highway Cost Allocation Study
HPMS	Highway Performance Monitoring System
NAPCOM	National Pavement Cost Model
NDOT	Nevada Department of Transportation
NMTA	Nevada Motor Transport Association
PCE	Passenger Car Equivalent
RGW	Registered Gross Weight
TIUS	Truck Inventory and Use Survey
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle Miles of Travel
WIM	Weigh in Motion

Glossary

Ad Valorem Tax. A tax based on the assessed value of real or personal property.

Cost Allocation. The analytical process of determining the cost responsibility of highway system users.

Cost Responsibility. The principle that those who use the public roads should pay for them and, more specifically, that payments from road users should be in proportion to the road costs for which they are responsible. The proportionate share of highway costs legitimately assignable to a given vehicle class or user group.

Equity. Generally interpreted as the state of being just, impartial, or fair. Horizontal equity refers to the fair treatment of individuals with similar circumstances. Vertical equity refers to the fair treatment of individuals in different circumstances.

Equity Ratio. The ratio of the share of revenues paid by a highway user group to the share of costs imposed by that group. A user group that meets 110 percent of its cost responsibility would be assigned an equity ratio of 1.1. Equity ratios above 1.0 are assigned to user groups who are paying more than their cost-responsible share while payments from user groups assigned equity ratios of less than 1.0 fall short of the costs imposed by the group.

Gross Vehicle Weight. The loaded weight for a vehicle.

Highway Cost Allocation Study. A study that estimates and compares the costs imposed and the revenues paid by different classes of vehicles over some time period.

Highway Performance Monitoring System. FHWA collects and reports data about a sample of road segments in every state in a common format.

Highway User. A person responsible for the operation of a motor vehicle in use on highways, roads, and streets. In the case of passenger vehicles, the users are the people in the vehicles. In the case of goods-transporting trucks, the user is the entity transporting the goods.

Incremental Cost. The additional costs associated with building a facility to handle an additional, heavier (or larger) class of vehicle.

Light (or Basic) Vehicles. The lightest vehicle class, usually including passenger cars, vans, and pickups.

Registered Weight. The weight that determines the registration fee paid by a single-unit truck or a tractor. For a tractor, it is the highest weight at which the vehicle may operate.

Revenue Attribution. The process of associating revenue amounts with the classes of vehicles that produce the revenues.

Truck. A general term denoting a motor vehicle designed for the transportation of goods. The term includes single-unit trucks and truck combinations.

User Charge. A fee, tax, or charge that is imposed on facility users as a condition of usage.

User Revenues. Highway revenues raised through the imposition of user charges or fees.

Vehicle Class. Any grouping of vehicles having similar characteristics for cost allocation, taxation, or other purposes. The number of vehicle classes used in a cost allocation study will depend on the needs, purpose, and resources of the study. Potential distinguishing characteristics include weight, size, number of axles, type of fuel, time of operation, and place of operation.

Vehicle Miles of Travel. The sum of the number of miles each vehicle travels within a time period.

Vehicle Registration Fees. Fees charged for being allowed to operate a vehicle on public roads.

Weight-Distance Tax. A graduated fee based on the weight of a vehicle and the miles it travels.

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1.0 Introduction

This report summarizes a series of sensitivity analyses performed to evaluate the degree of confidence in the findings of the 2009 Nevada Highway Cost Allocation Study (HCAS). More specifically, this report evaluates the extent to which the specific quantitative equity assessments reported in the 2009 Nevada HCAS Final Report might be expected to change under a set of plausible changes in the HCAS model inputs or changes in the default data that are internal to the model.

This analysis is the first time this state HCAS model and its application have been subjected to such a broad evaluation of this type. Thus, this work is potentially of significant value to other states that will use it in the future.

In the Summary and Conclusions section at the end of this report we attempt to show the approximate upper and lower confidence limits of the adjusted equity ratios for each vehicle configuration and registered gross weight (RGW) class based on all of the sensitivity analyses. That section has been written so that it, combined with this Introduction, provides a summary for the reader interested in a quick overview.

Perhaps the most important phase of this work was the first one when an agreement was reached between the Nevada Department of Transportation (NDOT) and the study team's consultant leaders on a preliminary set of criteria and a resulting list of specific sensitivity analyses to be performed.

The criteria agreed on were:

- Evaluation of how input data changes might affect the results
- Evaluation of how changes in the choices of important cost allocation factors might change study results
- Evaluation of how the results might possibly be affected by weaknesses in the model itself

The findings of this analysis are expressed in terms of equity ratios. The equity ratio compares the highway user revenues paid by a group to the cost responsibility imposed by that group. Cost responsibility in the 2009 Nevada HCAS represents the share of highway expenditures and preservation backlog costs for which each vehicle class is responsible. See Section 3.1 of the 2009 Nevada HCAS Final Report for a more thorough discussion of cost allocation procedures (Balducci et al. 2009). Equity ratios above 1.0 show that the user groups are paying more than their cost responsibility while payments from user groups with equity ratios of less than 1.0 fall short of paying for the costs imposed by the group.

An adjusted equity ratio is the share of revenues paid divided by the share of cost responsibility. The adjusted equity ratio accounts for differences between total revenues attributed and total costs allocated to all vehicle classes. If highway user payments exceed total cost responsibility, the unadjusted equity ratios for each vehicle class are adjusted downward so that total shares of allocated costs equal total shares of revenues and the overall adjusted equity ratio for all users equals 1.0. For example, if total highway user revenues exceeded total cost responsibilities by 50 percent, each unadjusted equity ratio would be divided by 1.5 to get the adjusted equity ratio. This procedure is necessary for examining equity in tax structures

with highway user revenues collected for non-road purposes, as is done in Nevada with the vehicle sales tax and ad-valorem governmental service tax (GST), or when non-user sources (e.g., general fund revenues) are used to pay for part of the highway program.

The equity findings for the examined sensitivity analyses are presented by vehicle and RGW class. The 12 vehicle configurations established by the Highway Performance Monitoring System (HPMS) were contracted into 11 classes by combining four-wheel light trucks with passenger cars and combining single-unit three axle and single-unit four or more axle vehicles together into a single vehicle class. For this study, an 11th vehicle configuration was added: tractor-triple semitrailer (triples) were separated from the rest of the vehicle configuration class in which they were classified in the database (i.e., truck double semitrailer combinations with seven or more axles). Vehicle classes are further differentiated in the Federal Highway Administration (FHWA) State HCAS Model, which was used to support the calculations presented in this report, based on RGW in 2000-pound increments above 8,000 pounds. The vehicle classes examined in this report are presented in Table 1.1.

