Benefits of Transit Study Technical Report

Prepared for:

Washington Metropolitan Area Transit Authority

Prepared by:
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EBP

Spring 2024

Where to find each key highlight in this technical report (1 of 2)

Transit is vital to the region.

Page 17 Jobs and Economy

$3.2 B
Annual property tax revenue generated by land and buildings near Metro stations

$9.4 B
Annual value of business output the region would lose without transit

$29 B
What the region would have to spend building new roads and parking if it didn't have transit

Page 17 Jobs and Economy

Metro repays the region's investment many times over.

Metro station areas = **3% of land**

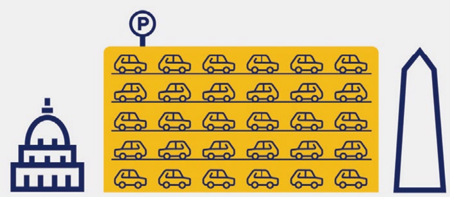
30% of property value

$3.2 billion tax revenue

40% of regional jobs

Page 9 Traffic and Congestion

Without transit we would need to spend an extra **$2 billion** on parking, equivalent to covering the National Mall in a 5-story parking garage!

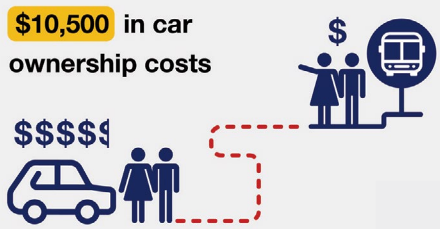


Page 25 Quality of Life

Every year, households that ride transit instead of cars save:

$2,800 in rideshare/taxi, parking, and toll costs

$10,500 in car ownership costs



Page 26 Health and Environment

Transit is **20 times safer** than driving a car, saving the region $950 million a year in collision costs and avoiding nearly 30 deaths and over 2,500 injuries.

Where to find each key highlight in this technical report (2 of 2)

Transit connects the region, drives the economy, reduces traffic, protects the environment, and advances equity. Investing in transit benefits everyone, whether they ride or not.

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Traffic and Congestion

Investing in transit reduces congestion and avoids tens of billions in additional road and parking costs.

By 2025, transit will keep about 1.2 million cars off the road every day. Lined up in a row, those cars would stretch from Washington, DC to Alaska.

Without transit, the region would have to spend $27 billion building 1,300 new miles of roadway—enough to cover 3 Arlington National Cemeteries. The region would also need $2 billion of new parking, enough additional cars to cover the National Mall in a 5-story parking garage.

Driving on I-66, I-95, or New York Avenue would take twice as long, adding 20-30 minutes to every trip. Even for people who only commute 3 days a week, that's an extra 2-3 hours stuck in traffic each week.

Page 25
Quality of Life

Investing in transit saves households money and improves quality of life, for everyone.

Transit riders save about $2,800 a year by not having to pay for rideshares, taxis, parking, and tolls. It costs around $12,000 a year to own a car and an average of $1,500 a year to ride Metro, so households that ride rather than drive save $10,500 per year.

Transit creates economic efficiencies that support 64,000 non-transit jobs. Without transit, traffic congestion would slow down the economy, and those jobs might not exist.

Page 17
Jobs and Economy

Investing in transit grows the economy and makes the region more competitive.

Metro station areas hold only 3% of the region's land, but they make up about 30% of property value ($330 billion), 30% of annual property tax revenue ($3.2 billion), and 40% of jobs (960,000).

Metro station areas also host 65% of new office development, 50% of new multifamily rental housing, and 25% of affordable housing.

Metro stations have twice as many businesses, three times more jobs, and three times more property value than areas without Metro.

Over half of the region's 240,000 businesses—and more than 70% of its 2.5 million jobs—are within a half-mile of a Metro rail station or bus stop.

Transit saves the region $30 million a year in freight and shipping costs. Transit reduces congestion, which makes freight and deliveries cheaper and more reliable.

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Health and Environment

Investing in transit improves health and helps the region meet its environmental goals.

Transit avoids an additional 1.2 million metric tons of greenhouse gases each year. That's the same as if all the households in Arlington, VA didn't use energy for an entire year.

Transit saves the region almost $950 million per year in costs from traffic crashes. Transit is 20 times safer than driving a car, which helps avoid nearly 30 people killed and over 2,500 people injured in car crashes per year.

Transit improves health. People who ride transit walk as much as 30 minutes more a day, increasing heart health, building muscle, and reducing risk of heart disease, Type 2 diabetes, and some cancers.

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About The Study

The Benefits of Transit Study refreshes and updates analyses and findings from 2011 and provides a Communications Toolkit to help share those findings with stakeholders and the public. The study and Communications Toolkit detail transit's value to the region by identifying the benefits of an extensive, reliable, safe, frequent, and equitable transit network. The study analyzes and quantifies the societal, environmental, transportation, and economic impacts delivered by the region's transit network, including all transit services and providers.

Analytical outputs and findings apply to one of three geographies: the WMATA Compact Area (also referred to as "the region" for the sake of simplicity and relatability), the "state"-level jurisdictions within the Compact Area, and the Metro transit system itself. This technical report and associated key highlights, analysis, and Communications Toolkit materials specify the applicable geography for each finding.

Overview

This report documents the technical methodology used by the study team to carry out analyses and produce quantitative results for the Washington Metropolitan Area Transit Authority (Metro) Benefits of Transit Study.

Working closely with Metro stakeholders, the study team used the analysis results to write concise "key highlights" emphasizing the benefits that Metro's services, or transit in general, create for the region. The team selected 12 key highlights, which most effectively conveyed transit's benefits to the region, for use in a Communications Toolkit. The team categorized the key highlights into one of four benefit themes: Traffic and Congestion, Quality of Life, Jobs and Economy, and Health and Environment.

- **Traffic and Congestion** represents changes in travel conditions that results from transit no longer being a viable mode for travel.
- **Quality of Life** represents changes to savings and jobs that impact households and individuals' ability to maintain their standard of living.
- **Jobs and Economy** represents the economic value that a robust transit network adds to the region.
- **Health and Environment** represents the improvements in individual and environmental health from the transit network.

These four themes comprise the sections of this report, and each section includes its relevant key highlights. For each key highlight, the report explains what methods the team used to quantify transit's benefits.

The report also provides complete quantitative results from the analyses, including some that were not incorporated into the final key highlights. Each analysis produced results that are summarized in tables throughout this memo under their relevant themes, and the key highlights represent a small portion of these.

Table 1 presents the Communications Toolkit key highlights, including the benefit theme of each point and the analytical method used to derive it.

Table 1: Communications Toolkit Key Highlights

#	Key Highlight	Theme	Analysis
Investing in transit reduces congestion and avoids tens of billions in additional road and parking costs.			
1	By 2025, transit will keep about 1.2 million cars off the road every day. Lined up in a row, those cars would stretch from Washington, DC to Alaska.	Traffic and Congestion	Travel Demand Model
2	Without transit, the region would have to spend $27 billion building 1,300 new miles of roadway – enough to cover 3 Arlington National Cemeteries. The region would also need $2 billion of new parking, enough additional cars to cover the National Mall in a 5-story parking garage.	Traffic and Congestion	Travel Demand Model
3	Driving on I-66, I-95, or New York Avenue would take twice as long, adding 20-30 minutes to every trip. Even for people who only commute 3 days a week, that's an extra 2-3 hours stuck in traffic each week.	Traffic and Congestion	Travel Demand Model

Investing in transit saves households money and improves quality of life, for everyone.			
4	Transit riders save about $2,800 a year by not having to pay for rideshares, taxis, parking, and tolls. It costs around $12,000 a year to own a car and an average of $1,500 a year to ride Metro, so households that don't have a car drive can save an extra $10,500 per year.	Quality of Life	Economic Analysis
5	Transit creates economic efficiencies that support 64,000 non-transit jobs. Without transit, traffic congestion would slow down the economy, and those jobs might not exist.	Quality of Life	Economic Analysis
Investing in transit grows the economy and makes the region more competitive.			
6	Metro station areas hold only 3% of the region's land, but they make up about 30% of property value ($330 billion), 30% of annual property tax revenue ($3.2 billion), and 40% of jobs (960,000). Metro station areas also host 65% of new office development, 50% of new multifamily rental housing, and 25% of affordable housing.	Jobs and Economy	Geospatial Analysis
7	Metro stations have twice as many businesses, three times more jobs, and three times more property value than areas without Metro.	Jobs and Economy	Geospatial Analysis
8	Over half of the region's 240,000 businesses—and more than 70% of its 2.5 million jobs—are within a half-mile of a Metro rail station or bus stop.	Jobs and Economy	Geospatial Analysis
9	Transit saves the region $30 million a year in freight and shipping costs. Transit reduces congestion, which makes freight and deliveries cheaper and more reliable.	Jobs and Economy	Economic Analysis
Investing in transit improves health and helps the region meet its environmental goals.			
10	Transit avoids an additional 1.2 million metric tons of greenhouse gases each year. That's the same as if all the households in Arlington, VA didn't use energy for an entire year.	Health and Environment	Economic Analysis, Miscellaneous
11	Transit is 20 times safer than driving a car, saving the region $950 million a year in collision costs and avoiding nearly 30 deaths and over 2,500 injuries.	Health and Environment	Economic Analysis
12	Transit improves health. People who ride transit walk as much as 30 minutes more a day, increasing heart health, building muscle, and reducing risk of heart disease, Type 2 diabetes, and some cancers.	Health and Environment	Miscellaneous

Source: Fehr & Peers, 2024.

