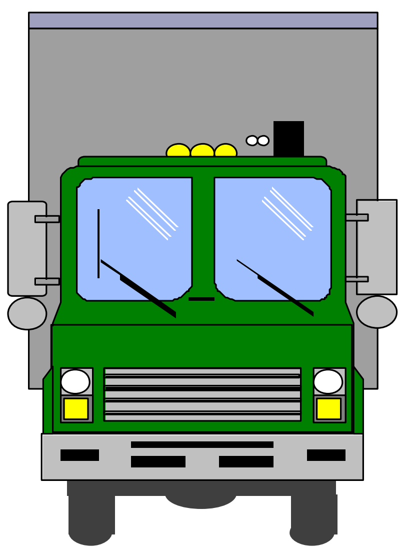
CHAPTER X



Energy and Environment

Introduction

The study scenarios are evaluated in terms of energy consumption, air quality, global warming, and noise emissions. The magnitude of each of the four areas is influenced by the extent of truck travel (vehicle-miles-of-travel—VMT). Other significant variables include vehicle weight, speed, and truck operational parameters.

Fuel consumption, air pollution, and noise emissions occur everywhere trucks operate. The impacts of air pollution and noise emissions vary geographically; both vary according to the population exposed to those impacts, and air pollution can vary according to other regional factors including the presence of other sources of air pollution and atmospheric conditions that may affect the dispersal of pollution. Energy consumption has a nationwide impact.

Noise pollution is very localized. It is measured in terms of the impact of the noise on residential property values. To be affected, residences must be immediately adjacent to a high volume roadway; the denser the residential development, the greater the total impact. The cost of noise is estimated based on the estimated residential density adjacent to freeway sections, as reported in the Highway Performance Monitoring System (HPMS) database and on changes in noise levels caused by changes in truck VMT resulting from truck size and weight (TS&W) policy changes.

Air pollution impacts are highly dependent on meteorological conditions and to a lesser extent on geographic features that cause air stagnation. Air pollution tends to be regional with some long distance conveyance in the lower levels of the atmosphere. Air pollutant emissions are related to VMT, but the transformation of those emissions into secondary pollutants involves complex chemical processes that may vary considerably from area to area depending on other sources of pollution in the area, climatic factors, and other variables.

Estimating total nationwide economic costs of air pollution attributable to motor vehicles is complex. The Department collaborated with the Environmental Protection Agency (EPA) to develop a nationwide cost estimate in connection with the *1997 Federal Highway Cost Allocation (HCA) Study*. Resource constraints prohibited development of such estimates for each illustrative scenario. In general, scenarios that would reduce truck VMT would reduce air pollution costs, but changes would not be proportional with changes in VMT, particularly at specific locations. However, changes in truck emissions would be largely proportional to changes in VMT.

Basic Principles

Energy Consumption

Table X-1 illustrates how fuel consumption varies with truck configuration and weight. It shows that a longer configuration at the same weight does not necessarily have a higher rate of fuel use. Inherent for each truck configuration is the selection of the most efficient engine for that configuration and use.

A configuration’s impact on diesel fuel use depends on its miles of operation at its given weight, speed, and roadway grade. For this study, each configuration is

Table X-1. Miles Per Gallon for Study Truck Configurations

Configurations	GVW (pounds)					
	40,000	60,000	80,000	100,000	120,000	140,000
Three-axle Single-Unit Truck	5.11	4.42				
Four-axle Single-Unit Truck	4.80	4.15				
Five-Axle Semitrailer		5.44	4.81	4.31		
Six-Axle Semitrailer		5.39	4.76	4.27		
Five-Axle STAA Double		5.95	5.29	4.76		
Seven-Axle Rocky Mt. Double			5.08	4.58	4.36	4.16
Eight-Axle (or more) Double			5.08	4.82	4.58	4.36
Triple-Trailer Combination			5.29	5.01	4.76	4.54

Source: Highway Revenue Forecasting Model

Table X-2. Air Pollutant Emission Rates

Configuration	Air Pollutant Emission (grams/VMT)			
	Nitrogen Oxides	Particulate Matter(10)	Volatile Organic Compounds (VOC)	Sulphur Oxides
Three-axle Single Unit	9.55	0.399	1.94	0.111
Other Heavy Trucks	12.65	0.788	1.03	0.520

Source: Derived from EPA's Mobile 5A and Part5 models assumed to operate at the same speed under the same conditions. It is important to note that fuel use does not increase on a one-to-one relationship with vehicle weight.

Air Quality

As indicated earlier, air pollutant emissions by large trucks correlate with VMT. Analytical models of these emissions do not generally differentiate between truck configurations or different weight groups. Consequently, only the available rates for three-axle single unit trucks and heavy trucks, (trucks with four axles or more) on urban routes are reported in Table X-2.