Table 1.1. 2009 Nevada HCAS Vehicle Types

Vehicle Class	Acronym	Description
1	Auto	Automobiles, vans, light trucks with 2-axles and 4 tires and motorcycles
2	Bus	Buses (all larger types)
3	SU2	Single unit 2-axle, 6-tire trucks
4	SU3+	Single unit trucks with 3 or more axles
5	CB3&4	Combination trucks with 3 or 4 axles
6	CB5	Combination trucks with 5 axles
7	CB6+	Combination trucks with 6 or more axles
8	DS5	Tractor-double semitrailer combinations with 5 axles
9	DS6	Tractor-double semitrailer combinations with 6 axles
10	DS7+	Tractor-double semitrailer combinations with 7 or more axles
11	TRPL	Tractor-triple semitrailer

2.0 List of Sensitivity Analysis Options

The criteria outlined in Section 1.0 led to a draft list of sensitivity analyses, which went through several iterations of refinement as a result of review and suggestions by the study team and NDOT. The list was further refined based on the learning process we went through in performing the several sensitivity analyses.

The final list, as actually performed, is as follows:

1. Refine miles per gallon (MPG) estimates by RGW class based on updated 2002 vehicle inventory and use survey (VIUS) estimates and evaluate effects of possible future significant improvements in fuel efficiency for each major vehicle class (USCB 2004).
2. Exclude from the revenue attribution process all those highway user revenues used to fund general fund programs.
3. Make a set of changes in the selection of allocators for all those expenditures for which the choice of allocator used in the final report could arguably have been made more unfavorable for heavy vehicles (suboption A), and make another set of changes that are favorable for heavy vehicles (suboption B).
4. Increase miles per year by ten percent for light vehicles (suboption A), and increase heavy vehicle miles per year by ten percent (suboption B).
5. Increase vehicle miles of travel (VMT) by five percent on higher functional classes for single unit trucks and decrease the VMT by an equal amount on lower functional classes, so that total single unit truck VMT remains unchanged.
6. Increase the operating weights for single unit trucks by ten percent by shifting the distribution of weights upward.
7. Decrease the average RGW by five percent for single unit trucks (suboption A), and increase their average RGW distribution by five percent (suboption B).

3.0 Report on Each of the Seven Sensitivity Analysis Options

Results of each of the seven sensitivity analysis evaluations are presented in a separate pair of tables in the following pages, along with explanatory text. In each pair of these tables, comparison is made with the adjusted equity ratios shown in the 2009 Nevada HCAS Final Report.

Tables 3.1 and 3.2 on the following page provide a summary of the results of the Nevada HCAS presented in the Final Report. These two tables show results broken down by vehicle configuration and summary RGW categories. Note that Table 3.2 also provides a set of summary results for light vehicles (i.e., up to 8,000 pounds RGW) and heavy vehicles (i.e., over 8,000 pounds RGW).

A portion of the 2009 Nevada HCAS Final Report results shown in Tables 3.1 and 3.2 are repeated in similar formats for each of the pairs of tables for the seven sensitivity analyses as a basis for comparison of results. In general, for each sensitivity analysis option, inputs were changed as far in each direction as the research team thought was reasonably plausible to do so. As an example, in evaluating the impacts of possible improvements in fuel efficiency for each major class of vehicle in Sensitivity Analysis 1, the research team chose 10 percent based on the judgment that this is about as far as improvements in MPG are likely to be pushed for the average of the fleet for a major vehicle class within the time frame of this study (mid-point of 2012-2013).

Table 3.1. Summary Results by Vehicle Class Used in Final Report

Vehicle Configuration	Vehicle Miles (Millions)	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost Responsibility Ratios		Cost Per Mile (Cents)	Revenue Per Mile (Cents)
				Unadjusted	Adjusted		
Passenger Vehicle	23,699	1,018,537	430,343	2.37	1.57	1.82	4.30
Bus	122	22,447	22,821	0.98	0.65	18.75	18.44
SU2	570	48,563	41,960	1.16	0.77	7.36	8.52
SU3+	123	22,036	20,165	1.09	0.72	16.38	17.90
CS3&4	105	11,730	12,481	0.94	0.62	11.86	11.14
CS5	950	107,015	219,869	0.49	0.32	23.15	11.27
CS6+	27	3,370	7,383	0.46	0.30	27.53	12.56
DS5	67	7,555	24,208	0.31	0.21	36.03	11.24
DS6	24	2,974	6,610	0.45	0.30	27.42	12.34
DS7+	68	8,704	29,492	0.30	0.20	43.45	12.82
Trp	46	5,859	19,267	0.30	0.20	42.17	12.82
Total	25,800	1,258,789	834,599	1.51	1.00	3.23	4.88

Table 3.2. Summary Results by Registered Weight Used in Final Report

Registered Gross Weight Class		Vehicle Miles (Millions)	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Cost Per Mile (Cents)	Revenue Per Mile (Cents)
From	To				Unadjusted	Adjusted		
0	8,000	23,636	1,015,319	429,150	2.37	1.57	1.82	4.30
8,001	16,000	441	30,112	24,562	1.23	0.81	5.56	6.82
16,001	26,000	221	29,532	24,496	1.21	0.80	11.10	13.39
26,001	40,000	126	19,130	20,515	0.93	0.62	16.28	15.18
40,001	55,000	132	20,961	19,201	1.09	0.72	14.58	15.92
55,001	75,000	73	9,360	11,951	0.78	0.52	16.27	12.74
75,001	80,000	1,020	114,863	245,314	0.47	0.31	24.05	11.26
80,001	90,000	28	3,568	7,445	0.48	0.32	27.05	12.96
90,001	100,000	20	2,733	7,357	0.37	0.25	36.46	13.54
100,001	105,500	103	13,170	44,450	0.30	0.20	43.04	12.75
105,501	150,000	0	41	158	0.26	0.17	50.37	13.10
Total Heavy Vehicles		2,164	243,470	405,448	0.60	0.40	18.73	11.25
Total		25,800	1,258,789	834,599	1.51	1.00	3.23	4.88

3.1 Sensitivity Analysis 1

Sensitivity Analysis 1 refines MPG estimates by RGW class based on updated 2002 VIUS estimates and evaluates effects of plausible significant improvements in fuel efficiency for each major vehicle class. This evaluation has been done in two parts: (a) an update of the default data for Nevada on estimated fuel economy (MPG) based on the VIUS last conducted by the U.S. Census Bureau in 2002, and (b) incorporation of reasonable foreseeable improvements in fuel economy for each major vehicle class: (1) light vehicles, predominantly autos, pickups, and light vans, (2) single unit trucks, and (3) combination trucks.