Study Area

Unless specified otherwise, all analyses and results are reported for the WMATA Compact Area. This region, which falls entirely within the larger Metropolitan Washington Council of Governments (MWCOG) Area, includes the following jurisdictions:

- District of Columbia
- Virginia
    - Arlington County, VA
    - Fairfax County, VA
    - Loudoun County, VA
    - City of Alexandria, VA
    - City of Fairfax, VA
    - City of Falls Church, VA
- Maryland
    - Montgomery County, MD

- Prince George’s County, MD

Some results are reported for the entire WMATA Compact Area and for three subregions, which group the above jurisdictions into DC, Maryland, and Virginia.

The team used two additional geographies certain analyses. The first is Metro’s Equity Focus Communities (EFCs), which are Census Block Groups in the WMATA Compact Area with a high proportion of residents who are people of color, low-income individuals, or individuals with disabilities.

The second additional geography is MWCOG’s Activity Centers. These are locations expected to accommodate most of the region’s future growth. They include Urban Centers, Priority Growth Areas, Traditional Towns, and Transit Hubs. MWCOG created the Activity Centers using traffic analysis zones (TAZs) from the MWCOG Transportation Planning Board (TPB) Travel Demand Forecasting Model.

Data Collection

The study team applied the following data sources and analytical tools to quantize and monetize the benefits of transit in the WMATA Compact Area. Further sections of the report explain how each dataset and tool was used.

Table 2: Data Sources and Corresponding Analyses

Data Source	Analysis
MWCOG Activity Centers, depicted at transportation analysis zone (TAZ) level	Subarea Comparison (Geospatial Analysis)
Metro 2023 bus and rail ridership, received from Metro Office of Planning in August 2023	Metro Forecasts (Travel Demand Model)
ITE Trip Generation and ITE Parking Generation Manuals	Parking (Travel Demand Model)
Metro Equity Focus Communities (EFCs)	Accessibility Analysis
IMPLAN Economic Data, 2021	Economic Analysis
Municipal property data with parcel data, obtained through individual jurisdictions’ websites	Geospatial Analysis
Employment data (jobs, business entities), NAICS 2018	Geospatial Analysis
Census American Community Survey (ACS) Block Group population, land area, water area, and workers 16 years of age and older, 2020	Geospatial Analysis

Source: Fehr & Peers, 2024.

Analytical Tools

Table 3 lists the tools and software that the study team used to process datasets to produce results for this study.

Table 3: Analytical Toolkit

Tools	Analysis
ESRI ArcGIS Pro	Geospatial Analysis
MWCOG Transportation Planning Board (TPB) Travel Demand Forecasting Model (Ver 2.4)	Travel Demand Model
TREDIS	Economic Analysis
Remix	Accessibility Analysis

Source: Fehr & Peers, 2024.

ESRI ArcGIS Pro

ArcGIS Pro is a desktop GIS application that allows users to explore, visualize and analyze spatial data. It was used as part of the geospatial analysis for this study to understand how various metrics may differ between areas of the WMATA Compact Area.

MWCOG Transportation Planning Board (TPB) Travel Demand Forecasting Model (Ver 2.4)

To quantify the benefits of transit to the region, the team used MWCOG's TPB Travel Demand Forecasting Model to test two scenarios for the year 2025. The version of the model used for this project was Gen2/Ver 2.4, received on May 19, 2023, from MWCOG.

Travel demand models are used to predict future transportation patterns based on data representing land use and the transportation network of the area they represent. Based on land use data (which includes population, employment, and housing) and the transportation network, models estimate the total number of trips being generated, where these trips are going, what travel mode they use, and the paths they will take. These models are frequently used in transportation studies to estimate future travel patterns, especially how changes in land use and the transportation network may affect these patterns.

The following text in this section describes the TPB model, as summarized from the **User's Guide for the COG/TPB Gen2/Version 2.4 Travel Demand Forecasting Model (2021)** (https://www.mwcog.org/assets/1/6/mwcog_tpb_travel_model_v2.4_user_guide_final.pdf), and the Travel Demand Modeling section on MWCOG's website (https://www.mwcog.org/transportation/data-and-tools/modeling/.)

The TPB model is a classic, "four-step," trip-based, regional travel demand model. The two basic inputs to the travel demand model are:

1. Land use data – forecasts of future population, households, and employment throughout the region.

2. Highway and transit networks – including today's transportation system and any planned changes and improvements.

These inputs are then processed through a series of mathematical procedures and representations, broken down into four "steps." The four steps in a classic travel demand model are:

1. Trip generation
2. Trip distribution
3. Mode choice
4. Trip assignment

The first three steps estimate the demand for travel. The last step, trip assignment, is where the demand for travel is assigned to the transportation network and balanced with supply. **Figure 1** summarizes the flow of the TPB model. The TPB Version 2.4 Travel Model assigns trips both as:

- Private automobiles to a roadway network
- Person trips to the transit network

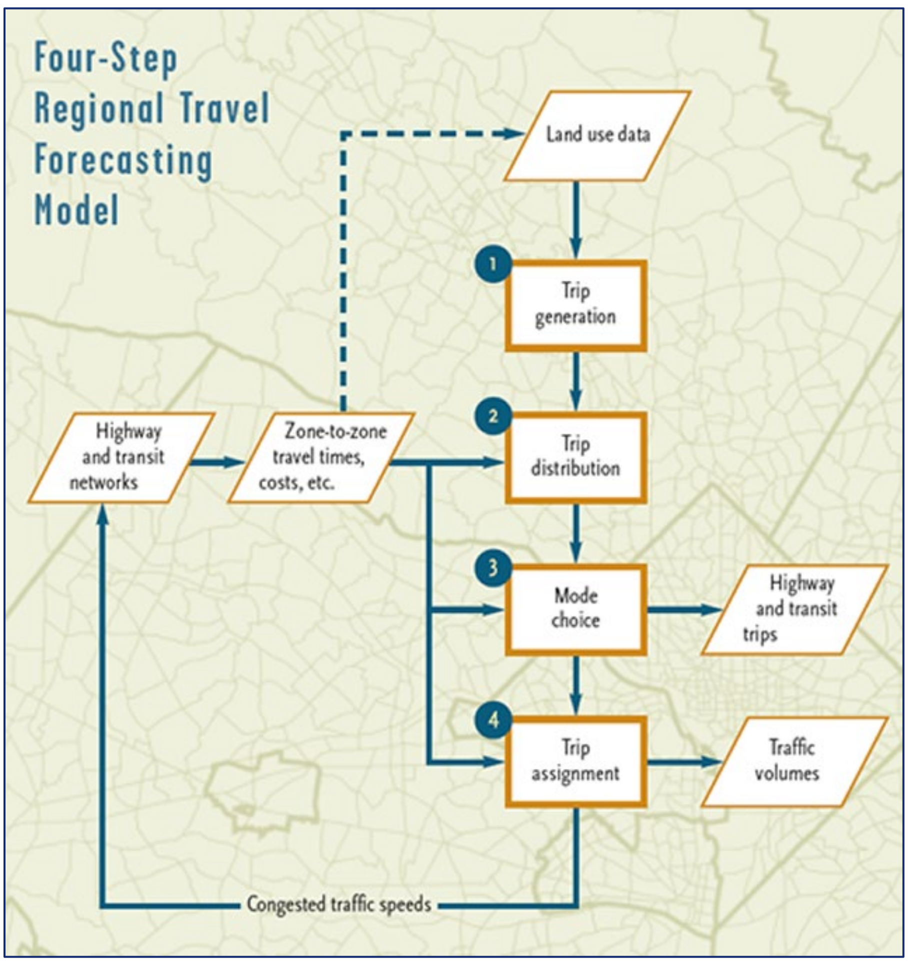

Figure 1: *Overview of the four-step model. (Source: MWCOG)*

In the TPB model, eight trip purposes are modeled. Five are for person travel: home-based work (HBW) trips, home-based shop (HBS), home-based other (HBO), non-home-based work (NHW), and non-home-based other (NHO). Two are for truck travel—medium truck and heavy-duty truck—and one is for non-freight commercial vehicles (e.g., delivery trucks, service vehicles).

