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A Summary of the TPB and COG Scenario Study Findings

Informing Planning for the Metropolitan Washington Region

National Capital Region
Transportation Planning Board

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TRANSPORTATION PLANNING BOARD (TPB) SCENARIO PLANNING STUDIES – SUMMARY OF FINDINGS

DRAFT

This document reviews the eleven scenario studies that COG and the TPB have conducted over the last 15+ years and presents a summary of findings.

November 3, 2022

TPB SCENARIO PLANNING STUDIES – SUMMARY OF FINDINGS Prepared by TPB staff based on reports from past scenario studies.

ABOUT THE TPB

The National Capital Region Transportation Planning Board (TPB) is the federally designated metropolitan planning organization (MPO) for metropolitan Washington. It is responsible for developing and carrying out a continuing, cooperative, and comprehensive transportation planning process in the metropolitan area. Members of the TPB include representatives of the transportation agencies of the states of Maryland and Virginia and the District of Columbia, 24 local governments, the Washington Metropolitan Area Transit Authority, the Maryland and Virginia General Assemblies, and nonvoting members from the Metropolitan Washington Airports Authority and federal agencies. The TPB is staffed by the Department of Transportation Planning at the Metropolitan Washington Council of Governments (COG).

CREDITS

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1. EXECUTIVE SUMMARY

The Executive Summary is under development.

2. INTRODUCTION

Scenario planning is an important and often used tool to help planning agencies examine possible futures, test strategies, and inform decision-making regarding investments in projects, programs, and policies to achieve goals. The Metropolitan Washington Council of Governments (COG) and the National Capital Region Transportation Planning Board (TPB) have conducted numerous scenario planning activities and analyses to predict and prepare for the future of the region. This document reviews the analyses that COG and the TPB have conducted and presents a summary of findings. The region's planning agencies can use these findings to inform future projects, programs, and policies to support integrated planning to help achieve the numerous and broad goals of the TPB's policy framework.

1.1. What is Scenario Planning?

Scenario planning is a practice by which organizations and communities plan for an uncertain future by exploring multiple possibilities of what might happen. A scenario depicts a potential future generated by external forces that are largely beyond an agency's control, actions within an agency's purview, or a combination of both.[1] Scenarios can be depicted as narratives or as charts and maps illustrating trajectories of change over time.

1.2. Types of Scenario Planning

There are three types of scenario planning: predictive, normative, and exploratory. Table 1 lists the type of scenario planning used in each of the recent COG and TPB studies.

- Predictive is the most common of these being predictive scenario planning. Travel demand modeling techniques are used to shape integrated land-use and transportation scenarios, especially in environmental sustainability and multimodal accessibility. This form of planning uses alternative strategies that are tested against a forecast of future conditions extrapolated from past trends. Typically generating scenarios of anticipated system performance by combining one forecast of land development conditions (e.g., predicted numbers of jobs and households in a geography) with different packages of potential transportation improvements (e.g., adding more lane miles of roadways, increasing transit service coverage, or making no new capital investments).

Scenario Planning for uncertain future conditions typically takes one of two forms:

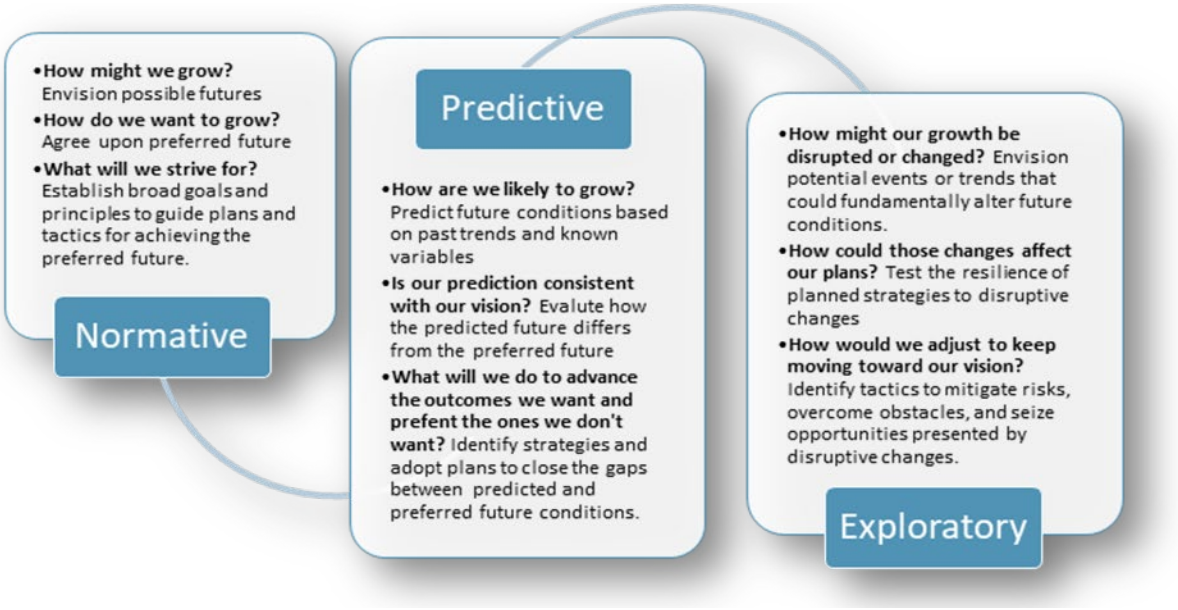
- Normative – A value driven process to build consensus toward a vision for a desired end state.

[1] Definition developed by the TPB staff Oversight Committee for the Organization Awareness and Understanding of Scenario Planning report.

- Exploratory – A Tactical process to identify strategies for managing risks and leveraging opportunities to achieve long-term goals under a variety of different potential future conditions.

Predictive scenario planning puts the focus on reacting to predicted future conditions, while normative and exploratory scenario planning emphasizes preparing for desired future conditions.