Noise Emissions

Truck noise comes from three sources—the engine (as a function of engine revolutions per minute), the exhaust pipe (particularly from the use of engine compression brakes), and tires (tire noise increases significantly with speed and begins to dominate other truck noise sources above 30 miles-per-hour). Truck noise begins to dominate noise from other traffic once trucks account for more than 3 percent of the traffic. For example, to produce a noticeable difference in highway noise, such as a decrease of 2.5 decibels, the percentage of trucks in the traffic stream would have to drop from 20 percent to 5 percent of all traffic.

Analytical Approach

Energy Consumption

Truck travel and fuel use information developed for the *1997 Federal HCA Study* provided the basis for the analysis of annual energy consumption associated with the introduction or elimination of particular vehicle configurations and weights.

Base Case VMT for the Year 2000 by truck type and operating weight, was obtained from the diversion analysis (see Chapter IV). For each scenario, an alternative Year 2000 VMT distribution was also developed. This was multiplied by gallons-per-vehicle-mile-of-travel estimates to estimate total truck fuel consumption for each scenario.

Air Quality

As noted above, relating changes in truck travel to changes in nationwide economic costs of air pollution is complex and resource intensive. Furthermore, effects in any specific location could be very different from effects estimated for the Nation as a whole. As indicated earlier, DOT is working with EPA to develop an air quality impact methodology based on the best and most current information available.

Important factors in estimating changes in air quality costs are the dollar values assigned to mortality (death), morbidity (illness), visibility impairment, soiling, materials damage, effects on plants and wildlife, and other impacts caused by air pollutants. These are extremely difficult to quantify in terms of their effects and wide ranges of costs have been estimated in previous studies. Furthermore, our understanding of the health effects of various pollutants continues to evolve, and thus estimates of motor-vehicle related air pollution costs must be periodically updated to reflect the latest scientific knowledge.

Table X-3. Noise Passenger Car Equivalents for Trucks

Vehicle Type	Speed (mph)				
	20	30	40	50	60
Passenge	1.00	1.00	1.00	1.00	1.00
Truck	84.85	43.82	27.42	19.06	14.16

A key issue that will be the subject of future research is the relationship between vehicle weight and emissions. The EPA's models currently do not differentiate among the vehicle classes of interest in TS&W policy options.

Noise Emissions

As previously mentioned, scenario VMT was obtained through the diversion analysis. Using passenger cars as the base, noise equivalency factors were determined under differing operating circumstances for each vehicle class and weight group. Noise equivalency factors for trucks relative to passenger cars are shown in Table X-3. The cost per noise equivalent was estimated for each vehicle class based on a synthesis of research findings from other studies.

The Department has developed models for evaluating impacts of traffic-related changes in noise levels. These models served as the basis for the noise emission cost calculations. The models were also used for the *1997 Federal HCA Study*. Figure X-1 describes DOT's noise prediction model. Highway Performance Monitoring System (HPMS) data on VMT by highway class and density of development were used to estimate the number of residential units affected. Noise cost estimates were based on predicted changes in residential property value caused by changes in noise levels.

Noise-related costs are only estimated for freeway travel. There are several reasons why the analysis was limited to freeway travel including:

Figure X-1. Federal Highway Administration Highway Traffic Noise Prediction Model

The Federal Highway Administration Traffic Noise Model calculates traffic noise levels using updated acoustical algorithms, as well as newly-measured emission levels for five standard vehicle types: automobiles, medium trucks, heavy trucks, buses, and motorcycles. The model considers the sources of truck noise (engine, exhaust stack, and tires) among other factors. It estimates overall weighted sound levels for locations with and without noise barriers. It analyzes: (1) both constant-flow and interrupted-flow traffic, (2) attenuation due to rows of buildings and dense vegetation, (3) effects of parallel noise barriers, (4) results of multiple diffractions, and (5) noise contours.

(1) virtually all studies used as background for the cost estimates were limited to freeway locations, and (2) except in commercial areas where there are many other sources of noise, truck volumes in urban areas are relatively low.

Assessment of Scenario Impacts

The area-wide impacts of energy consumption, exhaust emissions, and noise all vary with VMT. Changes in VMT for key truck configurations are shown in descriptions of impacts for each scenario.

For air pollution, meteorological conditions and, to a lesser extent geography, have a large effect on impacts. These conditions determine how concentrated the air pollutant emissions become and the chemical reactions that take place in the atmosphere to produce critical levels of air pollution. Since air pollution costs for the various TS&W scenarios could not be estimated within the scope of this study, the impact table for each scenario shows that these costs are not available (NA). However, as an indicator of changes in emissions, each impact table shows an estimate of the change in truck VMT estimated for the scenario.