The model ultimately estimates trips by travel mode, volumes on roadway segments, traffic speeds, origin-destination movements, and other transportation outcomes.

In step 1, trip generation, a set of equations is used to estimate the number of trips produced by and attracted to each zone based on its residential and employment characteristics.

In step 2, trip distribution, the produced trips in step 1 are linked geographically into complete trips. For example, trips produced by residents in Arlington, Virginia may be linked to trips attracted to an employment center in downtown Washington, DC. This process relies on the assumption that time spent traveling is perceived negatively, and so produced trips will be linked to attracted trips based on estimated trip length and time.

In step 3, mode choice, trips are assigned to modes based on relative availability and attractiveness of each mode. This includes travel time, cost, accessibility of transit, automobile ownership and proximity to carpool lanes.

In step 4, trip assignment, determines the routes travelers choose to reach their destinations. Automobile trips are assigned to the roadway network, and transit trips are assigned to the transit network. For roadways, the effects of congestion are considered. This is an iterative process, as shown in **Figure 1**. The model estimates congested roadway speeds, and these are fed back into prior modeling steps to ensure that the system is in equilibrium.

TREDIS 6

The economic modeling is conducted using TREDIS. TREDIS is a decision support system for transportation planners that spans benefit-costs analysis, economic impact analysis, and freight and trade impact analysis. It is used to evaluate economic outcomes of projects, programs, and policies. TREDIS is multimodal, and each TREDIS license is calibrated to a specific local, regional, or state economy—in this case the economy of the WMATA Compact Area.

The following text, as summarized from the **TREDIS 6 Technical Documentation: Dynamic Regional Economic Simulation Model (2023)** (https://tredis.com/pdf/User_Docs/TREDIS-6_Dynamic_Economic_Model_TechDoc.pdf) describes the workflow of the TREDIS model.

Baseline economic and demographic growth projections are part of the inputs to the model. The baseline includes economic measures (employment, wages, value added or gross regional product, and output) plus demographic measures (households, population, school age children, prime workforce-eligible age group, retirees/others).

Economic impacts of proposed transportation interventions are then calculated based on a specification of what the intervention will mean in terms of changes in spendings patterns (capital and operating costs to be expended), and changes in transportation system performance and use (in terms of trips, modes, routes, travel times and fees). The model also determines social costs associated with increased crashes (including insurance administration, loss of productivity at work, legal costs, property damage) separately from strictly monetary costs.

TREDIS consists of several model elements including:

- A travel cost module that translates changes in mode split, traffic volumes, vehicle occupancy, speed, distance, reliability, and safety into travel efficiency changes and direct cost savings for household and business travel.
- A benefit-cost module that calculates benefits and costs over time. Valuation follows international best practice, including the benefit-cost guidance of USDOT modal agencies.
- An economic adjustment module that incorporates a dynamic, multi-regional economic-demographic model to estimate economic impacts over time from changes in transportation system performance. The model accounts for changes in productivity, capital investment, labor supply and demand, employment and wage shifts, and population migration. Changes in supply, demand, and prices redirect spending patterns to different industries and affect their relative profitability and competitiveness. In this way various transportation changes can affect the magnitude of economic growth.

Remix

Remix is a planning platform for transit that allows users to calculate destinations accessible to transit riders using existing or custom transit routes and schedules. The Network Jane analysis in Remix was used to determine how many jobs, schools, grocery stores, and healthcare facilities are available to the average resident of the WMATA Compact Area by transit. The platform allows users to select geographies and add transit lines to their network, and Network Jane calculates the destinations accessible through transit across the selected areas through the specified transit lines. For this analysis, the WMATA Compact Area was selected as the study area, and all regional transit lines, including Metro, were included.

Traffic and Congestion

Table 4: Key Highlights Relevant to Traffic and Congestion

Key Highlight	*Analysis*
By 2025, transit will keep about 1.2 million cars off the road every day. Lined up in a row, those cars would stretch from Washington, DC to Alaska.	Travel Demand Model
Without transit, the region would have to spend $27 billion building 1,300 new miles of roadway – enough to cover 3 Arlington National Cemeteries. The region would also need $2 billion of new parking, enough additional cars to cover the National Mall in a 5-story parking garage.	Travel Demand Model
Driving on I-66, I-95, or New York Avenue would take twice as long, adding 20-30 minutes to every trip. Even for people who only commute 3 days a week, that's an extra 2-3 hours stuck in traffic each week.	Travel Demand Model

Source: Fehr & Peers, 2024.

Travel Demand Model

Scenarios

The purpose of using the travel demand model for this study was to understand how travel patterns in the region would respond to a lack of transit. The 2025 model was run because this most closely represents a near-term future without transit. The two scenarios run for this study are:

1. **2025 Baseline**
   No changes were made to the 2025 model, and it was run as received. This represents future conditions in which Metro, and other regional transit agencies, are able to function as planned without any reductions in service.

2. **2025 No Transit**
   To model a world without transit, all transit links in the model were deleted. The team removed all transit, rather than just Metro, because many regional transit providers offer services that are planned around connections with Metro. Therefore, a scenario without Metro service would likely impact their operations. No further changes were made to the transportation network, scripts, or land use values. The results from this model run show no trips in the region being assigned to transit. This represents future conditions without any transit service, including Metro.

The difference between these two scenarios represents the “benefits of transit” for this study. Comparing a region with transit to a region without transit allows us to isolate changes in travel behavior, and cascading socioeconomic impacts, that can be ascribed to the presence or absence of transit service.

Isolating the WMATA Compact Area

Using the “JUR” (jurisdiction) code in the model’s link attributes, links that were part of the WMATA Compact Area were isolated for output metrics. The following codes were included:

- 0/DC
- 1/Montgomery County

- 2/Prince Georges County
- 3/Arlington County
- 4/City of Alexandria
- 5/Fairfax County
- 6/Loudoun County

The cities of Falls Church and Fairfax (also part of the WMATA Compact Area) are incorporated into the above jurisdictions in the model. Travel demand model outputs were reported for the entire WMATA Compact Area and the three subregions that make up this area.

Results

The results from the travel demand model were both directly incorporated into the key highlights, and further processed using TREDIS to determine the impact of transit on the economy and the existing transportation network. The results from the model can be found in **Table 5**. Overall, the 2025 No Transit scenario shows greater vehicle trips and higher travel times, which may be attributed to fewer travel options resulting in increased congestion on roads. The results also show a reduction in trip length in the 2025 No Transit scenario, which suggests increased congestion is forcing drivers to work, shop, and pursue other opportunities closer to home.

The impact of transit on commute trips, average trip time, and trip length were calculated for HBW trips, as these represent work trips.

Regarding the key highlight in **Table 4**: 1.2 million "cars off the road" is the difference in total vehicle trips between 2025 No Transit and 2025 Baseline. Assuming that the "average" personal vehicle is 15 feet long, the total length of these vehicles, end-to-end, will be 18,678,870 feet, or 3,538 miles. The distance between Washington, DC, and the northern tip of Alaska (Utqiagvik, AK) is 3,474 miles.

To calculate road-specific commute times, roadway travel times for the direction and period of congestion were summed, and the difference between the two scenarios is reported in the key highlight in **Table 4**.