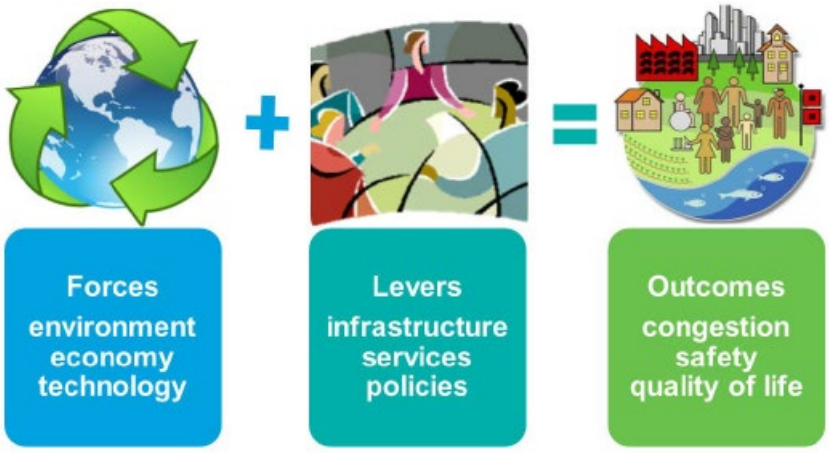
Figure 1 Three Types of Scenario Planning Processes



Source: TPB report: Organization Awareness and Understanding of Scenario Planning, 2021, Page 2

Scenario analysts develop plausible descriptions of future conditions by combining assumptions about changes in external forces that are largely beyond the control of a single person or agency (e.g., socio-economic, technology, environmental trends) with potential actions or "levers" (e.g., infrastructure investments and public policies) that could be applied to influence outcomes (e.g., travel demand, transportation network characteristics, and land development patterns).

Figure 2 Inputs and Outputs of Scenario Planning Studies



Source: TPB report: Organization Awareness and Understanding of Scenario Planning, 2021, Page 2

1.3. The TPB Policy Framework

For the TPB's Long-Range Transportation Plan Technical Inputs Solicitation, the projects, programs, and policies submitted by sponsoring agencies should uphold the TPB planning principles, advance one or more regional goals, and implement the TPB priority strategies to support desired performance outcomes as reflected in the summarized policy framework.

How we define principles, goals, strategies, and performance outcomes:

- **Principles:** Principles are values that the TPB holds. An equitable transportation system is one that incorporates and upholds these principles or values.
- **Goals:** What we as the TPB aim to accomplish.
- **Strategies:** How we intend to accomplish our goals through multimodal transportation projects, programs, polices, and technologies.
- **Performance Measures:** How we determine the impact of the planned strategies and if we have succeeded in advancing or reaching our goals.

THE TPB PRINCIPLES

Equity: The TPB has adopted equity as a key principle to promote fairness and justice. The TPB sees equity considerations as an integral part of all its principles, goals, and strategies. Equity in transportation includes the distribution of affordable and readily available multimodal travel options throughout the region that encourage safe and efficient mobility.

Accessibility: All people who use the transportation system in the region, including residents, visitors, and businesses, should be granted reasonable physical and affordable access to travel by road, transit, biking, walking, micromobility, water, and housing choices. The TPB seeks a broad range of public and private transportation options that maximize physical access and affordability for everyone and minimize reliance on a single mode.

Sustainability: Transportation infrastructure and programs in the region should be financially and structurally sustainable, promoting regional interconnectedness and longevity based on growth patterns, projected demand and capacity, and technology. Sustainability also results from a significant decrease in greenhouse gas emissions, efficient use of energy, and meeting or exceeding standards for air, water, and land quality and protection. Also, retaining and preserving appropriate green space, public space, and historic and cultural resources are integral to a sustainable transportation network.

Prosperity: The National Capital Region's prosperity depends on growing a diversified, stable, and competitive economy that offers a wide range of employment opportunities. The regional transportation network should be an asset to attract high quality employers. It should minimize economic disparities and enhance the prosperity of each jurisdiction and the region through balanced growth and access to high-quality jobs and greater access to education for all levels.

Livability: Vibrant, healthy, and safe neighborhoods are the heart of the region's livability. Livability revolves around a range of travel and housing choices that are affordable, and accessible to all community resources, including services that promote health and wellness. The region's transportation network should continue partnerships within and between jurisdictions to manage emergencies, protect public health and safety, and support economic well-being.

THE TPB GOALS

Safety: The safety of all users, including travelers and maintenance and operations personnel alike, should be ensured on all parts of the transportation system at all times. To provide a safe transportation system:

- Maintain the system in a state of good repair.
- Communicate across numerous media platforms.
- Conduct ongoing transportation operator training and education.
- Provide ongoing traveler education and corresponding law enforcement.
- Incorporate safety in system design and operations, including emergency services.

Maintenance: All aspects of the transportation system's infrastructure should be maintained in a state of good repair to provide reliable, safe, and comfortable mobility to all its users. Maintaining the existing system is a top priority that takes precedence over new systems. To maintain the existing system in a state of good repair:

- Conduct regular checkups and programmed maintenance to ensure roads provide a smooth, safe ride, bridges are trustworthy, buses, train cars, stations, and rails function reliably.
- Ensure bicycle paths and sidewalks are passable and free of debris and obstacles.
- Proactively maintain transportation technology such as lights, signals, and signs, necessary for safe and efficient function of the entire system.

Reliability: Any and all options of travel available should be reliable to get the user to their destination on time every time. To make travel reliable:

- Maintain and operate the system using effective technology.
- Reduce congestion on roadways and crowding on transit.
- Provide frequent service that is responsive to predictable changes in demand throughout the day.

- Make transit, biking, walking, micromobility and expanding alternatives such as water travel competitive travel choices.