The first part of this evaluation was necessary because the default data in the FHWA State HCAS model used to support the 2009 Nevada HCAS was based on an old set of data – the Truck Inventory and Use Survey (TIUS) conducted by the U.S. Census Bureau in 1992. Due to concern over the errors that might have been introduced by use of this data, the model was updated soon after completion of the final Nevada HCAS report. The second part of this evaluation was desired due to the uncertainty of how future fuel prices, fuel economy regulations, and responses of the market might affect the fuel economy of each major vehicle class.

Tables 3.3 and 3.4 on the following pages present the results of Sensitivity Analysis 1. Note that the last four columns of these tables show that the adjusted equity ratios change very little (0.01 or less) for each vehicle configuration and RGW class for the update of MPG based on the 2002 VIUS.

Somewhat greater effects would be caused by future 10 percent increases in MPG. However, the largest changes are still very modest, the largest being -0.04 for three or more axle single unit trucks and -0.03 for two axle single unit trucks. Table 3-4 shows a change of -0.03 for single unit trucks in the 8,001 to 16,000 pound RGW range and the 40,001 to 55,000 pound range. Only one other cell in these two tables shows a change of -0.02 – again, for single unit trucks.¹

¹ Note that all values in these and other tables in this report are rounded, as are the differences between values reported in the text throughout the report. Therefore, differences between values reported may not agree with differences calculated between the rounded off values presented in the tables.

Table 3.3. Summary Results by Vehicle Class for Sensitivity Analysis 1

Vehicle Configuration	Final Report Results				Adjusted Equity Ratios for Sensitivity Analysis 1			
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Updated MPGs	Increase in MPG from Final Report MPGs For Selected Vehicle Classes		
			Unadjusted	Adjusted		Autos only	SUs only	Combs only
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.57	1.57	1.57	1.57
Bus	22,447	22,821	0.98	0.65	0.65	0.66	0.66	0.66
SU2	48,563	41,960	1.16	0.77	0.76	0.78	0.74	0.78
SU3+	22,036	20,165	1.09	0.72	0.72	0.73	0.69	0.74
CS3&4	11,730	12,481	0.94	0.62	0.62	0.63	0.63	0.62
CS5	107,015	219,869	0.49	0.32	0.32	0.32	0.33	0.32
CS6+	3,370	7,383	0.46	0.30	0.31	0.30	0.31	0.30
DS5	7,555	24,208	0.31	0.21	0.21	0.21	0.21	0.20
DS6	2,974	6,610	0.45	0.30	0.30	0.30	0.30	0.29
DS7+	8,704	29,492	0.30	0.20	0.20	0.20	0.20	0.19
Trp	5,859	19,267	0.30	0.20	0.21	0.20	0.20	0.20
Total	1,258,789	834,599	1.51	1.00	1.00	1.00	1.00	1.00

Table 3.4. Summary Results by Registered Weight for Sensitivity Analysis 1

Final Report Results						Adjusted Equity Ratios for Sensitivity Analysis 1			
Registered Gross Weight Class		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Updated MPGs	Increase in MPG from Final Report MPGs For Selected Vehicle Classes		
From	To			Unadjusted	Adjusted		Autos only	SUs only	Combs only
0	8,000	1,015,319	429,150	2.37	1.57	1.57	1.57	1.57	1.57
8,001	16,000	30,112	24,562	1.23	0.81	0.81	0.82	0.79	0.82
16,001	26,000	29,532	24,496	1.21	0.80	0.80	0.81	0.78	0.81
26,001	40,000	19,130	20,515	0.93	0.62	0.61	0.62	0.61	0.63
40,001	55,000	20,961	19,201	1.09	0.72	0.72	0.73	0.70	0.74
55,001	75,000	9,360	11,951	0.78	0.52	0.51	0.52	0.51	0.52
75,001	80,000	114,863	245,314	0.47	0.31	0.31	0.31	0.31	0.31
80,001	90,000	3,568	7,445	0.48	0.32	0.32	0.32	0.32	0.31
90,001	100,000	2,733	7,357	0.37	0.25	0.26	0.25	0.25	0.24
100,001	105,500	13,170	44,450	0.30	0.20	0.21	0.20	0.20	0.19
105,501	150,000	41	158	0.26	0.17	0.18	0.17	0.17	0.17
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.40	0.40	0.40	0.40
Total		1,258,789	834,599	1.51	1.00	1.00	1.00	1.00	1.00

3.2 Sensitivity Analysis 2

Sensitivity Analysis 2 excludes from the revenue attribution process all those highway user revenues used to fund general fund programs. This evaluation differs from all the others. It has been included because of a question raised by the Nevada Motor Transport Association (NMTA), not because of any concern about the HCAS model or the quality of the data.

NMTA questions the inclusion in the study of highway user payments that are not used explicitly for highway purposes. Equity is defined to be an assessment of how much each highway user group pays for the use of highways (regardless of how the funds are used) compared to how much each highway user group should be paying for use of highways (regardless of where the funds come from).

Removing highway user payments diverted to the general fund results in the reduction of vehicle sales tax revenue attributed to highway users from \$461.2 million to \$0.4 million. The remaining sales tax revenue attributed to users represents only 2.0 percent of sales tax revenue collected by the Nevada Department of Motor Vehicles (DMV). For the basic GST, the Nevada DMV keeps roughly 6 percent of total collections to fund DMV costs of administering this tax program. The 6 percent DMV hold-back is equal to \$16.3 million. The 2009 Nevada HCAS attributes \$270.9 million in GST revenue. Tables 3.5 and 3.6 on the next page show the impact of removing funds not used for highway purposes from the revenue attribution process.

Note that the adjusted equity ratios in this evaluation would be lower for light vehicles by 0.21, reducing their overpayment by about one-third. On the heavy vehicle side, the most impacted classes would be the largest single unit truck class (SU3+), the smallest combination trucks (CS3&4) and trucks registered in the 40,001 to 55,000 and 55,001 to 75,000 pound range (+0.33, +0.37, and +0.36, respectively). The impact of Sensitivity Analysis 2 causes their current substantial underpayments to be nearly eliminated (i.e., increased from 0.72, 0.62, 0.72, and 0.52 to 1.06, 1.05, 1.09, and 0.88 respectively). More modest improvements in equity (varying from +0.01 to +0.27) would occur for other classes of heavy vehicles.