Table 5: Travel Demand Model Outputs

Metric	Area	2025 Baseline	2025 No Transit	Percent Change %
Total Vehicle Trips	DC	1,403,546	2,132,784	+52%
	MD	4,231,777	4,668,811	+10%
	VA	4,595,110	5,016,621	+9%
	Compact Total	9,209,470	10,454,728	+14%
Total Vehicle Miles Traveled (VMT)	DC	19,583,021	27,344,632	+40%
	MD	47,746,636	50,877,374	+7%
	VA	49,210,801	52,569,871	+7%
	Compact Total	101,153,036	111,260,259	+10%
Total Vehicle Hours Traveled (VHT)	DC	611,625	1,156,160	+89%
	MD	1,299,725	1,597,315	+23%
	VA	1,442,497	1,754,945	+22%
	Compact Total	2,829,676	3,634,588	+28%

Average Vehicle Trip Length (mi)	DC	14.0	12.8	-9%
	MD	11.3	10.9	-4%
	VA	10.7	10.5	-2%
	Compact Total	11	11	0%
Average Vehicle Trip Time (min)	DC	26.1	32.5	+25%
	MD	18.4	20.5	+11%
	VA	18.8	21.0	+12%
	Compact Total	18	21	+17%
Vehicle HBW Trips	DC	299,088	623,702	+109%
	MD	657,714	836,479	+27%
	VA	803,859	978,154	+22%
	Compact Total	1,480,590	2,000,610	+35%
VMT (HBW)	DC	6,549,744	10,584,076	+62%
	MD	12,592,438	13,942,476	+11%
	VA	14,559,288	16,060,933	+10%
	Compact Total	28,431,952	33,367,770	+17%
VHT (HBW)	DC	236,310	575,903	+144%
	MD	403,278	567,482	+41%
	VA	492,993	671,388	+36%
	Compact Total	929,241	1,400,524	+51%
Average Vehicle HBW Trip Length (mi)	DC	21.9	17.0	-22%
	MD	19.1	16.7	-13%
	VA	18.1	16.4	-9%
	Compact Total	19	17	-11%
Average Vehicle HBW Trip Time (min)	DC	47.4	55.4	+17%
	MD	36.8	40.7	+11%
	VA	36.8	41.2	+12%
	Compact Total	38	42	+11%
PM Peak Lane-Miles Congested	DC	17%	35%	+18%
	MD	9%	15%	+6%
	VA	10%	15%	+5%
	Compact Total	10%	17%	+7%

Source: Fehr & Peers, 2024.

Metro Ridership Adjustments for COVID-19

The travel demand model used for this analysis was originally not calibrated to COVID-19 transit ridership levels, and so transit results from the model were adjusted to conform to Metro's ridership estimates.

The COVID-19 pandemic led to a drastic decrease in the use of transit. Metro's bus and rail ridership data shows that although ridership is recovering, it has not yet reached pre-pandemic levels. This means that the 2025 ridership values from the travel demand model are an overestimation, and that Metro's ridership forecasts may provide a more accurate estimate. To account for changes in ridership that occurred because of the COVID-19 pandemic, the study team used the following steps to adjust the transit outputs from the model to match Metro's 2025 ridership forecast. All regional rail outputs were adjusted by the same factor as Metro's rail adjustments, and all regional bus outputs were adjusted by the same factor as Metro's bus adjustments.

1. Datasets Provided by Metro

- FY2024-2025 monthly ridership forecast
- 2023 ridership values for January through June 2023, including:
    a. Total monthly ridership
    b. Average total weekday entries
    c. Average weekday peak entries
- This analysis was carried out in late July of 2023. At the time, 2023 ridership data was available for January through June 2023

2. Model Assumptions

- Assumed that the travel demand model is calibrated to the average weekday
- Assumed that the FY2025 rail ridership estimates received from Metro have an 11% farecard non-tap rate, so rail forecasts only account for 89% of actual rail riders
- Assumed that buses have automatic passenger counters, so bus ridership is not affected by passengers not tapping farecards
- Assumed that other regional rail will require the same adjustment as Metrorail, and other regional bus will require the same adjustment as Metrobus

3. Ridership Factoring

- Using ratios from monthly totals, weekday average totals, and weekday average peaks, the team calculated the following values to incorporate into all transit outputs from the travel demand model, based on Metro's FY2025 forecast:
    a. Rail peak ridership
    b. Rail off-peak ridership
    c. Bus peak ridership
    d. Bus off-peak ridership
- The model transit outputs in the 2025 Baseline scenario were reduced to conform to the rail and bus ridership from Metro's forecast. Passenger hours, miles, and out-of-vehicle travel time were reduced by the same percentage as transit trips

Parking

The study team used the ITE Trip Generation (11^{th} Edition) and Parking Generation (6^{th} Edition) Manuals to calculate the additional parking that would be needed in a scenario without transit. To simplify calculations, parking requirement calculations were done for office and retail trips in the WMATA Compact Area, as other trip purposes reported by the TPB model are too diverse to calculate parking estimates for. All parking calculations are shown in **Table 6**. This table also includes the cost associated with constructing new parking.

Table 6: Parking Calculation

Metric	Calculation
Parking Space Per Trip (Office Employees)	Parking Demand Rate/Employee ÷ (Trip Generation Rate/Employee × 50%)
	0.84 ÷ (3.33 × 50%)
	0.50
Additional Office Parking Needed	Parking Space Per Trip × Increase in HBW Auto Trips × Percent Office Employment
	0.50 × 520,020 × 63%
	165,282
Parking Space Per Trip (Retail)	Parking Demand Rate/1000 SF ÷ Trip Generation Rate/1000 SF
	1.95 ÷ 3.40
	0.57
Additional Retail Parking Needed	Parking Space Per Trip × Increase in HBS Auto Trips × (Increase in HBW Auto Trips × Percent Retail Employment)
	0.57 × 11,493 × (520,020 × 15%)
	51,329
Additional Parking Needed (Total)	165,282 + 51,329
	216,611
Area Needed for Additional Parking	Minimum Parking Space Area (DC) × Additional Parking Spaces
	9 ft × 19 ft × 216,611
	1.33 sq mi
Cost	Land Cost + Construction Cost
	$299.6 million + $1.68 billion
	$1.98 billion

Source: ITE Trip Generation Manual (11th Edition), ITE Parking Generation Manual (6th Edition), Fehr & Peers, EBP, 2024.

The total office employment values for the WMATA Compact Area were pulled from the model's land use table, and this constitutes 63% of all employment in the WMATA Compact Area. Using the ITE Trip Generation Manual's trip generation rates for "General Office" (3.33 trips per employee during the AM period), parking spaces needed per trip for home-based work office trips were calculated.

This was multiplied by the increase in HBW Auto Trips reported by the model in the No Transit scenario. Since 63% of all employment in the WMATA Compact Area is categorized as "office," the resulting number of parking spaces was multiplied by 63%, assuming HBW trips are evenly distributed by employment type. The total number of office parking spaces needed was 165,282.

Parking was also calculated for retail trips, both work- and shopping-based (HBS and HBW) during the AM Peak. This methodology took a similar approach to that used for office parking.

Total retail employment in the WMATA Compact Area was pulled from the travel demand model's land use files, which makes up 15% of all employment. The ITE Trip Generation Manual's trip generation rates per employee for "Shopping Center (820)" were used (3.4 trips per 1000 SF during peak period) and the ITE Parking Generation Manual's parking demand rate for the same land use (1.95 per 1000 SF) are used to find the parking space needed per trip.

These rates are made up of trips made by both employees and shoppers. The total number of additional HBS and HBW Retail Trips (assuming all HBW trips are evenly distributed among employment types) were calculated between the two model scenarios, and the number of additional parking spaces needed was found by multiplying this difference by the parking space per trip calculated.

The combined additional spaces needed are 216,600, rounding to the nearest 100. This is a conservative estimate because it does not address the parking needs of other types of employment and trips.

To calculate the area needed to build these parking spaces, the Washington, DC minimum parking space dimensions of 9 feet in width and 19 feet in length was used. This results in each space requiring at least 171 square feet, and all additional spaces requiring at least 1.33 square miles in total. This space does not include any aisles, access drives, ramps, or columns, and therefore also represents a conservative estimate.

Additional parking is costly for the region as it requires both land purchases and construction. Based on Fehr & Peers' estimates of the number of additional office and retail parking spaces required, and the size of each parking space, EBP estimated the infrastructure costs as a combination of the land purchase price and construction costs, assuming that office parking is in a garage while retail parking is surface level. Based on that analysis, total parking infrastructure costs are $1.98 billion.

Regarding the key highlight in **Table 4**, the width of the National Mall's open space between Madison Drive NW and Jefferson Drive SW is 656 feet. Extended from the Lincoln Memorial to the Capitol Steps, this is around 0.26 square mile in area, which can be covered five times over by the 1.33 square miles of parking space required for office and retail trips if transit were not available.

Roadway Lane-Miles

The travel demand model outputs were used to calculate the increase in roadway lane-miles that would need to be constructed to accommodate the increase in congestion in a world without transit. The steps to calculate this, and the cost associated with this, are shown in **Table 7**.