Efficient System Operations: Implement transportation systems management and operations:

- Apply technology for improved efficiency.
- Conduct integrated management practices.
- Plan for cross-agency incident response.
-

Affordable and Convenient: Provide affordable, realistic multimodal options:

- Offer convenient travel times, reasonable costs, and flexibility for commuters, including late-shift workers.
- Make it possible for travelers to choose from more than one type of mode for each leg of a trip.

Environmental Protection: Provide, facilitate, and incentivize methods that build, operate and maintain the transportation system in a manner that provides for healthy air, water, and other environmental factors. Protecting the environment includes meeting federal air quality standards and meeting the TPB's climate goals: reduce greenhouse gas (GHG) emissions 50 percent below 2005 levels by 2030 and 80 percent below 2005 levels by 2050. To minimize environmental impacts:

- Offer an interconnected multimodal system, with integrated services and technologies.
- Encourage and implement travel demand management strategies.
- Keep up with transportation vehicle and energy technologies that reduce emissions of pollutants including GHG.

Resilient Region: The region's transportation system should remain able to move people in the face of one or more major obstacles to normal function. These obstacles could include extreme weather events, major accidents and incidents, and equipment or infrastructure failures. This goal includes becoming a Climate Ready Region and making significant progress by 2030. It also includes the need to incorporate equity principles and expand education on climate change into its members' actions to reach climate mitigation and resiliency goals. To build resiliency:

- Prepare contingency plans for operations and maintenance.
- Coordinate across sectors (transportation, land-use, environment) to implement strategies that address multiple community planning challenges.
- Provide options for travel and goods movement, design and use of technologies.

Livable and Prosperous Communities: Support regional economic competitiveness and opportunity and a high quality of life for all people.

- Implement a range of strategies that help to achieve each of the TPB principles and goals.
- Support a high-quality transportation system to attract businesses to the region.
- Shorten trips and minimize delay so that residents and visitors enjoy more time with family and friends.

1.4. Why does the TPB do Scenario Planning?

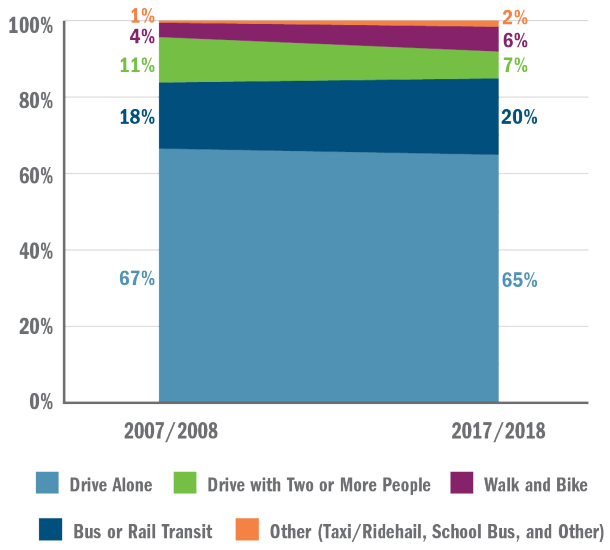
The TPB policy framework includes a set of broad transportation planning goals that provide policy guidance to shape the region's transportation projects, programs, and policies. Achieving the goals for the future transportation system and how it serves our communities is not without significant challenges. The TPB's latest long-range transportation plan, the Visualize 2045 update (Approved

June 15, 2022), discusses those challenges and the TPB's response to address them including coordination, planning activities, and priority strategy identification. The plan highlights projects, programs, and policies that the TPB member agencies implement to address these challenges.

The TPB has identified challenges to meeting its goals by conducting regular performance analysis of the transportation system. Challenges create barriers to achieving our shared regional goals and show us where we must focus and prioritize our efforts. The TPB has also conducted numerous studies, including the many scenario studies summarized in this document to test strategies (projects, programs, and policies) to address these challenges. Applying the most effective strategies, the TPB's members then take steps to plan, analyze, program, and implement based on local context and authority. The LRPTF, for example, specifically responded to the challenges enumerated in the TPB's Regional Priorities Plan and led to the endorsement of the TPB's seven Aspirational Initiatives.

Some of the region's primary transportation challenges include, but are not limited to, concerns such as roadway congestion, including travel time and bottlenecks, transit crowding, insufficient bus service, and unsafe walking and biking. Other challenges include meeting the need for more development where multimodal transportation options can be made available, such as in Activity Centers and near High-Capacity Transit stations. Ensuring safety for all users on the transportation system is another significant challenge that matters to all. Improving the equity outcomes of the transportation system is yet another challenge. The TPB recognizes that protecting the environment, including wildlife habitat and water, is essential while developing our region and the transportation that serves it. Mitigating climate change and planning for resiliency is critical to ensure quality of life for all.

Figure 3 Change in Mode Share of Commute Trips, 2007/2008 – 2017/2018 (Source: 2007/2008 and 2017/2018 TPB RTS)



To inform challenges, the TPB uses surveys to report on "where we are today" and conducts forecasts to understand the potential future performance of the transportation system. Through the TPB's Regional Travel Survey (RTS), the TPB monitors the regional totals for trips by type and mode. Figure 3 shows the recent trends based on observed data, comparing the change in mode share of commute trips, for survey years 2007/2008 – 2017/2018. Approximately 17 million trips are taken per day on all modes of transportation for all purposes, including travel to work, school, medical appointments, and other destinations. Of those trips, 41 percent are people driving alone, 38 percent are in a vehicle with two or more people, 11 percent are by walking

or biking, 6 percent are by bus or rail transit, and the remaining 5 percent use taxi/ride hail, school bus, and other services.[2]

Over the past 10 years, shares of single occupancy vehicle trips and carpool trips for all purposes have remained steady. For commute trips, shares of single occupancy vehicle and carpool trips decreased while other modes such as bus transit, walk, bicycle, and taxi/ride hail increased. Following this trend, the share of single occupancy vehicle trips will likely continue to decline slightly as additional transit services come online, as bicycle and pedestrian infrastructure continues to grow, and land-use policies push for the concentration of jobs and households in regional Activity Centers (Figure 3). The decline in driving is happening but is slight, as one might expect, given freight and other commercial travel, and non-commute trips, not all trips by vehicle can be substituted for transit, biking and walking.