As a practical matter, the only simple way these equity improvements could be achieved is if either (a) user taxes on light vehicles were substantially reduced, or (b) user taxes on heavy vehicles were substantially increased, (c) some combination of (a) and (b) that would be more revenue neutral, or (d) those user taxes not used for state highway purposes were repealed.

Table 3.5. Summary Results by Vehicle Class for Sensitivity Analysis 2

Vehicle Configuration	Final Report Results				Adj. Equity Ratios for Sens. Anal. 2 - Omit User Rev. Used for Non-Hwy. Purposes
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		
			Unadjusted	Adjusted	
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.36
Bus	22,447	22,821	0.98	0.65	0.69
SU2	48,563	41,960	1.16	0.77	0.84
SU3+	22,036	20,165	1.09	0.72	1.06
CS3&4	11,730	12,481	0.94	0.62	1.05
CS5	107,015	219,869	0.49	0.32	0.59
CS6+	3,370	7,383	0.46	0.30	0.54
DS5	7,555	24,208	0.31	0.21	0.38
DS6	2,974	6,610	0.45	0.30	0.53
DS7+	8,704	29,492	0.30	0.20	0.35
Trp	5,859	19,267	0.30	0.20	0.36
Total	1,258,789	834,599	1.51	1.00	1.00

Table 3.6. Summary Results by Registered Weight for Sensitivity Analysis 2

Registered Gross Weight Class		Final Report Results				Adj. Equity Ratios for Sens. Anal. 2 - Omit User Rev. Used for Non-Hwy. Purposes
		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		
				Unadjusted	Adjusted	
From	To					
0	8,000	1,015,319	429,150	2.37	1.57	1.36
8,001	16,000	30,112	24,562	1.23	0.81	0.82
16,001	26,000	29,532	24,496	1.21	0.80	0.87
26,001	40,000	19,130	20,515	0.93	0.62	0.79
40,001	55,000	20,961	19,201	1.09	0.72	1.09
55,001	75,000	9,360	11,951	0.78	0.52	0.88
75,001	80,000	114,863	245,314	0.47	0.31	0.57
80,001	90,000	3,568	7,445	0.48	0.32	0.56
90,001	100,000	2,733	7,357	0.37	0.25	0.43
100,001	105,500	13,170	44,450	0.30	0.20	0.35
105,501	150,000	41	158	0.26	0.17	0.30
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.62
Total		1,258,789	834,599	1.51	1.00	1.00

3.3 Sensitivity Analysis 3

In Sensitivity Analysis 3, the research team made a set of changes in the selection of allocators for all those expenditures for which the choice of allocator used in the final report could arguably have been made more unfavorable for heavy vehicles (suboption A), and made another set of changes that are favorable for heavy vehicles (suboption B).

This evaluation involves changes in the allocators used for the 2009 Nevada HCAS Final Report, which arguably could have been done differently. For the basic HCAS covered by the final report, the research team chose what was judged to be the most equitable set of allocators without bias favoring any of the major categories of highway users. However, having limited knowledge of all the construction projects and all the practices involved in NDOT's, DMV's, and the Nevada Department of Public Safety's (DPS's) programs, the research team had to rely on information made available to it and judgment based on experience in other states and limited previous experience in Nevada.

The most important example of this is the choice of allocators used for "residual" or "common" costs – i.e., those costs that cannot be directly related in a cause and effect manner to such vehicle characteristics as operating weights, vehicle lengths, number of axles, and widths. The most important and frequently used allocators for these common costs are (a) VMT for construction projects in which congestion relief is not a primary factor in the investment decision, and (b) the product of Passenger Car Equivalencies (the accepted measure of each vehicle configuration's contribution to congestion) for each class of vehicle and VMT, abbreviated as "PCE-miles," for construction projects in which congestion relief is a primary factor in the investment decision.

In the work done for the 2009 Nevada HCAS Final Report, the research team chose to use PCE-miles as a primary allocator for common costs and "general" costs for new construction costs on principal arterials in urban areas and VMT for new construction projects in rural areas and on all lower urban functional classes of highways and streets.

In the sensitivity analysis favoring light vehicles, PCE-miles are used to allocate common and general costs for all new construction projects regardless of functional class of highway. In the sensitivity analysis favoring heavy vehicles, VMT is used instead of PCE-miles for all of these costs. Other changes involved the use of different allocators for DMV costs and the use of different measures of the impacts of axle weights on pavements.

The results of these two evaluations are summarized in Tables 3.7 and 3.8 on the following page. The last two columns of these tables show that the shift of allocators toward those favoring light vehicles would increase their overall equity ratio from 1.57 to 1.75, and the shift of allocators toward those favoring heavy vehicles would increase their overall equity ratio from 0.40 to 0.43.

Table 3.7. Summary Results by Vehicle Class for Sensitivity Analysis 3

Vehicle Configuration	Final Report Results				Adjusted Equity Ratios with Changes in Allocators	
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Favoring Light Vehicles	Favoring Heavy Vehicles
			Unadjusted	Adjusted		
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.75	1.47
Bus	22,447	22,821	0.98	0.65	0.60	0.68
SU2	48,563	41,960	1.16	0.77	0.65	0.79
SU3+	22,036	20,165	1.09	0.72	0.66	0.77
CS3&4	11,730	12,481	0.94	0.62	0.55	0.65
CS5	107,015	219,869	0.49	0.32	0.29	0.36
CS6+	3,370	7,383	0.46	0.30	0.27	0.33
DS5	7,555	24,208	0.31	0.21	0.19	0.22
DS6	2,974	6,610	0.45	0.30	0.27	0.32
DS7+	8,704	29,492	0.30	0.20	0.18	0.21
Trp	5,859	19,267	0.30	0.20	0.18	0.22
Total	1,258,789	834,599	1.51	1.00	1.00	1.00