Table 7: Roadway Lane-Mile Calculation

Metric	Calculation
Baseline Vehicle Miles Travelled Per Lane-Mile (PM)	VMT (PM) ÷ Roadway Lane-Miles
	30,009,707 ÷ 13,777
	2,178
No Transit Vehicle Miles Travelled Per Lane-Mile (PM)	VMT (PM) ÷ Roadway Lane-Miles
	32,848,960 ÷ 13,777
	2,384
Percent Change in Congestion	((No Transit – Baseline) ÷ Baseline) × 100%
	(206 ÷ 2,178) × 100%
	+ 9.46%
Additional Lane-Miles Needed to Maintain Baseline Congestion	Total Lane-Miles × Percent Change in Congestion
	13,777 × 9.46%
	1,303

Area Needed for Additional Lane-Miles	Lane Width × Additional Lane-Miles
	12 ft × 1,303 mi
	2.96 sq mi
Overall Cost of Additional Lane-Miles	Additional Lane-Miles × Overall Costs
	1,303 × $26.8 million
	$35 billion
Construction Cost of Additional Lane-Miles	Additional Lane-Miles × Construction Costs
	1,303 × $8.4 million
	$10.9 billion
Right-of-Way Cost of Additional Lane-Miles	Additional Lane-Miles × Right-of-Way Costs
	1,303 × $18.4 million
	$24 billion

Source: Fehr & Peers, 2024.

The study team compared AM and PM vehicle miles traveled (VMT) from the model and calculated VMT per lane-mile for PM, as this represents the time period with higher congestion. This VMT per lane-mile value is used as a proxy for congestion on roads in the WMATA Compact Area. It is indicative of the level of congestion expected in the roadway network. This value was found by dividing the total PM VMT by the total lane-miles.

There is a 9% increase in overall PM VMT per lane-mile between the 2025 Baseline and 2025 No Transit model runs. This is multiplied by the total number of lane-miles in the WMATA Compact Area to calculate additional roadway needed to maintain 2025 Baseline PM VMT per lane-mile. This calculation results in 15,080 lane-miles needed to maintain 2025 Baseline levels of congestion, which is an increase of 1,300 lane-miles (rounded to the nearest 100) from existing roadways.

A lane width of 12 feet was used to estimate 2.96 square miles needed to build the additional lane-miles. This is a conservative estimate, as it does not include additional right-of-way needed to construct roadways or infrastructure needed to support travel lanes.

The study team used the costs for several roadway construction projects from MWCOG's FY 2023-2026 Transportation Improvement Program (TIP) to determine the cost of constructing additional lane-miles in the WMATA Compact Area. Many projects do not separate right-of-way (ROW) cost from that of construction. The team also relied on a previous study to determine the cost of construction and subtracted this from the average TIP lane-mile cost to separate construction from ROW.

The cost of constructing the additional lane-miles was estimated using cost values from Metro's 2011 Making the Case for Transit study. This cost estimate was developed by a highway cost engineer, and was then verified against recent construction projects involving increasing lane capacity published by the Federal Highway Administration (FHWA) and the Departments of Transportation (DOTs) of the District, Maryland and Virginia. It was reported as $6.1 million per lane-mile in 2011. This cost was combined with the Federal Highway Administration's National Highway Construction Cost Index to determine the increase in roadway construction costs between 2011 Q1 and 2023 Q1. This comes out to $8.4 million per lane-mile.

To calculate additional right-of-way costs of new roadway construction, the study team retrieved the costs for several roadway construction projects from MWCOG's FY 2023-2026 Transportation Improvement Program that are within the WMATA Compact Area. Many of these. These projects have an average cost of $26.8 million per lane-mile. Subtracting the roadway construction from this results in average ROW costs coming out to $18.4 million per roadway lane-mile of construction.

Regarding the key highlight in **Table 4**: the area covered by Arlington National Cemetery is 639 acres, as of early 2020. This represents around 1 square mile in area, which can be covered three times over by 2.96 square miles of new roadway.

Jobs and Economy

Table 8: Key Highlights Relevant to Jobs and Economy

Key Highlight	Analysis
Metro station areas hold only 3% of the region's land, but they make up about 30% of property value ($330 billion), 30% of annual property tax revenue ($3.2 billion), and 40% of jobs (960,000). Metro station areas also host 65% of new office development, 50% of new multifamily rental housing, and 25% of affordable housing.	Geospatial Analysis
Metro stations have twice as many businesses, three times more jobs, and three times more property value than areas without Metro.	Geospatial Analysis
Over half of the region's 240,000 businesses—and more than 70% of its 2.5 million jobs—are within a half-mile of a Metro rail station or bus stop.	Geospatial Analysis
Transit saves the region $30 million a year in freight and shipping costs. Transit reduces congestion, which makes freight and deliveries cheaper and more reliable.	Geospatial Analysis

Source: Fehr & Peers, 2024.

Geospatial Analysis

The study team completed a geospatial analysis of socioeconomic data in the WMATA Compact Area using the following datasets:

- Land area (Census Block Groups)
- Population (Census Block Groups)
- Households (Census Block Groups)
- Businesses (Census Statistics of U.S. Businesses [SUSB])
- Jobs (Census SUSB)
- Assessed property values (received from Metro)
- Property tax revenue (received from Metro)

In addition to determining these values for the entirety of the WMATA Compact Area, these datasets were overlayed with half-mile radii buffers around Metro rail stations and bus stops to understand the proportion concentrated within these areas of high transit influence. These values were then compared to those calculated for the overall WMATA Compact Area and its subregions. The process to complete this analysis is outlined below.

GIS Workflow

The study team developed a GIS model that integrates the spatial data layers noted above, applies a buffer analysis to define influence zones, converts these zones to point and polygon features, and finally performs spatial apportioning to calculate the proportion of each socioeconomic variable present within the half-mile rail station and bus stop areas. The model includes the following steps:

1. Environment Settings and Data Preparation

    a. Configure the model's environment with a specific coordinate system and specify a scratch workspace for temporary data storage.
    b. Declare a set of input datasets and output feature class names for use in the model.
    c. Calculate land area by excluding water bodies, ensuring an accurate presentation of land.

2. Data Merging

    a. Merge multiple geographic datasets into a single output dataset, with specific field mappings defined for attributes.

3. Buffer Analysis

    a. Create buffer zones around Metro stations and bus stops of a radius of 0.5 miles.

4. Feature to Point Conversion
    a. Convert buffered areas to point features for both Metro stations and bus stops.

5. Thiessen Polygon Creation
    a. Generate Thiessen (Voronoi) polygons from the point features of Metro stations and bus stops.

6. Further Merging and Dissolving

    a. Merge and dissolve input feature classes (such as buffer layers of Metro Stations and bus stops, and parcel layers) to create unified spatial features, which involves combining similar geographic features into single entities.

7. Polygon Apportionment Analysis
    a. Apportion polygon tool is used to summarize the data of input polygon layers based on the spatial overlay of target polygon layers (in this project, buffer polygon layers from transit stations and bus stops).
    b. Apportion polygons based on the merged buffer and specific attributes like population, jobs, total housing, estimated annual tax revenue.

GIS Results

Table 9 shows the results of the GIS analysis described in the section above. Although rail and bus stops make up less than 24% of the WMATA Compact Area’s land area, and rail stations alone make up around 3%, the results from the geospatial analysis indicate that all metrics assessed are disproportionately concentrated in these areas. These results were used directly in three of the four key highlights shown in **Table 8**.

Table 9: GIS Analysis Results

Metric	Area	Total	Within Half-Mile of Metrorail Stations and Metro Bus Stops	Within Half-Mile of Metrorail Stations
Land Area (sq mi)	DC	68	62	23
	MD	1,006	264	21
	VA	978	164	24
	Compact Total	2,052	490	68
Population	DC	701,974	695,139	340,201
	MD	1,958,212	1,163,445	148,042
	VA	1,987,115	980,591	181,492
	Compact Total	4,647,301	2,839,175	669,735
Population (Equity Focus Communities Only)	DC	295,433	295,433	106,063
	MD	900,578	646,108	56,278
	VA	270,556	173,590	10,243
	Compact Total	1,466,568	1,115,131	172,550
Households	DC	288,307	286,121	153,360
	MD	688,459	416,542	65,316
	VA	725,493	389,602	89,686
	Compact Total	1,702,259	1,092,265	308,362
Businesses	DC	43,619	43,646	29,651
	MD	84,457	42,458	6,314
	VA	111,597	48,300	12,396
	Compact Total	239,673	134,404	48,361
Jobs	DC	639,391	611,489	491,118
	MD	748,248	480,973	167,395
	VA	1,073,833	648,597	302,847
	Compact Total	2,461,472	1,741,059	961,341
Property Value	DC	$307,426,664,769	$306,108,252,924	$212,857,074,466
	MD	$336,222,977,000	$189,932,450,328	$35,788,797,888
	VA	$465,153,940,925	$263,325,659,663	$80,718,669,827
	Compact Total	$1,108,803,582,694	$759,366,362,915	$329,357,165,719
Annual Tax Revenue	DC	$2,584,756,859	$1,836,649,518	$2,018,980,739
	MD	$3,760,555,598	$2,185,197,723	$382,631,028
	VA	$4,730,085,866	$2,680,929,201	$803,507,897
	Compact Total	$11,075,398,324	$6,702,776,442	$3,205,114,552

Source: Fehr & Peers, 2024.