The performance analysis of the Visualize 2045 update (Figure 3) forecasts that the region will make progress on many of its goals, due in part to the inclusion of projects that align with the Aspirational Initiatives that the TPB calls on its members to advance. The land-use inputs used in the TPB's LRTP performance analysis, COG's Round 9.2 Cooperative Forecast data, suggest that the region is looking to bring jobs and housing closer together through targeted density increases in certain parts of the region.

People will have more and improved travel options in 2045 and that is reflected in the performance forecasts. The region will increase availability and use of High-Capacity Transit (HCT) and other "reliability-enhanced" modes (such as rail, bus rapid transit, walk and bike, and High Occupancy Toll and High Occupancy Vehicle lanes), decrease driving per person, and improve average access to jobs.

However, growth will likely continue to place heavy demands on the transportation network. The region expects 19 percent growth in population and 23 percent increase in jobs by 2045 compared to 2023.[3] While this growth is expected throughout the region, it will likely be focused in Activity Centers and HCT station areas, where 67 percent of jobs and 24 percent of residents are predicted to be located. While the increase in use of biking, walking, and transit are promising, these options still make up less than half of all commute trips. The Visualize 2045 performance analysis forecasts that the VMT per capita in the region will decrease by 3 percent for all types of drivers while still experiencing a 15 percent increase in VMT. It forecasts a 48 percent increase in daily vehicle hours of delay. These are substantial challenges as the roadway system needs to accommodate more vehicles with comparatively less expansion (5 percent increase in roadway miles).

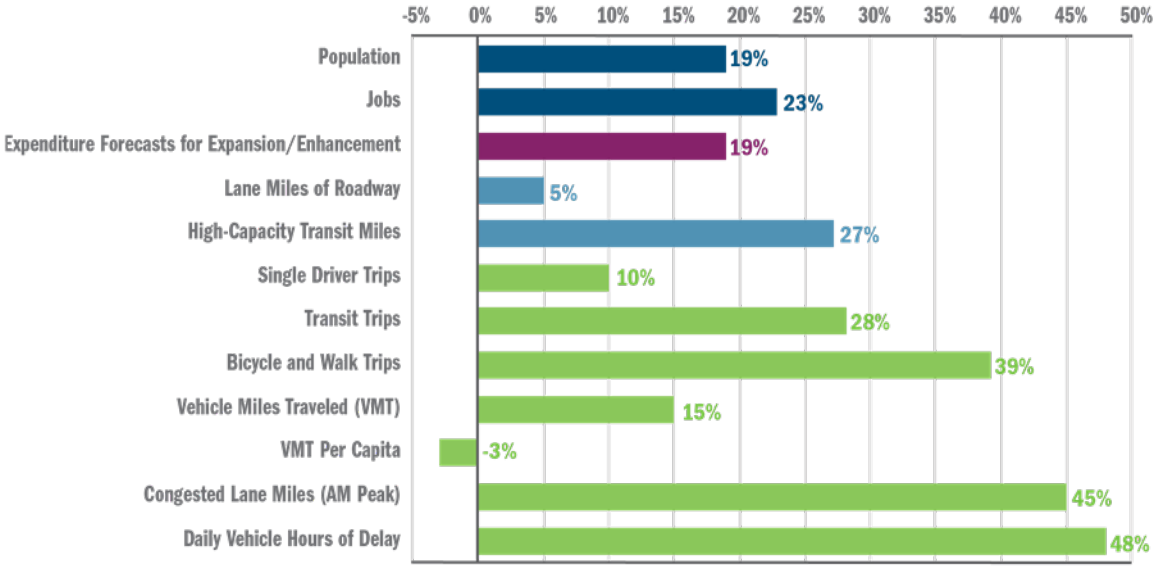
The region's financial obligations to maintain and operate the existing system limit the availability of funds for system expansions and enhancements, providing for an additional five percent in roadway

[2] National Capital Region Transportation Planning Board, 2017/18 Regional Travel Survey; mwcog.org/transportation/data-and-tools/household-travel-survey/

[3] Population and Job figures presented in this section use a 2023 base year and are different from figures presented in other sections of this plan, notably Chapter 2. These figures are calculated from the Gen2/Ver. 2.4 Travel Demand Model as informed by COG's Round 9.2 Cooperative Land-Use Forecasts.

miles and 27 percent increase in HCT miles compared to 2023 (Figure 4 and 5).[4] Roadway and transit demand increases will likely place more stress on an already stressed transportation network, increasing delay and congestion and reducing auto-based job access for parts of the region.

Figure 4 Visualize 2045 Update (2022): Performance Overview (Travel Demand Model outputs present data for years 2023 and 2045, therefore percentage increases vary from other reporting in this plan that is based on COG Round 9.2 Cooperative Forecast with 2020 as the base year.)



[4] High-Capacity Transit miles includes additional transit service mileage from Metrorail, light rail and streetcar, bus rapid transit, and commuter rail. While not included in this figure, commuter rail infrastructure improvements within existing transit service, like planned third and fourth tracks, are documented within this plan's project listings and TIP.

With about 81 percent of funding needed to maintain and operate the region's extensive transportation system, this leaves a small percentage of funding for enhancements.