Table 3.8. Summary Results by Registered Weight for Sensitivity Analysis 3

Registered Gross Weight Class		Final Report Results				Adjusted Equity Ratios with Changes in Allocators	
		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Favoring Light Vehicles	Favoring Heavy Vehicles
From	To			Unadjusted	Adjusted		
0	8,000	1,015,319	429,150	2.37	1.57	1.75	1.47
8,001	16,000	30,112	24,562	1.23	0.81	0.69	0.82
16,001	26,000	29,532	24,496	1.21	0.80	0.70	0.83
26,001	40,000	19,130	20,515	0.93	0.62	0.56	0.65
40,001	55,000	20,961	19,201	1.09	0.72	0.65	0.76
55,001	75,000	9,360	11,951	0.78	0.52	0.47	0.55
75,001	80,000	114,863	245,314	0.47	0.31	0.28	0.34
80,001	90,000	3,568	7,445	0.48	0.32	0.29	0.35
90,001	100,000	2,733	7,357	0.37	0.25	0.22	0.27
100,001	105,500	13,170	44,450	0.30	0.20	0.18	0.21
105,501	150,000	41	158	0.26	0.17	0.16	0.19
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.36	0.43
Total		1,258,789	834,599	1.51	1.00	1.00	1.00

3.4 Sensitivity Analysis 4

Sensitivity Analysis 4 increases miles per year by ten percent for light vehicles (suboption A), and increases heavy vehicle miles per year by ten percent (suboption B). This evaluation involved increasing the average annual miles per vehicle by 10 percent each for auto and other light vehicles, and in a separate model run, increasing the average annual miles per heavy vehicle by 10 percent.

The reason for performing this evaluation is that (a) the miles per year factor is based on data that are difficult to estimate and are performed by the U.S. Census on a nationwide basis for each state, and (b) miles per year is a factor that affects both the estimates of user payments and cost responsibility in fairly complex ways in the HCAS model, thus causing significant uncertainty about the effects of these changes.

Tables 3.9 and 3.10 on the following page present the results of these evaluations. Note that the last two columns of these tables show that there is little impact of these rather significant changes in annual miles per year. Auto and other light vehicles have an equity ratio decreasing from 1.57 to 1.56 and the same occurs for all heavy vehicles as a whole – i.e., from 0.40 to 0.39. More significant but still modest changes occur for 2 axle single unit trucks (by +0.05 and –0.05 for the two sets of the evaluation) and for heavy vehicles in the 8,001 to 16,000 and 16,001 to 26,000 pound RGW ranges (by +0.05 each for the light vehicle increase in annual miles, and by -0.04 and –0.03 respectively for the heavy vehicle increase in annual miles).

Table 3.9. Summary Results by Vehicle Class for Sensitivity Analysis 4

Vehicle Configuration	Final Report Results				Adj. Equity Ratios for Sens. Anal. 4 - Increase in Annual Miles for Selected Vehicle Classes	
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Autos only	SUs & Combs
			Unadjusted	Adjusted		
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.56	1.58
Bus	22,447	22,821	0.98	0.65	0.69	0.66
SU2	48,563	41,960	1.16	0.77	0.82	0.72
SU3+	22,036	20,165	1.09	0.72	0.74	0.70
CS3&4	11,730	12,481	0.94	0.62	0.64	0.61
CS5	107,015	219,869	0.49	0.32	0.33	0.32
CS6+	3,370	7,383	0.46	0.30	0.31	0.30
DS5	7,555	24,208	0.31	0.21	0.21	0.20
DS6	2,974	6,610	0.45	0.30	0.30	0.29
DS7+	8,704	29,492	0.30	0.20	0.20	0.19
Trp	5,859	19,267	0.30	0.20	0.21	0.20
Total	1,258,789	834,599	1.51	1.00	1.00	1.00

Table 3.10. Summary Results by Registered Weight for Sensitivity Analysis 4

Registered Gross Weight Class		Final Report Results				Adj. Equity Ratios for Sens. Anal. 4 - Increase in Annual Miles For Selected Vehicle Classes	
		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Autos only	SUs & Combs
From	To			Unadjusted	Adjusted		
0	8,000	1,015,319	429,150	2.37	1.57	1.56	1.58
8,001	16,000	30,112	24,562	1.23	0.81	0.86	0.77
16,001	26,000	29,532	24,496	1.21	0.80	0.85	0.77
26,001	40,000	19,130	20,515	0.93	0.62	0.64	0.62
40,001	55,000	20,961	19,201	1.09	0.72	0.74	0.70
55,001	75,000	9,360	11,951	0.78	0.52	0.53	0.51
75,001	80,000	114,863	245,314	0.47	0.31	0.32	0.31
80,001	90,000	3,568	7,445	0.48	0.32	0.32	0.31
90,001	100,000	2,733	7,357	0.37	0.25	0.25	0.24
100,001	105,500	13,170	44,450	0.30	0.20	0.20	0.19
105,501	150,000	41	158	0.26	0.17	0.18	0.17
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.41	0.39
Total		1,258,789	834,599	1.51	1.00	1.00	1.00

3.5 Sensitivity Analysis 5

Sensitivity Analysis 5 increases VMT by five percent on higher functional classes for single unit trucks and decreases the VMT by an equal amount on lower functional classes, so that total single unit truck VMT remains unchanged.

This evaluation is important because there is wide recognition that many operators of single unit trucks, who tend to operate locally, are well aware of the location of all local weigh stations and even local temporary portable weigh-in-motion (WIM) locations. Thus, their observed VMT on higher functional classes of highway may be significantly lower than actual, particularly for those single unit trucks operating near or above their weight limits.

This evaluation involved increasing the VMT for single unit trucks by 5 percent on higher functional classes and shifting an equivalent amount of single unit VMT from lower functional classes, on the assumption that the model is able to make good estimates of overall single unit VMT, as seems to be confirmed by other sensitivity analyses.

Tables 3.11 and 3.12 present the results of this evaluation on the next page. Note the very low impacts of this change. Clearly this phenomenon of single unit trucks avoiding weigh stations, even if it actually occurs to a significant extent, is not a substantial factor affecting the Nevada HCAS results.