Economic Analysis

TREDIS Setup

Travel demand model data was used as input data to TREDIS. The 2025 Baseline scenario data factored down transit ridership numbers to match Metro's FY 2025 average weekday ridership projections more closely. The 2025 No Transit scenario post-processing involved reducing the total number of person trips, to reflect trip suppression that would occur if transit was no longer available.

Travel demand data was reported for daily trips and was annualized for use in TREDIS using an annualization factor of 260 to capture total weekdays. Because taxi trips are not included in the travel demand data, EBP assumed that 45% of driving trips that would have been made on transit would be made by taxi instead when no transit was available, which is consistent with Metro's 2023 Metrorail Passenger Survey. Average transit fares were estimated based on National Transit Database (NTD) data on fare revenue and unlinked passenger trips. Average taxi fares were estimated based on DC's guidelines for taxi fares based on mileage. Tolls were estimated from the travel demand model. TREDIS uses 2021 IMPLAN data in the analysis.

Trip Suppression

The TREDIS model is meant to represent "Day 1" of a world in which transit no longer exists. This means that travelers have not had the time to adjust their home or work locations in response to changes in the transportation network. The outputs of the MWCOG model runs, however, assume that all modes, including a lack of transit, have been considered when considering trip productions and attractions. That is, the 2025 No Transit scenario represents a world in which residents have changed their home and work locations as needed to make their trips by other modes. This differs from "Day 1," in which many trips that were originally being made by transit will now be too inconvenient, and they will not be made by other modes until travelers have had time to change their home or work locations. Because of this distinction, model results will need to be "suppressed" for the TREDIS run. The methodology described in this section was only used to reduce the number of trips for the TREDIS model. Any findings reported from the travel demand model for this study do *not* include this suppression, because they represent a world without transit, as opposed to "Day 1" without transit.

The trip suppression that occurs on "Day 1" without transit may be attributed to:

- Congested roadways – the model assumes travelers will shorten their trips if the roads are too congested, which is not immediately possible.
- Transit-dependent population – the model assumes they will find another way to travel, which may not be possible if destinations have not changed yet.

Total Person Trips are reduced by the percent reduction in VMT per Person Auto Trip between the two scenarios. It is assumed that drivers cannot make shorter trips for the same needs, and this removes these trips from the 2025 No Transit results.

The Vehicle Trips for each time period and purpose are reduced by maintaining the average vehicle occupancy that the 2025 No Transit model originally reports. Average vehicle occupancy is the number of person trips divided by vehicle trips. The causes a reduction in overall Vehicle Trips in 2025 No Transit.

The VMT per Vehicle Trip (or the average miles traveled during each vehicle trip) from the 2025 NP scenario is preserved, because it is assumed that drivers cannot shorten their trips without any changes in land use. This causes a reduction in overall VMT in 2025 No Transit.

VMT is an output of the model's vehicle hours traveled (VHT) determination. That is, the distance that a person drives is calculated after the model determines how much time that trip will take. Therefore, VHT per Vehicle Trip from the 2025 No Transit scenario is preserved. This causes a reduction in overall VHT in 2025 No Transit.

Economic Performance Metrics

Societal Benefit Metrics

Societal benefits include reductions in the following:

- **Vehicle Operating Costs**: These include costs associated with tires, maintenance, depreciation, and fuel and are estimated on a per mile basis (reflecting changes in VMT). For mileage driven in congestion, additional fuel consumption costs reflect stop-and-go conditions. Electric vehicles incur lower per mile operating costs than conventional passenger vehicles.
- **Person-Based Travel Time and Reliability (Personal and Business)**: Travel time costs include the value of time for drivers, passengers, and crew. Reliability costs capture additional time costs associated with the "buffer time" that travelers add on top of average travel time to ensure an on-time arrival 95% of the time.
- **Freight Time and Reliability (Shipper/Logistics) Costs**: As with passengers and crew, freight travel time has an opportunity cost, which is related to handling or storage costs, lost sales or late delivery penalties, and production costs associated with holding extra inventory or raw materials. These costs accrue to shippers and receivers of freight.
- **Environmental Costs of Emissions**: This category is based on the change in emissions and reflects the monetized social value for each type of pollutant, based on economic costs of health impacts. Pollutants considered are: Carbon Dioxide (CO2), Nitrogen Oxide (NOx), Sulfur Dioxide (Sox), Volatile Organize Compounds (VOC), and Particulate Matter (PM). Changes in emissions are driven by changes in vehicle miles traveled (VMT) by mode, vehicle fuel efficiency, and changes in the proportion of vehicular travel occurring in congested conditions.
- **Safety Costs**: Crashes result in fatalities, personal injuries, and property damage, with each type of crash having an associated value. The number of crashes reflect overall travel exposure (as measured by VMT) and mode share (because some modes, like bus, are safer on a per mile basis compared to passenger car travel).

The net effects in terms of tolls, transit fares, and parking costs are also evaluated. These cost savings are beneficial to travelers in terms of providing affordable transportation options, but from an overall societal perspective represent transfers between parties (if someone no longer pays a toll, the toll collecting entity no longer receives the toll, etc.).

Economic Impact Metrics

Economic activity and growth are measured using four key metrics, reported for the year 2025:

- **Jobs**. Headcount of full and part time jobs.
- **Business Output**. Value of goods and services produced (revenue or sales).

- **Value Added**. Value of goods and services produced (business revenue) minus the cost of "intermediate consumption" (i.e., non-labor inputs). Value added is the sum of (1) income paid to workers and (2) income kept as business profit within a specified area. GDP, GRP & GSP are essentially measures of value added (at national, regional or state spatial levels).
- **Labor Income**. Value of compensation paid to workers (a portion of value added).

Note that business output, value added, and labor income are different metrics that can be used to quantify the same overall level of economic activity. They are nested concepts, where value added is a subset of business output, and labor income is a subset of value added. As such, they should never be added together.

Travel Time & Reliability Savings

Travel time and reliability savings are calculated based on changes in VHT between the two scenarios. Congestion levels in the 2025 No Transit scenario are a major driver of travel time and reliability savings. As shown in **Table 10**, Transit saves the region nearly $30 million a year in freight costs, and this value is reported in a key highlight in **Table 8**.

Table 10: Value of Time & Reliability Savings in Millions, 2025 (2021$)

Benefit	WMATA Compact Area	DC	MD	VA
Business Time and Reliability	$2,097.6	$801.3	$355.2	$427.0
Value of Personal Time and Reliability	$306.2	$292.9	$60.7	$221.1
Logistics/Freight Costs	$29.8	$13.3	$5.7	$6.3
Total Time-Related Benefits	**$2,433.6**	**$1,107.5**	**$421.6**	**$654.4**

Source: EBP, 2024.

Vehicle Operating Costs

Because the 2025 No Transit scenario requires more travel to occur in personal vehicles, overall vehicle operating costs increase when no transit is available. Vehicle operating costs include fuel, maintenance, and repair of personal vehicles. Providing transit saves users a total of $1.2 billion annually in the region, $486.3 million in DC, $252 million in Virginia, and $255.6 million in Maryland.

Total User Benefits

Total regional benefits by category for all travelers in the region are shown in **Table 11**. **Table 11** also presents a subset of benefits for people in each subregion. The benefits of the three subregions may not add up to the regionwide benefit, because the regionwide benefits include external users, like those traveling through, beginning, or ending their trip in the WMATA Compact Area.

Subregional benefits have been factored to be consistent with regional results. Factoring accounts for the fact that the travel demand model uses a more simplistic and less accurate method to estimate transit travel time by origin and destination at the subregional level that resulted in over estimation of travel time savings compared to regional estimates. The regional run provides the best estimate of the overall magnitude of benefits.

Table 11: Total Benefits Relative to the No-Transit Alternative in 2025, in Millions (in 2021 Dollars)

Benefit	Regionwide	DC	MD	VA
Vehicle Operating Costs	$1,150.4	$486.3	$255.6	$252.0
Business Time & Reliability	$2,097.6	$801.3	$355.2	$427.0
Value of Personal Time & Reliability	$306.2	$292.9	$60.7	$221.1
Safety	$946.5	$376.7	$204.6	$202.2
Logistics/Freight Costs	$29.8	$13.3	$5.7	$6.3
Environmental	$75.2	$48.0	$13.1	$19.7
Total Benefits	**$4,605.7**	**$2,018.5**	**$894.4**	**$1,128.4**

Source: EBP, 2024.