Figure 5 Visualize 2045 Update (2022): Roadway and Transit Facilities added to the Transportation System (Source: TPB Travel Demand Model)

	System	Existing (2023)	Added by Visualize 2045 update	Total 2045
Roadway (Lane Miles)	Freeways/Expressways	3,802	682	4,484
	Arterials	13,479	211	13,690
	Total	**17,281**	**893**	**18,174**
Tolled Lanes (Lane Miles)*	**Total**	**532**	**221**	**753**
High-Capacity Transit (Miles)	Metrorail	129	0	129
	Light Rail/Streetcar	18	5	23
	Bus Rapid Transit	19	87	106
	Commuter/Regional Rail	173	**	173
	Total	**339**	**92**	**431**

* Tolled lanes are a subset of freeways/expressways

** An approximate additional 16 miles of rail are included in the plan, not presented in the table as they are not reflected in the model outputs.

Our region's communities and transportation system are both built out to a large degree. The metropolitan Washington's transportation system is already extensive, requiring about 81 percent of transportation funding to be dedicated to the upkeep and operation of the system. Every other dollar spent must be highly effective in making the system better for its users. Likewise, a substantial amount of built environment/development already exists in the region, about 80 percent of the total land-use forecast for 2045 is already built. It is "on the ground" now. With limits on available funding and space, tradeoffs must made as to what transportation enhancements our region makes, where they are made, and how the region uses the existing space between our buildings.

But, to plan effectively, expectations and investments must accept the realities exposed by analysis: adding any individual project or project mix to the huge existing system cannot alone make enough progress on the TPB's goals. This means, how the system is operated will be critical for making progress in future years. This will in part be driven by policies, such as pricing. But also, the vehicle and communications technologies and fuels used by the transportation system that can help contribute to progress on some of TPB's goals, including GHG reduction goals.

1.5. Scenario Planning by the TPB and COG

The TPB and COG have conducted numerous scenario planning studies that have examined many assumptions, scenarios, future factors and have tested strategies for their ability to achieve desired outcomes, as summarized in Table 1. This report provides a summary of TPB/COG's scenario planning efforts to date and provides a summary of findings that can be used to continue advance planning in the region.

As the TPB begins planning for future updates to its LRTP, these scenario findings can continue to inform regional planning as agencies make decisions about when, where, and how to invest in

projects, programs, and policies, and how to coordinate these investments to benefit the region and prepare it to be successful in a range of possible futures.

This report breaks down the different scenario planning considerations that were used to analyze the possible futures, such as, several facets of transportation (roadway, transit, bicycle, pedestrian, TDM, land use, legislation/policy and vehicle technology and fuels). Each study examined the potential impacts of various on-road transportation projects, programs, and policies, as well as vehicles technologies. These are referred to in this document as "strategies." Depending on how the study is designed, a strategy could be a single project, program, or policy, or a few similar projects, programs, and policies combined for analysis purposes. Table 1 shows the scenario studies and various topics considered in each.

Table 1 TPB Scenario Studies since 2006

Study	Year	Scenario Planning Type	Land Use	Transportation Roadway	Transportation Transit	Transportation Bike/Pedestrian	Energy/Built Environment	Legislation/Policy
Regional Mobility and Accessibility Study: What If? (RMAS)	2006	Normative	X					X
Regional Value Pricing Study (RVP)	2008	Predictive		X				X
What Would it Take? Scenario (WWIT)	2010	Predictive	X	X	X	X	X	X
CLRP Aspirations Scenario Study	2010	Normative	X	X	X	X	X	X
Multi-Sector Approach to Reducing Greenhouse Gas Emissions in the Metropolitan Washington Region Final Technical Report (Multi-Sector Working Group)	2016	Predictive	X	X	X	X	X	X
Long-Range Plan Task Force (LRPTF) Phase 1: From No-Build to All-Build	2017	Exploratory	X	X	X	X	X	X
Congestion Reduction Test (by 25 Percent Relative to 2030)	2017	Exploratory		X	X			X

LRPTF Phase 2 Study: 10 Initiatives	2017	Predictive	X	X	X	X	X	X
2030 Climate Energy and Action Plan- Risk and Vulnerability Analysis (CEAP CRVA)	2021	Predictive	X	X	X	X	X	X
Climate Change Mitigation Study of 2021 (CCMS)	2021	Exploratory	X	X	X	X	X	X
LRTP, 2022 Update: No Build Tests	2022	Exploratory	X	X	X			

1.6. Brief Summary of Scenario Studies

The TPB has conducted approximately one scenario study every 16 months for the last 15 years. These studies each built on the previously conducted studies, ensuring that each iteration provides new and useful insights. For example, the TPB staff would use the outputs of prior studies as inputs to the newer studies. The following section describes the numerous scenario studies conducted by the COG and TPB over the last 15 years. For detailed descriptions of each scenario, please see Appendix A.

TPB and COG Scenario Studies: Timeline

In 2006, the Regional Mobility and Accessibility Study (RMAS) was conducted in response to increasing congestion, the TPB sought creative new options for improving the performance of the region's transportation system that might emerge from the examination of additional transportation improvements together with potential future changes in land use

This was followed in 2008 by a Regional Value Pricing Study (RVP) to examine how value pricing could benefit the region.

In 2008, the TPB began developing the Constrained Long-Range Plan (CLRP) Aspirations Scenario Study to integrate the best components of the RMAS and RVP studies into a comprehensive scenario that could offer a promising path forward for the region.

Also in 2008, the TPB began a scenario study to see how the region could achieve the newly adopted regional GHG reduction goals within the transportation sector, known as the "What Would it Take?" Scenario Study (WWIT).

In 2015, the TPB partnered with the Metropolitan Washington Air Quality Committee (MWAQC) and COG's Climate, Energy, and Environment Policy Committee (CEEPC) to form the Multi-Sector Working Group (MSWG), which was tasked with identifying potentially viable and implementable local, regional, and state strategies for reducing GHG emissions across key sectors - Energy, the Built Environment, Land Use, and Transportation.