Uniformity Scenario

For this scenario, it is assumed that much of the freight in those truck configurations that typically operate above the Federal weight limits will divert to those configurations that operate most economically at or below the Federal limits. As seen in Table X-4, this scenario results in an estimated 3.2 percent increase in heavy commercial truck VMT.

Table X-5 shows that this increase in VMT resulted in a 2.1 percent increase in fuel use and 0.9 percent increase in noise costs. While air pollution costs have not been determined, truck VMT in urban areas increased 3.2 percent, which indicates that there would be an increase in air pollution costs in areas prone to such impacts.

North American Trade Scenarios

For this scenario, with either the 51,000-pound or 44,000-pound tridem-axle weight limit, it is estimated that there would be significant diversion of freight to trucks that have more axles and are allowed more weight. This would be diversion from the three-axle single-unit truck to the four-axle truck. For the five-axle semitrailer, over 70 percent of its freight would divert to the eight-axle B-train double with a small amount to the six-axle semitrailer under either the 51,000-pound or 44,000-pound tridem-axle weight limit. Overall, this results in a 12 percent decrease in heavy commercial truck VMT under both tridem-axle weight limits (see Table X-6 and Table X-7). This decrease would result in over a 6 percent decrease in fuel use (see Table X-8 and Table X-9). Air pollution costs have not been determined yet, but truck VMT in urban areas would decrease by more than 5 billion miles in both cases, which indicates that there would be a decrease in air pollution costs in those areas prone to these impacts. Unexpectedly, noise costs increase even though urban freeway VMT decreases by 3 billion. This may be explained by the fact that the VMT decrease is small and that the number of tires in use on the roads increases approximately 15 percent. There would also be an increase in engine noise from greater loads. Consequently, these secondary changes may overwhelm the effect of the small decrease in VMT.

Longer Combination Vehicles Nationwide Scenario

This scenario has the greatest estimated reduction in heavy commercial truck VMT, 23.2 percent, which is shown in Table X-10. The nine-axle turnpike double with its high cubic capacity and GVW allowance is expected to be very attractive to freight shippers. Also, the triple-trailer combination attracts virtually all the freight from the Surface Transportation Assistance Act (STAA) double-trailer combinations (twin-trailer vehicles operating at weights less than 80,000 pounds GVW), which are predominately used by less-than-truckload (LTL) carriers. The reduced heavy commercial truck VMT resulted in a 13.8 percent reduction in fuel consumption but a very modest increase of 0.5 percent or $21 million in noise costs (see Table X-11). The estimated reduction of 5 billion miles in heavy commercial truck travel on urban roadways indicates that air pollution costs would be reduced in those areas prone to having significant air pollution.

H.R. 551 Scenario

As shown in Table X-12, this scenario has virtually no impact on heavy commercial truck VMT. Consequently, there is virtually no impact on energy consumption, air pollution, or noise as seen in Table X-13.

Triples Nationwide Scenario

In this scenario, the triple-trailer combination attracts not only most of the LTL freight from the STAA double-trailer combination vehicles (with STAA double-trailer combination VMT reduced 82.1 percent), but it also attracts both light and heavy density truckload freight (a 72.1 percent reduction in VMT for the five-axle semitrailer combination) because it is the configuration with the most cubic capacity and the highest weight allowance. The scenario resulted in a 20.2 percent reduction in heavy commercial truck VMT as shown in Table X-14.

This reduced heavy commercial truck VMT and resulted in a 12.8 percent reduction in fuel consumption, but only a very modest reduction in noise costs, 0.2 percent or $7 million, resulted (see Table X-15). The estimated reduction of 8 billion miles in heavy commercial truck travel on urban roadways indicates that air pollution costs would be reduced in those areas prone to significant air pollution.

Table X-4. Vehicle Miles of Travel by Configuration Under Uniformity Scenario

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Single Unit	3	9,707	9,949	242	2.5
	4	2,893	3,224	331	11.4
Semitrailer	5	83,895	91,205	7,310	8.7
	6 and 7	6,595	3,660	-2,935	-44.5
STAA Double-Trailer	5 and 6	5,994	5,986	-8	-0.1
B-Train Double-Trailer	8	683	178	-505	-73.9
Rocky Mountain Double-	7	632	290	-342	-54.1
Turnpike Double-Trailer	9	76	20	-56	-73.7
Triple-Trailer	7	126	54	-72	-57.1
Total for Heavy	—	128,288	132,351	4,063	3.2
All Highway Vehicles	—	2,693,845	2,697,908	4,063	0.2