Household Savings

In addition to the user benefits above, which are included in a traditional benefit-cost analysis, transit enables additional household savings, considered transfers within the regional economy, but with significant impacts on the region's households.

As part of the TREDIS analysis, the team evaluated the total savings on taxi fares and tolls that is enabled by transit, which can be directly compared to transit fare expenditures to estimate household savings. In addition, transit allows households to avoid parking costs. Office parking needs were multiplied by the daily cost of parking inferred from the DC Parking Cashout Law Toolkit, while retail parking costs assumed 2 hours of parking at the DC meter rate. Error! Reference source not found. summarizes these savings.

Divided over the region's 1.7 million households, this amounts to $2,848 in annual savings per household.

Table 12: Household Savings

Savings Type	Savings in 2021 $ Millions
Taxi Fare Savings	$4,055
Toll Savings	$47
Spent on Transit Fares	-$391
Parking Savings	$474
Total	**$4,200**

Source: EBP, 2024.

Parking Infrastructure Cost Savings

Parking provision is also costly for the region as it requires both land purchases and construction. Based on estimates of the number of additional office and retail parking spaces required described in the “Traffic and Congestion” section of this report, and the size of each parking space (171 square feet), the study team estimated the infrastructure costs as a combination of the land purchase price and construction costs, assuming that office parking is in a garage while retail parking is surface level. Based on that analysis, total parking infrastructure costs are $1.976 billion.

Gross Regional Product (GRP) and Output

Gross Regional Product (GRP), or “value added,” considers the compensation of employees, taxes paid on production and imports, and gross operating surplus. On the other hand, business sales, or “output,” is a measure of gross business sales and incorporates the value of intermediate goods and services used in production, resulting in a higher measure than GRP. The total GRP for transit is $5.1 billion and total business sales is $9.4 billion.

Quality of Life

Table 13: Key Highlights Relevant to Quality of Life

Key Highlight	*Analysis*
Transit riders save about $2,800 a year by not having to pay for rideshares, taxis, parking, and tolls. It costs around $12,000 a year to own a car and an average of $1,500 a year to ride Metro, so households that don't have a car drive can save an extra $10,500 per year.	Economic Analysis
Transit creates economic efficiencies that support 64,000 non-transit jobs. Without transit, traffic congestion would slow down the economy, and those jobs might not exist.	Economic Analysis

Source: Fehr & Peers, 2024.

Economic Analysis

See "Jobs and Economy" section for a detailed description of this analysis.

Personal Transportation Costs

The team calculated the personal transportation costs associated with riding transit versus driving by comparing costs for Metro's monthly transit passes to those of owning and operating a car. A monthly transit pass can cost riders between $770 and $2,300 a year, depending on the distance traveled. This can be averaged to $1,500 per year for purchasing transit passes. The average cost of car ownership was $12,000 per year, according to AAA. This value is included in a key highlight in **Table 13**.

Jobs

Job estimates were created through the economic analysis described in detail in the "Jobs and Economy" section of this document. These job estimates include both part- and full-time positions. Annual capital and operating expenses under 2025 Baseline versus the No Transit scenario will result in an annual average of 64,072 net new jobs created and supported. This includes construction, operations and maintenance expenditures, additional household expenditures due to net new income, increased sales from local suppliers, and the transportation efficiencies that provide local businesses with improved access and reduced costs. This number does not include people who are directly employed by a transit agency, as a total of 14,399 regional transit agency jobs were removed. This value is included in a key highlight in **Table 13**.

Health and Environment

Table 14: Key Highlights Relevant to Health and Environment

Key Highlight	*Analysis*
Transit avoids an additional 1.2 million metric tons of greenhouse gases each year. That's the same as if all the households in Arlington, VA didn't use energy for an entire year.	Economic Analysis, Miscellaneous
Transit is 20 times safer than driving a car, saving the region $950 million a year in collision costs and avoiding nearly 30 deaths and over 2,500 injuries.	Economic Analysis
Transit improves health. People who ride transit walk as much as 30 minutes more a day, increasing heart health, building muscle, and reducing risk of heart disease, Type 2 diabetes, and some cancers.	Miscellaneous

Source: Fehr & Peers, 2024.

Economic Analysis

See "Jobs and Economy" section for a detailed description of this analysis.

Emissions

The level of emissions changes when transit is available. Changes in emissions are driven by changes in vehicle miles traveled (VMT) by mode, vehicle fuel efficiency, and changes in the proportion of vehicular travel occurring in congested conditions.

The document **Data Sources and Default Value (2023)** (https://www.tredis.com/pdf/User_Docs/TREDIS6_Data_Sources_and_Default_Values.pdf), accessed through TREDIS' website, includes the following details for emissions calculations. For passenger cars, light trucks, medium-duty trucks, heavy-duty trucks, and buses, the TREDIS team developed national emissions inventories for the years 2023-2027 using MOVES3. Emissions rates were aggregated for each year, and the final rates took the average of the five evaluation years. The TREDIS emissions inventories use MOVES3 default inputs without exception and were specified using all available road type combinations (i.e., urban/rural, restricted/unrestricted). The run specification and subsequent emissions rates include running, starting, and extended idle emissions processes for all pollutants. Aggregating engine starts into a distance-based emissions rate may be imprecise for project-level analysis. However, in aggregate regional analysis generalized over time using MOVES3's national inputs, this assumption is appropriate. Particulate matter includes brake wear and tire wear as well as exhaust emissions. Emission rates are provided in grams per vehicle mile travelled. Rail (diesel) emissions are based on factors used by the Surface Transportation Board's Section on Environmental Analysis' in a 2008 draft environmental impact statement concerning CN's proposal to acquire control of EJ&E West Company. These rates are shown in **Table 15**.

For CO_2, emissions are calculated using production factors associated with gallons of different fuel types consumed. These values can be found in **Table 16**.

The environmental sustainability savings reflect the monetized social value for each type of pollutant, based on economic costs of health and environmental quality impacts. Pollutants considered are: Carbon

Dioxide (CO2), Nitrogen Oxide (NOx), Sulfur Dioxide (Sox), Volatile Organize Compounds (VOC), and Particulate Matter (PM). Metric tons saved are in **Table 18.**

The costs associated with emissions are taken from the US DOT BCA Guidance, dated January 2023, which set emissions values for PM 2.5, SOx and NOx for years 2022 through 2050, all in 2021 dollars. For VOC, cost is taken from the US DOT BCA Guidance January 2020 edition, when it gave a single value in 2018 dollars. These are shown in **Table 17**.

Table 15: Emissions Rates in Grams Per Vehicle Mile Travelled (Data Year 2021)

Mode	VOC	NOx	SO2	PM 2.5
Passenger Car	0.2080	0.1705	0.0021	0.0092
Light-Duty EV	0.0000	0.0000	0.0000	0.0050
Light/Medium Truck	0.2456	0.7227	0.0031	0.0231
Heavy Truck	0.1708	3.5446	0.0053	0.0700
Bus & BRT	0.3727	2.8327	0.0061	0.0397
Rail – Diesel	13.2721	275.3306	0.2014	8.6881
Rail – Electric	0.0000	0.0000	0.0000	0.0000
Rail Freight	47.4458	984.4327	0.7199	31.0711
Water	0.0000	0.0000	0.0000	0.0000
Aircraft	0.0000	0.0000	0.0000	0.0000

Source: TREDIS, 2023.

Table 16: CO2 Production Factors

Fuel Type	CO2 Emissions
Gasoline	19.6 lbs. per gallon consumed
Diesel	22.4 lbs. per gallon consumed
Maritime	22.4 lbs. per gallon consumed
CNG	14.83 lbs. per GGE consumed
Aviation	19.75 lbs. per gallon consumed

Source: TREDIS, 2023.

Table 17: Costs per Metric Ton of Emissions, 2025

Metric	VOC	NOx	SOx	PM 2.5	CO2
Costs per metric ton	$2,500	$17,200	$46,900	$838,800	$59

Source: TREDIS, 2023.

Table 18 shows the results of emissions analysis between the 2025 Baseline and 2025 No Transit scenario. Emissions of all types increase when transit is removed from the transportation network, except for NOx. This may be because NOx emissions are impacted by commuter rail, and the analysis therefore decreases NOx emissions when commuter rail is removed from the WMATA Compact Area.

Using the emissions costs estimates in **Table 17** and the emissions in **Table 18**, total savings in the region annually are $75 million, $48 million in DC, $19.7 million in Virginia, and $13.1 million in Maryland.