In 2016, the TPB convened its Long-Range Plan Task Force (LRPTF) to identify projects, programs, and policies to improve the performance outcomes of the region's transportation system. This study

was conducted in two phases. In preparation for the modeling activities for phase 2, the TPB staff conducted a congestion reduction test (by 25 Percent Relative to 2030). Staff completed a scenario analysis to explore how a 25 percent congestion reduction, relative to today (2015), might be attained with the implementation of "extreme" project and policy scenarios in 2040.

In 2020, CEEPC updated its Climate and Energy Action Plan and conducted analysis to examine climate change mitigation and resilience strategies.

In 2021, the TPB conducted a new study to answer the question "what would it take to address the multisectoral GHG reduction goals" endorsed by the TPB, as stated in the COG's 2030 Climate and Energy Action Plan.

In 2022, associated with the Long-Range Transportation Plan 2022 Update, staff conducted No-Build tests to compare against the planned build for the updated plan. The main purpose of this internal staff exercise was to try to estimate the impacts of different components of the TPB's Long-Range Transportation Plan (LRTP), i.e., highway projects, transit projects, and land-use, on the transportation system performance. This included testing a set of 2045 no-build and build scenarios and comparing the results with the 2023 model outputs, based on the 2022 Update to Visualize 2045 Long-Range Transportation Plan. A similar analysis was conducted in 2015 associated with the plan developed at that time.

2. USING THE SCENARIO FINDINGS TO INFORM REGIONAL PLANNING: ROLES AND RESPONSIBILITIES

The TPB has conducted numerous studies over the last decade to identify the most effective strategies to achieve the goals represented in the TPB policy framework, including but not limited to the scenario studies described in this document. All of the TPB's studies and the resulting endorsed strategies include as a foundation prioritizing a state of good repair.

The TPB member agencies develop projects, programs, and policies to meet local and regional transportation goals based on the results of the TPB and COG's scenario findings and other local, regional, and state analyses, public input, and other factors, such as funding availability and feasibility of implementation. Many of the projects, programs, and policies documented in the TPB's recent regional LRTPs reflect the scenario findings, and performance evaluation and forecast demonstrate the impact of these targeted investments.

2.1. How TPB Members Agencies Can use the Scenario Findings

As the TPB has directed in Resolution R-19 2021, the scenario findings herein should inform the TPB member agencies' local and transit planning activities. As the findings communicate the types of strategies that are most effective at making progress on regional goals, the priority strategies should be increasingly represented in the TPB's plan over time. The TPB member agencies should consider both the potential impacts of external factors/strategies as well as the priority strategies within the

authority of the member agencies when making decision about the policies, programs, and projects they could invest in, as appropriate, based on local context.

As the next technical inputs solicitation (also known as a call for projects) begins for the 2024 LRTP update, sponsor agencies are advised to consider the projects they have included in the current regional plan (Visualize 2045 update), and evaluate if these projects should still move forward based on the scenario findings and the priorities stated in the TPB policy framework. The scenarios can also inform future projects, programs, and policies implemented by the TPB's member agencies.

Recognizing two key facts:

1. Projects that have not proceeded through the local planning process, and projects that do not yet have funding reasonably expected by the plan horizon, cannot be included in the plan. A lot of planning takes place before a project is included in the region's plan:
    - Projects can take a long time— sometimes decades—to plan and develop, and the result can be different than the original project concept. Projects evolve based on local and regional priorities, public input, design and funding limitations, and advances in technology.
    - Projects in the TPB's LRTP are typically developed at the state and local levels. Each state, locality, the District of Columbia, and the Washington Metropolitan Area Transit Authority (WMATA) control their own funding stream.
    - Each jurisdiction has its own system for moving projects forward. New major WMATA capital projects such as stations or lines are built by the jurisdictions that the projects are in—in coordination with WMATA.
    - Within each state, projects may be pursued for a variety of reasons and may have multiple sponsors.

2. Per federal requirements, some projects, programs, and policies must be in the constrained element used for the Air Quality Conformity analysis and the financial analysis. Some projects, programs, and policies cannot be represented in the constrained element.
    - For numerous reasons some projects, programs, and policies cannot be represented in the constrained element, these include factors such as the required analytical approach, data and tools used to conduct the conformity analysis, federal constraints on assumptions.
    - The TPB strategies are not limited to projects, programs, policies, that can- and must-be included in the constrained element for its LRTP or Transportation Improvement Program, such as Bus Rapid Transit (BRT) projects and other major projects that impact the capacity of the transportation system as reflected in the regional air quality analysis network. The TPB's priority strategies extends to projects that do not use federal funds and to many that are not reflected in the regional air quality analysis network. Examples could include certain land-use plans/policies and goals, many small projects for walking and biking, some transit station improvements, and electrical vehicle charging stations.

3.SUMMARY OF SCENARIO FINDINGS

The next section presents a high-level summary of all findings that are based on lessons learned from all of the scenario analysis referenced in this document (see Table 1 for a listing) including findings from all of the topics analyzed: transportation options, legislation and policies, vehicle technologies and fuels. Following the high level summary, the findings for each of the topics are reviewed individually.

To assist the reader's review of the findings, the following key terms and caveats are presented:

Key terms:

- Baseline: a scenario that is used for comparison against alternative scenarios, sometimes is a baseline is a base-year, other times, it is a future year planned build.
- Base-year: year considered "existing conditions" that is used for comparison against the future analysis year.
- All build: typically refers to a scenario where all projects in the LRTP are assumed to be built and a wish list of non-financially constrained projects.
- No build: typically refers to a scenario where base-year transportation projects are assumed to be included in the analysis, but future-year transportation projects in the LRTP are not built or realized.
- Planned build; typically refers to a scenario where all projects in the LRTP are assumed to be built.
- Strategies: Each study examined the potential impacts of various on-road transportation projects, programs, and policies, as well as vehicles technologies. These are referred to in this document as "strategies". Depending on how the study is designed, a strategy could be a single project, program, or policy, or a few similar projects, programs, and policies combined for analysis purposes.