Table 3.11. Summary Results by Vehicle Class for Sensitivity Analysis 5

Vehicle Configuration	Final Report Results				Adj. Equity Ratios for Sens. Anal. 5 - Shift SU VMT to Higher Level Functional Classes
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		
			Unadjusted	Adjusted	
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.57
Bus	22,447	22,821	0.98	0.65	0.66
SU2	48,563	41,960	1.16	0.77	0.75
SU3+	22,036	20,165	1.09	0.72	0.70
CS3&4	11,730	12,481	0.94	0.62	0.63
CS5	107,015	219,869	0.49	0.32	0.32
CS6+	3,370	7,383	0.46	0.30	0.30
DS5	7,555	24,208	0.31	0.21	0.21
DS6	2,974	6,610	0.45	0.30	0.30
DS7+	8,704	29,492	0.30	0.20	0.20
Trp	5,859	19,267	0.30	0.20	0.20
Total	1,258,789	834,599	1.51	1.00	1.00

Table 3.12. Summary Results by Registered Weight for Sensitivity Analysis 5

Registered Gross Weight Class		Final Report Results				Adj. Equity Ratios for Sens. Anal. 5 - Shift SU VMT To Higher Level Functional Classes
		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		
				Unadjusted	Adjusted	
From	To					
0	8,000	1,015,319	429,150	2.37	1.57	1.57
8,001	16,000	30,112	24,562	1.23	0.81	0.80
16,001	26,000	29,532	24,496	1.21	0.80	0.78
26,001	40,000	19,130	20,515	0.93	0.62	0.62
40,001	55,000	20,961	19,201	1.09	0.72	0.71
55,001	75,000	9,360	11,951	0.78	0.52	0.52
75,001	80,000	114,863	245,314	0.47	0.31	0.31
80,001	90,000	3,568	7,445	0.48	0.32	0.32
90,001	100,000	2,733	7,357	0.37	0.25	0.25
100,001	105,500	13,170	44,450	0.30	0.20	0.20
105,501	150,000	41	158	0.26	0.17	0.17
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.40
Total		1,258,789	834,599	1.51	1.00	1.00

3.6 Sensitivity Analysis 6

Sensitivity Analysis 6 increases the operating weights for single unit trucks by ten percent by shifting the distribution of weights upward. This evaluation increases the operating weights of single unit trucks by 10 percent at the top half of the percentage distribution for each of the two single unit configurations (SU2 and SU3+). In order to normalize each of their weight distributions so that they each add to 100 percent, the research team subtracted 5 percent from the bottom half of each distribution and forced closure on the totals adding to 100 percent by compromising between –5 percent and +10 percent for a few cells in the middle range of operating weights.

The reason for focusing on single unit trucks in this evaluation is related to the observation made in the description of Sensitivity Analysis 5. Owners of single unit trucks tend to operate on a local basis to a larger extent than owners of combination trucks in general, and therefore they tend to know where the weigh stations are located on main highways and generally know how they operate, including use of portable scales at varying locations.

Thus, single unit trucks may not only travel more miles on higher functional classifications of highways than what is measured at WIM weigh stations, but they also may tend to operate more often at higher operating weights than measured at the weigh stations.

Tables 3.13 and 3.14 present a summary of the results of this evaluation on the next page. Consistent with the findings for Sensitivity Analysis 5, the data in the last two columns of these tables show that the increases in operating weights described above result in very little change in the equity ratios – decreasing from 0.77 to 0.75 for SU2s and from 0.72 to 0.70 for SU3+s. Comparable decreases are shown in the common RGW ranges of from 8,001 to 55,000 pounds for these types of trucks.

Table 3.13. Summary Results by Vehicle Class for Sensitivity Analysis 6

Vehicle Configuration	Final Report Results				Adj. Equity Ratios for Sens. Anal. 6 - Increase SU's Operating. Weight
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		
			Unadjusted	Adjusted	
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.57
Bus	22,447	22,821	0.98	0.65	0.66
SU2	48,563	41,960	1.16	0.77	0.75
SU3+	22,036	20,165	1.09	0.72	0.70
CS3&4	11,730	12,481	0.94	0.62	0.63
CS5	107,015	219,869	0.49	0.32	0.32
CS6+	3,370	7,383	0.46	0.30	0.30
DS5	7,555	24,208	0.31	0.21	0.21
DS6	2,974	6,610	0.45	0.30	0.30
DS7+	8,704	29,492	0.30	0.20	0.20
Trp	5,859	19,267	0.30	0.20	0.20
Total	1,258,789	834,599	1.51	1.00	1.00

Table 3.14. Summary Results by Registered Weight for Sensitivity Analysis 6

Registered Gross Weight Class		Final Report Results				Adj. Equity Ratios for Sens. Anal. 6 - Increase SU's Operating. Weight
		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		
From	To			Unadjusted	Adjusted	
0	8,000	1,015,319	429,150	2.37	1.57	1.57
8,001	16,000	30,112	24,562	1.23	0.81	0.80
16,001	26,000	29,532	24,496	1.21	0.80	0.78
26,001	40,000	19,130	20,515	0.93	0.62	0.62
40,001	55,000	20,961	19,201	1.09	0.72	0.71
55,001	75,000	9,360	11,951	0.78	0.52	0.52
75,001	80,000	114,863	245,314	0.47	0.31	0.31
80,001	90,000	3,568	7,445	0.48	0.32	0.32
90,001	100,000	2,733	7,357	0.37	0.25	0.25
100,001	105,500	13,170	44,450	0.30	0.20	0.20
105,501	150,000	41	158	0.26	0.17	0.17
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.40
Total		1,258,789	834,599	1.51	1.00	1.00

3.7 Sensitivity Analysis 7

Sensitivity Analysis 7 decreases the average RGW by five percent for single unit trucks (suboption A), and increases their average RGW distribution by five percent (suboption B). The reason for performing this evaluation began as an attempt to assess the capability of the model to develop reasonably accurate estimates of each vehicle configuration's distribution of VMT by RGW ranges. It is necessary for the model either to use the default data provided in it or to use VMT provided by the user broken down only by vehicle configuration (and functional class of highway), but not broken down by RGW class. This is important because there is no practical way of collecting such data from direct field measurements or from registration data.

After reviewing how the model operates in performing this task, and reviewing how the model was applied in the 2009 Nevada HCAS, the research team decided to focus attention again on single unit trucks and to assess the impacts of both decreasing their RGW distributions (thereby lowering their average registered weights), and, in a separate model run, increasing their RGW distributions.

Tables 3.15 and 3.16 on the following page present the results of these two model runs, again in the last two columns. Again, the impacts shown are quite small – comparable to the results shown in Sensitivity Analyses 5 and 6. As expected, only equity ratios for single unit trucks are affected to any significant extent, and again only for those RGW ranges into which most single unit trucks are registered.

The research team chose, based on judgment regarding the plausible range of uncertainty, to make sensitivity adjustments smaller, using 5 percent changes in contrast to the 10 percent changes chosen for some of the other evaluations. If 10 percent had been chosen instead of 5 percent, the magnitude of the changes would have approximately doubled and been more comparable to the results presented for Sensitivity Analysis 4, which involved increases in annual miles per vehicle class of 10 percent for selected major classes of vehicles.

