

APPENDIX H: FREIGHT AND PASSENGER RAIL BENEFIT METHODOLOGY



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FREIGHT BENEFIT METHODOLOGY

In 2013, America’s railroads moved a ton of freight an average of 473 miles on one gallon of fuel. That is the approximate distance between Richmond and Lexington, KY. On average, railroads are four times more fuel efficient than trucks. Moving freight by rail instead of truck reduces greenhouse gas emissions by 75 percent. One train can carry as much freight as several hundred trucks. Significant freight volumes traverse Virginia’s rail infrastructure annually. Such freight includes finished goods, materials, and supplies. Principal freight rail issues concern the identification of movements most important to Virginia, and the options to facilitate/support such movements. Identifying the importance of, and solutions for, freight rail comprises several perspectives, including: volumes (especially compared to capacity), units, and directional movements.

The Association of American Railroads (AAR) uses terminated tons which includes all goods that end in Virginia regardless of the products origin. As such, the terminated tons include both imported tons from other parts of the country and world as well as intrastate rail movements that begin and end within Virginia. Similarly, originated tons include both exports and internal Virginia rail movements. In 2012 (the most recent statistical year), Virginia ranked fourth in the nation in total rail tons terminated (77.6 million tons) and was 16th in total rail tons originated (32.2 million tons).

Several types of data and assumptions, along with the number of avoided truck miles, are necessary to estimate freight benefits. **Table H-1** indicates the basic approach to estimating benefits for each category. Benefits are computed as a product of physical “drivers” of impact and the value per unit of impact. For example, “User Cost Savings” are computed as the total amount of annual rail ton-miles and the difference in truck shipping and rail shipping costs.

Table H-1: Benefits Estimation Methodology, by Benefit Category

Benefit Category	Drivers	Valuation	Other Factors
User Cost Savings	Annual Rail Ton-Miles	Truck Shipping Cost - Rail Shipping Cost (Dollar per Ton-Mile)	
Pavement Maintenance Cost Savings	Truck VMT	Urban, Rural Pavement Costs (Dollar per VMT)	
Congestion Cost Reduction	Truck VMT	Urban, Rural Pavement Costs (Dollar per VMT)	Percentages of urban, rural trips
Air Pollutant	Truck VMT * Truck Emission	Pollutant Cost	Pollutants: NOx, CO,



Benefit Category	Drivers	Valuation	Other Factors
Emissions Cost Reduction	Rates; Train VMT * Train Emission Rates, by Pollutant	(Dollar per VMT, by pollutant)	PM, VOC, CO2
Crash Reduction	Truck VMT, Train VMT	Accident Costs (Dollar per VMT)	

Data to estimate the impact and value of each benefit category are contained in **Table H-2**, and are organized by benefit category. The original sources of these values includes VDOT, USEPA, and other federal documents and all have obtained from the Virginia Department of Rail and Public Transportation Rail Enhancement Fund benefit-cost analysis model (DRPT REF Model); a model that has been updated for 2016.

Table H-2: Variables and Computations Involved in Estimating Benefits of Freight Use, by Benefit Category

Variables	Units	Value in 2016 units	Source
User Cost Savings Variables			
Truck Shipping Cost	Dollar per ton-mile	\$0.11	DRPT REF Model
Rail Shipping Cost	Dollar per ton-mile	\$0.04	DRPT REF Model
2015 Annual Rail Ton-Miles	Million Ton-Miles	25,067	TRANSEARCH 2012
Pavement Maintenance Impacts Variables			
Percentage of Urban Truck Trips	Percent	25	DRPT REF Model
Percentage of Rural Truck Trips	Percent	75	DRPT REF Model
Rail Tons to, from or through VA	Millions of Tons	158	TRANSEARCH 2012
Tons Carried per Truck	Tons per Truck	20.59	DRPT REF Model
Factor to adjust for truck capacity and demand	Multiplier	1.3	Assumption
Number of Trucks Needed	Millions of Trucks	9.9	Computed
Average Distance of Truck Trip	Miles	171	FAF (2014)
VMT Avoided by Trucks	Millions of VMT	1,701	Computed
Pavement Cost for a 60kip 4-axle (Urban Interstate)	Cost per VMT	\$0.252	DRPT REF Model
Pavement Cost for a 60kip 4-axle (Rural Interstate)	Cost per VMT	\$0.078	DRPT REF Model