Please note the following caveats:

Implications for development of the constrained element of the plan:

- Benefits from multiple strategies for mobility goals and GHG reduction goals are not always additive and at times are counteractive. In other words, a project, program, or policy might make progress on one goal while hindering a progress on another.
- Many of these complementary strategies will not be represented in the "constrained element" of the long-range transportation plan used for the air quality conformity analysis, but the TPB will continue to focus on regional coordination to support the implementation of these other strategies.

Limitations of this document:

- The scenario studies referenced in this document were conducted in different periods of time for different purposes, and used different sets of assumptions, methodologies and analysis tools. The findings reported in this document aim to take that into account; however, the reader should be cautioned against comparing the relative effectiveness of a particular strategy among other strategies across studies.
- Numeric results presented come mainly from the more recent studies (CCMS, LRPTF, and MSWG).
- The regional and on-road GHG goals were established as a percentage reduction off of 2005 levels, whereas most of the scenario studies use a future year baseline of the long-range

transportation plan for comparison. Studies such as WWIT and LRPTF measured only carbon dioxide (CO_2), while other studies (MSWG and CCMS) also included emissions from other greenhouse gases (methane and nitrous oxide) and reported total GHG emissions as in carbon dioxide equivalent (CO_2e). This document will refer to GHG emissions for all of the studies.

3.1. Summary of Scenario Findings:

While the numerous scenario studies looked at some individual factors and strategies, most of the studies also looked at how strategies would work when implemented together or when considered in context of other factors, such as various land-use scenarios. Findings are reported for both types of scenarios.

High-level findings from all scenarios include:

- The metropolitan Washington's transportation system is already extensive, requiring about 80 percent of transportation funding to be dedicated to the upkeep and operations of the system. Likewise, a substantial amount of built environment/development already exists in the region, and, about 80 percent of the total land-use forecast for 2045 is already built. The region faces challenges with congestion today. In a growing region planning to add one million people and jobs by 2045, scenario studies show that it is very challenging to reduce the future levels of congestion relative to what is observed today. The LRPTF Phase 1 study showed that the future VMT growth, and therefore congestion, was mainly driven by increases in people and jobs. The Visualize 2045 analysis similarly shows that the congestion reduction benefits of new projects are eroded by this additional demand. The LRPTF Phase 2 study showed that different strategies, most notably increases in telework and land-use density, can be effective in reducing the future levels of congestion, but that the overall congestion would still be higher in the future than today. The scenarios showed that **it is challenging to make substantial progress on the TPB's goals by adding any individual project or project mix to the existing system.** In the LRPTF studies, the TPB learned that adding projects or project mixes did not have a substantial impact on metrics such as VMT reduction or emissions reductions, and that land-use and policy-oriented initiatives had greater impact on system performance using these measures.
- This means:
    - How the system is operated will be critical for making progress in future years:
        - Strategies such as applying ITS technologies, roadway pricing, and more will be necessary to make significant progress on the TPB's mobility and accessibility goals.
        - Strategies such as vehicle electrification are essential to make progress on GHG reduction goals. Fuel efficiency, fuel technology (e.g., electrification), and policies were found to have the greatest potential to reduce GHG emissions. For example, federal strategies could include new GHG emissions standards for light-duty vehicles or heavy-duty vehicles, perhaps even more aggressive than the current standards promulgated in 2022.
    - Continuing to focus growth in Activity Centers and in High-Capacity Transit stations areas, while considering equity in planning for growth, will be essential to having land used in a way that enables multi-modal transportation options and facilitates shorter trips:

        - With the number of jobs forecasted to increase in the future, especially in the Activity Centers and near HCT stations, and with construction of new transit lines (BRT routes, Silver Line Phase 2, Purple Line, etc.), accessibility to jobs by transit is projected to increase substantially in the future (various LRTP analyses).
        - The new jobs, primarily located in the Activity Centers, are helping offset future losses in auto accessibility occurring due to the increased congestion. As a result, despite increases in congestion, access to jobs by auto in the future is projected to remain about the same as today (various LRTP analyses).
    - While any one project might not make substantial progress on regional goals, by implementing the most effective strategies together, progress can be made. To make the most progress members should expedite the implementation of the concepts represented by the TPB's endorsed Aspirational Initiatives (to the degree possible and within sponsor agency authority).

- Reducing GHG from on-road transportation in a growing region is difficult. Although vehicle fuel efficiency improvements and vehicle electrification strategies tend to be most impactful, there is not a single strategy or category of strategies that, if implemented, would achieve the TPB's on-road GHG reduction goals. The effectiveness of any individual strategy is affected by the scale and timeframe of its implementation. Construction and implementation of new highway and transit projects has a lower potential to significantly impact VMT and GHG emissions. The LRPTF Phase 2 study analyzed ambitious packages of initiatives that grouped together managed lanes projects and extensive transit service extensions, all of which had a fairly low level of impact on VMT (mainly within 1 percent). It is important to note that although individual projects / groups of projects may not have a significant impact on GHG emission reductions, many of them would benefit the residents of equity emphasis areas by providing additional access to jobs and other activities (health care providers, grocery stores, etc.).
- To make the most progress possible on the TPB's on-road GHG reduction goals:
    - the implementing agencies in the region, in partnership as necessary with other public and private organizations, should implement the priority GHG reduction strategies endorsed by the TPB. Not all of the most effective strategies are within the authority of the member agencies, are ready for implementation or are feasible according to TPB members surveyed.
    - Actions will be required at all levels of government – federal, state, and local.

TPB Priority Strategies

Most of the TPB priority strategies were examined in scenario studies, and then endorsed by the TPB, these include regional roadway safety, the Aspirational Initiatives, and GHG reduction are summarized below:

- Apply best practices to maintain the transportation system such as bridge and pavement management and transit asset management.
- Apply the endorsed safety strategies to design and operate safer infrastructure and encourage safer behavior.
- Increase frequency and capacity of transit by expanding Bus Rapid Transit and Transitways.