Table 3.15. Summary Results by Vehicle Class for Sensitivity Analysis 7

Vehicle Configuration	Final Report Results				Adj. Equity Ratios for Sens. Anal. 7	
	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Decrease SU's RGW distribution	Increase SU's RGW distribution
			Unadjusted	Adjusted		
Passenger Vehicle	1,018,537	430,343	2.37	1.57	1.57	1.57
Bus	22,447	22,821	0.98	0.65	0.65	0.65
SU2	48,563	41,960	1.16	0.77	0.74	0.80
SU3+	22,036	20,165	1.09	0.72	0.71	0.73
CS3&4	11,730	12,481	0.94	0.62	0.63	0.62
CS5	107,015	219,869	0.49	0.32	0.32	0.32
CS6+	3,370	7,383	0.46	0.30	0.30	0.30
DS5	7,555	24,208	0.31	0.21	0.21	0.21
DS6	2,974	6,610	0.45	0.30	0.30	0.30
DS7+	8,704	29,492	0.30	0.20	0.20	0.19
Trp	5,859	19,267	0.30	0.20	0.20	0.20
Total	1,258,789	834,599	1.51	1.00	1.00	1.00

Table 3.16. Summary Results by Registered Weight for Sensitivity Analysis 7

Registered Gross Weight Class		Final Report Results				Adj. Equity Ratios for Sens. Anal. 7	
		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Decrease SU's RGW distribution	Increase SU's RGW distribution
From	To			Unadjusted	Adjusted		
0	8,000	1,015,319	429,150	2.37	1.57	1.57	1.57
8,001	16,000	30,112	24,562	1.23	0.81	0.79	0.83
16,001	26,000	29,532	24,496	1.21	0.80	0.76	0.83
26,001	40,000	19,130	20,515	0.93	0.62	0.62	0.62
40,001	55,000	20,961	19,201	1.09	0.72	0.71	0.73
55,001	75,000	9,360	11,951	0.78	0.52	0.49	0.55
75,001	80,000	114,863	245,314	0.47	0.31	0.31	0.31
80,001	90,000	3,568	7,445	0.48	0.32	0.32	0.32
90,001	100,000	2,733	7,357	0.37	0.25	0.25	0.24
100,001	105,500	13,170	44,450	0.30	0.20	0.20	0.20
105,501	150,000	41	158	0.26	0.17	0.17	0.17
Total Heavy Vehicles		243,470	405,448	0.60	0.40	0.40	0.40
Total		1,258,789	834,599	1.51	1.00	1.00	1.00

4.0 Summary and Conclusions

Numerous other evaluations could easily have been performed; however, the evaluations of the seven sets of changes that are reported in Section 3.0 of this report are viewed by the research team as sufficient to draw conclusions. The research team believes these conclusions are based on sufficient evidence from the evaluations to provide significant findings for future state HCASs and related financial and policy studies.

Tables 4.1 and 4.2 on the following pages summarize the range of differences found from the seven sensitivity analyses. For each vehicle configuration and RGW range class, each row shows the range of increases and decreases that occurred from the adjusted equity ranges of the 2009 Nevada HCAS Final Report. The findings presented in these tables lead to the following conclusions.

First, by far the largest changes occur for Sensitivity Analysis 2, which ignores and excludes from the analysis the diversion of those user taxes that are not used directly for any state highway-related purposes. As noted in Section 3, this evaluation differs from all the others in that it does not evaluate any aspect of the HCAS model's capabilities nor any aspect of variability of the model's data inputs. It is really closer to being a policy analysis option – addressing the question of how the study's results would be changed if those highway user taxes were to be repealed. Therefore, Sensitivity Analysis 2 is not helpful in drawing conclusions related to the purposes of this report.

Second, the next largest set of changes shown in Tables 4.1 and 4.2 occurs for Sensitivity Analysis 3, involving the use of two different sets of allocators: (a) ones favoring light vehicles, and (b) ones favoring heavy vehicles. We conclude from this observation that more attention should be devoted to careful consideration of these choices in future state HCASs. Two states have emphasized these choices in past HCAS final reports – Oregon and Nevada. This finding also suggests that future state HCASs might benefit from national or regional comparisons and debate over these choices, perhaps leading to some degree of consensus among state practitioners of such studies.

A corollary of this second conclusion can be drawn by comparison of the remaining five sets of ranges of differences from the 2009 Nevada HCAS Final Report's equity ratios. This comparison reveals somewhat of a surprising result – the range of these differences is quite small, suggesting that no substantial problems exist due to model capabilities or uncertainty in data inputs, in terms of effects on the Nevada HCAS results and findings. No substantial problem has been identified requiring priority attention to improvements.

One caveat to this conclusion should be made. In this study, the research team made all the major updates it could, within the time and budget constraints – particularly the most important updates using the National Pavement Cost Model (NAPCOM), a special analysis of recent Nevada WIM data, and the use of the 2002 VIUS to update old default data on annual miles per vehicle and fuel economy (MPG). Such updates are strongly recommended on both national and state levels for the benefit of all future HCASs.

Table 4.1. Sensitivity Analyses Summary by Vehicle Class - Change from Adjusted Equity Ratios Shown in Final Report

Vehicle Configuration	1. Improve Fuel Efficiency		2. Ignore Diversion of User Tax	3. Change Allocators Favorable to Lt. & Hv. Vehicles		4. Increase Annual Miles for Selected Vehicles		5. Shift SU's VMT to Higher Functional Classes	6. Increase SU's Oper. Wt.	7. Decrease & Increase SU's Registered Wts	
	Low	High	Low & High	Low	High	Low	High	Low & High	Low & High	Low	High
Passenger Vehicle	0.00	0.00	-0.21	-0.10	0.18	-0.01	0.01	0.00	0.00	0.00	0.00
Bus	0.00	0.01	0.04	-0.05	0.03	0.01	0.04	0.00	0.00	0.00	0.00
SU2	-0.03	0.01	0.07	-0.12	0.02	-0.05	0.05	-0.02	-0.02	-0.03	0.03
SU3+	-0.04	0.02	0.33	-0.06	0.04	-0.02	0.02	-0.02	-0.02	-0.01	0.01
CS3&4	0.01	0.01	0.42	-0.08	0.03	-0.01	0.01	0.00	0.00	0.00	0.00
CS5	0.00	0.00	0.27	-0.03	0.03	-0.01	0.01	0.00	0.00	0.00	0.00
CS6+	0.00	0.01	0.23	-0.03	0.03	-0.01	0.01	0.00	0.00	0.00	0.00
DS5	0.00	0.00	0.17	-0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
DS6	0.00	0.00	0.23	-0.03	0.02	-0.01	0.01	0.00	0.00	0.00	0.00
DS7+	0.00	0.01	0.15	-0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Trp	0.00	0.01	0.16	-0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.2. Sensitivity Analyses Summary by Registered Weight – Change from Adjusted Equity Ratios Shown in Final Report