Regarding the key highlight in **Table 14**: the study team used the US Environmental Protection Agency's (EPA) Greenhouse Gas Equivalencies Calculator (www.epa.gov/energy/greenhouse-gas-equivalencies-calculator) to convert carbon dioxide emissions outputs shown in **Table 18** into the equivalent amount of household energy use. This translates to 151,240 homes' energy use for one year. Per the 2017-2021 ACS, there are 109,528 households in Arlington County, fewer than that needed to generate the metric tons of greenhouse gases added between the 2025 Baseline and 2025 No Transit scenario.

Table 18: Metric Tons Saved of Criteria Pollutant Emissions, 2025

Area	VOCs	NOx	SOx	PM 2.5	CO2
WMATA Compact Area	645	-289	6	8	1.2 million

Source: EBP, 2024.

Safety

Crash estimates were calculated as part of the economic analysis. Rates of vehicle crashes, crashes with serious injuries, and fatalities were collected for the DMV region for passenger vehicles, buses, heavy rail, and commuter rail. Rates of highway fatalities and serious injuries come from MWCOG estimates over 2017-2021. Bus and heavy rail fatalities, serious injuries, and crash rates come from NTD reporting, averaging rates over 2018-2022. Commuter rail fatalities and injuries are from the Federal Railroad Administration dashboard, with rates calculated from data for 2017 to 2023.

he analysis shows 28 fatalities, 2,539 injuries and 15,249 incidents of property damage associated with crashes are avoided each year through the decrease in VMT that occurs through transit.

Overall, transit provision saves $947 million in the region annually, $376.7 million in DC, $202.2 million in Viriginia, and $204.6 million in Maryland. These values are incorporated into a key highlight in **Table 14**.

Miscellaneous

The team consulted published sources, including Chris Rissel, Nada Curac, Mark Greenaway, and Adrian Bauman's *Physical Activity Associated with Public Transport Use—A Review and Modelling of Potential Benefits* (www.ncbi.nlm.nih.gov/pmc/articles/PMC3407915); EPA's Air Pollution and Cardiovascular Disease Basics (www.epa.gov/air-research/air-pollution-and-cardiovascular-disease-basics); and the Government of Victoria, Australia's Walking for Good Health guide (www.betterhealth.vic.gov.au/health/healthyliving/walking-for-good-health) to develop the key highlight related to transit's health benefits in **Table 14**.

Other Analyses

Remix

The Network Jane analysis tool was run in Remix's transit platform using Metro's rail and bus network. This analysis calculates the destinations accessible through transit using the existing pedestrian and roadway network, in addition to user-added transit lines. Other transit providers in the region were also included in the analysis. This was done because providers like ART, Dash, and Ride On have routes that are closely tied to Metro's services, and in a scenario without Metro, it is unlikely that these operators would continue existing service levels.

The analysis was run for all jurisdictions in the WMATA Compact Area except Loudoun County. Since Metro recently started service in Loudoun County (ignoring the express bus service WMATA previously provided to Dulles Airport), and because the county is sparsely populated, the team assumed that access to destinations through transit would be negligible.

The accessibility analysis was run for the AM and PM peak periods, for both 30 and 60 minutes for all destinations. The output of this analysis—a GIS layer showing destinations accessible in a hex grid overlaying the WMATA Compact Area—was aggregated into subregional (District of Columbia, Maryland, and Virginia) and Compact Area results and weighted by population. This meant that any sparsely populated hex grid cells, where transit was not able to provide access to a high number of jobs, did not skew the average down.

The GIS layers that were produced from the Remix analysis were also overlayed with Metro's EFCs to calculate the destinations accessible through transit for those beginning trips from EFC neighborhoods, and how this may differ from overall accessibility for the region.

The results of this accessibility analysis are included in **Table 19**.

Table 8: Accessibility Analysis Results for All Areas and Metro Equity Focus Communities Only

Area	Metric	Accessible by Transit	Accessible by Transit (EFC Only)
WMATA Compact Area	Jobs within 60 min	251,900	276,200
	Schools within 30 min	13	16
	Grocery stores within 30 min	12	15
	Hospitals and urgent cares within 30 min	9	10
Maryland	Jobs within 60 min	157,800	168,500
	Schools within 30 min	7	8
	Grocery stores within 30 min	10	7
	Hospitals and urgent cares within 30 min	6	6
Virginia	Jobs within 60 min	204,700	224,500
	Schools within 30 min	7	8
	Grocery stores within 30 min	8	14
	Hospitals and urgent cares within 30 min	8	9
DC	Jobs within 60 min	620,300	597,300
	Schools within 30 min	45	46
	Grocery stores within 30 min	28	37
	Hospitals and urgent cares within 30 min	21	19

Source: Fehr & Peers, 2024.

MWCOG Activity Centers Comparison

The study team repeated the geospatial analysis to compare how jobs, businesses, property value and property taxes differ between MWCOG Activity Centers with Metro rail access and those without. Activity Centers are locally-identified existing urban centers, priority growth areas, traditional towns, and/or transit hubs. These are considered a priority for growth and inform decision-making for MWCOG and other regional agencies. MWCOG's current Activity Centers are developed with local planning officials and the Region Forward Coalition, and approved by the COG board.

The team used MWCOG's TAZ depiction of Activity Centers to create boundaries for clusters of Activity Centers, and these were grouped by neighborhood and defined as "subareas." A subarea was selected from each jurisdiction in the WMATA Compact Area, except Loudoun County, where some datasets predate Metro rail access. The City of Alexandria was also excluded because Activity Centers in this jurisdiction with Metro rail access are too close in proximity to those without.

"Metro rail access" was defined as being within 1000 feet of a Metro station entrance. Jobs, property value, property tax and businesses were then summed from the Census Tract level to the subareas. Subareas that are within the same jurisdiction (e.g. Rosslyn-Ballston Corridor and Columbia Pike Corridor in Arlington County) were then compared to see how Metro access may have shaped Activity Centers within the same jurisdiction.

Table 20 shows the results of this analysis for subareas in all jurisdictions that make up the WMATA Compact Area, save Loudoun County.

Table 9: Activity Centers with and without Metro Access

Activity Centers	Metric	With Metro Rail	Without Metro Rail	Difference with Metro Rail
WMATA Compact Area Total	Area (Sq Mi)	97	141	-44
	Jobs	1,122,410	422,342	+700,068
	Businesses	56,692	23,768	+32,924
	Property Value	$376,424,341,978	$121,742,349,783	+$254,681,992,195
	Property Tax	$3,654,526,265	$1,226,857,095	+$2,427,669,170
Arlington County, **Rosslyn-Ballston Corridor** (with Metro rail) and **Columbia Pike Corridor** (without Metro rail)	Area (Sq Mi)	2.03	3.41	-1.38
	Jobs	80,237	9,620	+70,617
	Businesses	2,706	1,194	+1,512
	Property Value	$19,693,716,690	$8,100,327,719	+$11,593,388,971
	Property Tax	$187,090,309	$79,187,564	+$107,902,744
Fairfax County, **Tysons** (with Metro rail) and **Fairfax Center** (without Metro rail)	Area (Sq Mi)	3.52	10.69	-7.17
	Jobs	89,901	66,434	+23,467
	Businesses	1,070	3,019	-1,949
	Property Value	$16,867,057,487	$16,085,490,172	+$781,567,316
	Property Tax	$181,824,522	$160,995,295	+$20,829,228
Prince Georges County, **College Park** (with Metro	Area (Sq Mi)	3.45	5.13	-1.68
	Jobs	7,928	2,545	+5,383

rail) and **National Harbor** (without Metro rail)	Businesses	710	402	+308
	Property Value	$3,716,004,400	$3,758,881,882	-$42,877,482
	Property Tax	$49,794,459	$50,363,860	-$569,401
Montgomery County, **Bethesda** (with Metro rail) and **Kensington** (without Metro rail)	Area (Sq Mi)	1.82	4.74	-2.92
	Jobs	55,629	6,877	+48,752
	Businesses	1,249	1,708	-459
	Property Value	$7,333,597,160	$5,170,436,360	+$2,163,160,800
	Property Tax	$72,602,612	$51,187,320	+$21,415,292
Washington, DC, **Navy Yard** (with Metro rail) and **Georgetown/Glover Park** (without Metro rail)	Area (Sq Mi)	1.82	1.71	+0.11
	Jobs	14,539	8,987	+5,552
	Businesses	1,034	1,183	-149
	Property Value	$14,925,471,662	$8,431,351,003	+$6,494,120,658
	Property Tax	$96,113,003	$73,240,718	+$22,872,285

Source: Fehr & Peers, 2024.