Table X-5. Energy and Environmental Impacts of Uniformity Scenario

Impact	2000 Base Case	Change from 2000 Base Case	
		Absolute	Percentage
VMT for Heavy Trucks (millions)	2,693,845	4,063	3.2
Energy Consumption (million gallons)	29,947	635	2.1
Urban VMT for Heavy Trucks (millions)	51,625	1,700	—
Air Pollution Costs	NA	NA	NA
Urban Freeway VMT for Heavy Trucks (millions)	27,503	797	—

Table X-6. Vehicle Miles of Travel by Configuration Under North American Trade Scenario, 51,000 Pound Tridem Axle Weight Limit

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Single Unit	3	9,707	8,131	-1,576	-16.2
	4	2,893	3,578	685	23.7
Semitrailer	5	83,895	24,996	-58,818	-70.2
	6 and 7	6,595	6,792	197	3.0
B-Train Double-Trailer	8	683	46,619	45,936	6,726
Total for Heavy Trucks	—	128,288	114,632	-13,656	-10.6
All Highway Vehicles	—	2,693,845	2,680,189	-13,656	-0.5

Table X-7. Energy and Environmental Impacts of North American Trade Scenario, 51,000 Pound Tridem Axle Limit

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-13,656	-10.6
Energy Consumption (million gallons)	-1,870	-6.2
Urban VMT for Heavy Trucks (millions)	-5,163	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-2,849	—
Noise Cost ($millions)	255	5.9

Table X-8. Vehicle Miles of Travel by Configuration for North American Trade Scenario, 44,000 Pound Tridem Axle Weight Limit

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Single Unit	3	9,707	8,529	-1,178	-12.1
	4	2,893	3,595	702	24.3
Semitrailer	5	83,895	22,274	-61,621	-73.5
	6 and 7	6,595	6,755	160	2.4
B-Train Double-Trailer	8	683	49,003	48,320	7,075
Total for Heavy Trucks	—	128,288	114,671	-13,617	-10.6
All Highway Vehicles	—	2,693,845	2,680,228	-13,617	-0.5

Table X-9. Energy and Environmental Impacts of North American Trade Scenario With 44,000 Pound Tridem Axle Weight Limit

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-13,617	-10.6
Energy Consumption (million gallons)	-1,889	-6.3
Urban VMT for Heavy Trucks (millions)	-5,074	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-2,895	—
Noise Cost ($millions)	281	6.5

Table X-10. Vehicle Miles of Travel by Configuration for Longer Combinations Nationwide Scenario

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Semitrailer	5	83,895	19,611	-64,284	-76.6
STAA Double-Trailer	5 and 6	5,994	1,075	-4,919	-82.1
B-Train Double-Trailer	8	683	2,079	1,396	204.4
Rocky Mt. Double-Trailer	7	632	505	-127	-20.1
Turnpike Double-Trailer	9	76	32,418	32,342	42,555
Triple-Trailer	7	126	5,992	5,866	4,656
Total for Heavy Trucks	—	128,288	98,562	-29,726	-23.2
All Highway Vehicles	—	2,693,845	2,664,119	-29,726	-1.1

Table X-11. Energy and Environmental Impacts of Longer Combinations Nationwide Scenario

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-29,726	-23.2
Energy Consumption (million gallons)	-4,129	-13.8
Urban VMT for Heavy Trucks (millions)	-9,168	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-5,267	—
Noise Cost ($millions)	21	0.5

Table X-12. Vehicle Miles of Travel by Configuration Under H.R. 551 Scenario

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Semitrailer	5	83,895	83,916	20	0.03
	6 and 7	6,595	6,597	2	0.03
Total for Heavy Trucks	—	128,288	128,311	23	0.02
All Highway Vehicles	—	2,693,845	2,693,868	23	0.0009

Table X-13. Energy and Environmental Impacts of H.R. 551 Scenario

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	23	0.02
Energy Consumption (million gallons)	3.6	0.01
Urban VMT for Heavy Trucks (millions)	6	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	3	—
Noise Cost ($millions)	0.3	0.007

Table X-14. Vehicle Miles of Travel by Configuration for Triples Nationwide Scenario

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Semitrailer	5	83,895	23,405	-60,490	-72.1
STAA Double-Trailer	5 and 6	5,994	1,075	-4,919	-82.1
Triple -Trailer	7	126	39,647	39,521	31,366
Total for Heavy Trucks	--	128,288	102,400	-25,888	-20.2
All Highway Vehicles	--	2,693,845	2,667,955	-25,888	-1.0

Table X-15. Energy and Environmental Impacts of Triples Nationwide Scenario

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-25,888	-20.2
Energy Consumption (million gallons)	-3,819	-12.8
Urban VMT for Heavy Trucks (millions)	-8,010	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-5,301	—
Noise Cost ($millions)	-7	-0.2