Registered Gross Weight Class		1. Improve Fuel Efficiency		2. Ignore Diversion of User Tax	3. Change Allocators Favorable to Lt. & Hv. Vehicles		4. Increase Annual Miles for Selected Vehicles		5. Shift SU's VMT to Higher Func. Classes	6. Increase SU's Oper. Wt.	7. Decrease & Increase SU's Registered Wts	
From	To	Low	High	Low & High	Low	High	Low	High	Low & High	Low & High	Low	High
0	8,000	0.00	0.00	-0.21	-0.10	0.18	-0.01	0.01	0.00	0.00	0.00	0.00
8,001	16,000	-0.03	0.01	0.01	-0.12	0.01	-0.04	0.05	-0.01	-0.01	-0.02	0.02
16,001	26,000	-0.02	0.01	0.07	-0.10	0.04	-0.03	0.06	-0.02	-0.02	-0.03	0.03
26,001	40,000	-0.01	0.01	0.18	-0.06	0.03	0.00	0.02	0.00	0.00	0.00	0.01
40,001	55,000	-0.03	0.01	0.36	-0.07	0.04	-0.02	0.02	-0.02	-0.02	-0.01	0.01
55,001	75,000	-0.01	0.00	0.36	-0.05	0.03	-0.01	0.01	0.00	0.00	-0.03	0.03
75,001	80,000	0.00	0.00	0.26	-0.03	0.03	-0.01	0.00	0.00	0.00	0.00	0.00
80,001	90,000	0.00	0.01	0.24	-0.03	0.03	-0.01	0.01	0.00	0.00	0.00	0.00
90,001	100,000	0.00	0.01	0.18	-0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
100,001	105,500	0.00	0.01	0.15	-0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
105,501	150,000	0.00	0.01	0.13	-0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Total Heavy Vehicles		0.00	0.00	0.22	-0.04	0.03	-0.01	0.01	0.00	0.00	0.00	0.00

Finally, Tables 4.3 below and 4.4 on the following page provide the research team’s judgment based on the relevant six of the seven sensitivity analyses regarding the probable range of uncertainty of the adjusted equity ranges included in the 2009 Nevada HCAS in percentage terms. Under scenarios favorable to heavy trucks, the sensitivity results show that combination trucks with five or more axles are likely paying at best 35 percent of their cost responsibility.²

These judgments take into account the fact that some of the sensitivity analyses focused just on single unit trucks and, thus, the parallel impacts on combination trucks is not as well represented as the impacts on single unit trucks. Thus, the research team was forced to use judgment in extrapolating some of the single unit truck impacts to combination truck classes.

Also in making these judgments, the research team gave careful thought to the probable interrelationships of the several separate sensitivity analyses. We recognized that there would tend to be some counter-balancing between some of the results of the sensitivity analyses; and in other cases, the impacts of two or more of them may be correlated with each other and, therefore, would not be additive. Finally, the research team expected that few if any pairs of these evaluations would likely be compounding – i.e., have multiplying impacts on the results.

Table 4.3. Probable Range of Results by Vehicle Class – Change from Adjusted Equity Ratios Shown in Final Report

Vehicle Configuration	State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Probable Range (%) Adjusted Equity Ratios	
			Unadjusted	Adjusted	Low	High
Passenger Vehicle	1,018,537	430,343	2.37	1.57	-3%	6%
Bus	22,447	22,821	0.98	0.65	N.A.	N.A.
SU2	48,563	41,960	1.16	0.77	-7%	7%
SU3+	22,036	20,165	1.09	0.72	-4%	4%
CS3&4	11,730	12,481	0.94	0.62	-6%	6%
CS5	107,015	219,869	0.49	0.32	-9%	9%
CS6+	3,370	7,383	0.46	0.30	-10%	10%
DS5	7,555	24,208	0.31	0.21	-10%	10%
DS6	2,974	6,610	0.45	0.30	-10%	10%
DS7+	8,704	29,492	0.30	0.20	-10%	10%
Trp	5,859	19,267	0.30	0.20	-10%	10%
Total	1,258,789	834,599	1.51	1.00		

² That 35 percent best value is applicable to the CS5 configuration (5 axle tractor semi-trailers), which comprises almost 80 percent of the combination trucks with 5 or more axles (0.32 + 9% of 0.32 = 0.35). All of the other combinations having five or more axles would have their best values ranging from 0.22 and 0.34.

Table 4.4. Probable Range of Results by Registered Weight – Change from Adjusted Equity Ratios
Shown in Final Report

Registered Gross Weight Class		State User Revenue (Thousands \$)	State Cost Responsibility (Thousands \$)	State Revenue-To-Cost-Responsibility Ratios		Probable Range (%) Adjusted Equity Ratios	
From	To			Unadjusted	Adjusted	Low	High
0	8,000	1,015,319	429,150	2.37	1.57	-3%	6%
8,001	16,000	30,112	24,562	1.23	0.81	-4%	2%
16,001	26,000	29,532	24,496	1.21	0.80	-4%	3%
26,001	40,000	19,130	20,515	0.93	0.62	-5%	3%
40,001	55,000	20,961	19,201	1.09	0.72	-4%	4%
55,001	75,000	9,360	11,951	0.78	0.52	-4%	4%
75,001	80,000	114,863	245,314	0.47	0.31	-10%	10%
80,001	90,000	3,568	7,445	0.48	0.32	-10%	10%
90,001	100,000	2,733	7,357	0.37	0.25	-10%	10%
100,001	105,500	13,170	44,450	0.30	0.20	-12%	12%
105,501	150,000	41	158	0.26	0.17	-12%	12%
Total Heavy Vehicles		243,470	405,448	0.60	0.40	-8%	8%
Total		1,258,789	834,599	1.51	1.00		

5.0 References

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