Variables	Units	Value in 2016 units	Source
Average Marginal Pavement Cost for Trucks	Cost per VMT	\$0.165	DRPT REF Model
Congestion Cost for a 60kip 4-axle (Urban Interstate)	Cost per VMT	\$0.454	DRPT REF Model
Congestion Cost for a 60kip 4-axle (Rural Interstate)	Cost per VMT	\$0.045	DRPT REF Model
Air Pollutant Emissions Impacts Variables			
NOx - Truck Emissions	Grams per VMT	3.13	DRPT REF Model
CO - Truck Emissions	Grams per VMT	0.76	DRPT REF Model
PM2.5 - Truck Emissions	Grams per VMT	0.12	DRPT REF Model
PM10- Truck Emissions	Grams per VMT	0.13	DRPT REF Model
VOC - Truck Emissions	Grams per VMT	0.08	DRPT REF Model
CO2- Truck Emissions	Grams per VMT	1,628.5	DRPT REF Model
NOx - Train Emissions	Grams per VMT	0.227	DRPT REF Model
CO - Train Emissions	Grams per VMT	0.060	DRPT REF Model
PM2.5 - Train Emissions	Grams per VMT	0.006	DRPT REF Model
VOC - Train Emissions	Grams per VMT	0.010	DRPT REF Model
CO2- Train Emissions	Grams per VMT	18.990	DRPT REF Model
NOx - Truck Emission Cost	Dollar per Ton	\$4,113	DRPT REF Model
CO - Truck Emission Cost	Dollar per Ton	\$336	DRPT REF Model
PM2.5 - Truck Emission Cost	Dollar per Ton	\$76,224	DRPT REF Model
PM10 - Truck Emission Cost	Dollar per Ton	\$23,838	DRPT REF Model
VOC - Truck Emission Cost	Dollar per Ton	\$5,226	DRPT REF Model
CO2 - Truck Emission Cost	Dollar per Ton	\$43	DRPT REF Model
Crash Reduction Variables			
Accident Value Impact, Truck	Dollar per VMT	\$0.454	DRPT REF Model
Accident Value Impact, Train	Dollar per ton-mile	\$0.045	DRPT REF Model



PASSENGER BENEFIT METHODOLOGY

Several additional types of data and assumptions, along with the number of avoided truck miles, are necessary to estimate freight benefits. **Table H-3** indicates the basic approach to estimating benefits for each category. Benefits are computed as a product of physical “drivers” of impact and the “value per unit” of impact. For example, Congestion Cost Savings are computed as the total amount of annual passenger miles and the congestion cost per mile (of using passenger vehicles). In some cases, such as vehicle emissions where pollutant emissions and costs differ among pollutants, additional information is required.

Table H-3: Benefit Estimation Methodology, by Benefit Category

Benefit Category	Drivers	Value Per Unit	Other Factors
User Cost Savings	Auto VMT Avoided in the State	IRS Reimbursement Rate (Auto) – Cost per seat (Train) (Dollar per mile)	
Pavement Maintenance Cost Savings	Passenger Vehicle VMT	Urban, Rural Pavement Costs (Dollar per VMT)	
Congestion Cost Reduction	Passenger Vehicle VMT	Urban, Rural Congestion Costs (Dollar per VMT)	Interpolated costs between urban, rural trips, by highway
Air Pollutant Emissions Cost Reduction	Passenger Vehicle VMT * Truck Emissions Rates (Grams per VMT), by Pollutant	Pollutant Cost, by pollutant (Dollar per Ton)	Pollutant types include NO _x , CO, PM, VOC, CO ₂
Crash Reduction	Passenger Vehicle VMT	Accident Costs (Dollar per VMT)	



Data required for estimating passenger service benefits are contained in **Table H-4**. The original sources of these values include the Virginia Department of Transportation, US Environmental Protection Agency, and other federal documents. Where possible, data have been obtained from the most recent DRPT REF Model.

Table H-4: Passenger Service Benefits

Variables	Units	Value	Source
Pavement Maintenance Impacts and User Cost Savings Variables			
Percentage of Urban Auto Trips	Percent	25	Assumption
Percentage of Rural Auto Trips	Percent	75	Assumption
2015 Total Passenger Miles	Millions of Miles	412	Amtrak
Average Vehicle Occupancy	Persons per Auto	1.52	Assumption
Auto VMT Avoided in the State	Millions of VMT	271	HDR Calculation
IRS Reimbursement Rate for the Use of Car	Cost per Mile	\$0.54	IRS
North East Regional Cost per Seat	Cost per Mile	\$0.186	Amtrak
Marginal Pavement Cost for Auto (Urban Interstate)	Cost per VMT	\$0.001	DRPT REF Model
Marginal Pavement Cost for Auto (Rural Interstate)	Cost per VMT	\$0.00	DRPT REF Model
Average Marginal Pavement Cost for Auto	Cost per VMT	\$0.00035	HDR Calculation
Congestion Impact Variables			
Congestion Cost (Interpolated for major highways)	Cost per VMT	\$0.225	DRPT REF Model
Air Pollutant Emissions Impacts Variables			
NOx - Truck Emissions	Grams per VMT	0.133	DRPT REF Model
CO - Truck Emissions	Grams per VMT	1.468	DRPT REF Model
PM2.5 - Truck Emissions	Grams per VMT	0.003	DRPT REF Model



Variables	Units	Value	Source
PM10- Truck Emissions	Grams per VMT	0.004	DRPT REF Model
VOC - Truck Emissions	Grams per VMT	0.012	DRPT REF Model
CO2- Truck Emissions	Grams per VMT	309.919	DRPT REF Model
NOx - Truck Emission Cost	Dollar per Ton	\$4,113	DRPT REF Model
CO - Truck Emission Cost	Dollar per Ton	\$336	DRPT REF Model
PM2.5 - Truck Emission Cost	Dollar per Ton	\$76,224	DRPT REF Model
PM10 - Truck Emission Cost	Dollar per Ton	\$23,838	DRPT REF Model
VOC - Truck Emission Cost	Dollar per Ton	\$5,226	DRPT REF Model
CO2 - Truck Emission Cost	Dollar per Ton	\$43	DRPT REF Model
Crash Reduction Variables			
Accident Value Impact, Passenger Vehicles	Dollar per VMT	\$0.105	DRPT REF Model