- Reduce travel times on all public transportation bus services.
- Move more people on Metrorail and commuter rail.
- Bring jobs and housing closer together by focusing growth and adding housing units in Activity Centers and near High-Capacity Transit stations.
- Provide more telecommuting and other options for commuting such as vanpool or carpool and alternative work schedules.
- Expand the express highway network, with rapid transit, and allow carpool/vanpool ride free.
- Improve walk and bike access to transit, especially within TPB identified High Capacity Transit station areas, through application of Complete Streets and Green Streets policies.
- Complete the National Capital Trail Network.
- Implement Transportation Systems Management and Operations (TSMO) measures at all eligible locations.
- Apply effective technologies that advance the TPB's goals.
- Convert vehicles to clean fuels: 50 percent of new light-duty vehicles, 30 percent of medium and heavy-duty trucks sold; 50 percent of all buses on the road.
- Develop and implement an electric vehicle charging network.

Impacts on equity should always be considered to ensure that the EEA residents are not adversely impacted by our actions.

3.2. Findings by Topic

The following sections review the findings from past scenarios. The findings section highlights the many factors considered in the scenario studies. The topic-specific findings sections include tables highlighting how factors were considered and what COG and the TPB were looking to better understand. As the LRPTF and the CCMS were informed by and developed based on the findings of prior studies, the findings of these studies are most commonly cited to provide examples of analytical results.

Scenario Findings Organization:

- Transportation Options
  - Roadway
  - Transit
  - Bicycle/Pedestrian (bike/ped)
  - Other TPB studies

- Legislation and Policy
  - Pricing Policies
  - Transportation Demand Management
  - Land-Use
- Vehicle technology (electrification and alternative fuels)

3.2.1. FINDINGS: TRANSPORTATION OPTIONS

To understand what strategies might work best to make progress on the TPB goals, the TPB has conducted numerous studies to examine how adding new transportation projects to the system would impact these goals. The scenarios focused on different aspects of transportation from capacity building and infrastructure improvements to technological advances. In some scenarios the

impact of certain types of transportation enhancements were considered by themselves – such as adding more roadway capacity but not transit, or adding more transit capacity and service, but not roadway projects. Sometimes a full range of transportation projects were considered as a set. In most scenarios they were considered along with land-use or other policy changes, such as roadway pricing. Legislation and policy strategies are combined with many of the scenarios and are discussed in the "Legislation and Policy" section in this document.

The findings for scenario analysis related to transportation options are organized into four categories: roadways, transit, and bicycle/pedestrian and TDM. Following these summaries, an additional section "other studies" describes internal analysis that the TPB has performed regarding transportation improvement scenarios. The following sections describe scenarios related to each of the categories and review their findings, which generally fall into two categories: travel trends, and GHG emissions impact.

3.2.1.1. Findings from Roadways Strategies

Reducing congestion, delay, and travel time are important priorities for the TPB and the people and businesses in the metropolitan Washington region. The TPB and COG conducted numerous scenarios that considered roadway projects, programs, and policies including capacity increases, hot spot fixes, operational improvements and express lanes. These have resulted in the following summary findings:

- The LRPTF Phase 2 study showed that the policy initiatives outperformed the initiatives that focused on projects (e.g., Northern Bridge Crossing) and "Mega" projects that included land-use shifts (e.g., Regional Express Lanes Network). The most significant congestion reduction outcome, for example, came from reducing demand for on-road travel through travel demand management (which included significant increases in telework). This initiative resulted in a 24 percent decrease in vehicle hours of delay, more than double the reductions of Regional Express Lane Networks and three times the reduction resulting from Operational Improvements and Hot Spot Relief. The findings reflect a comparison to a long-range plan that was in effect at the time of the study (forecasts for outyear 2040).
- Regional Express Lanes Network* significantly improved reliable access to intercity hubs and to some degree also helped to meet goals associated with reducing bottlenecks, improving bus service and reducing road congestion.
- Operational Improvements and Hotspot Relief can have a positive impact on reducing congestion and reducing bottlenecks.
- Adding a Northern Bridge Crossing/Corridor had little impact in addressing regional congestion and delay.
- **These findings reinforce the overarching findings that it is challenging to make substantial progress on the TPB's goals by adding any individual project or project mix to the existing system.** In the Phase 1 and LRPTF Phase 2 studies, the TPB learned that adding projects or project mixes did not have a substantial impact on metrics such as VMT reduction or emissions reductions, and that land-use and policy-oriented initiatives had greater impact on regional system performance for these measures.

How did the TPB arrive at these findings?

The LRPTF Phase 1 study showed that the "All-Build" scenario, which included all funded and unfunded projects in the region, resulted in an increase in road capacity, access to jobs, and significant improvements (reductions) in the number of congested lane miles in 2040. In the first phase of the LRPTF study, the scenario analysis looked at the change in vehicle miles traveled (VMT), transit trips, accessibility, and other metrics between 2015 and 2040 based on the 2015 CLRP Amendment and scenario specific assumptions. The "No Build"–which adds no new transportation projects from 2015-2040 - results in an increase of VMT by 19 percent. The "Planned-Build" scenario, or the CLRP itself, added 372 new projects, and resulted in a 22 percent increase in VMT. The "All-Build" added an additional 550 new projects, and resulted in a 23 percent increase in VMT relative to 2015.

The LRPTF Phase 2 study showed a number of improvements possible through the initiatives that incorporated roadway strategies. These are the Regional Express Lanes Network and Operational Improvements and Hotspot Relief. The findings reflect a comparison to a long-range plan that was in effect at the time of the study (forecasts for outyear 2040):

- The Regional Express Lanes Network initiative included expanding the existing (as of 2016) tolled express lane system on the Capital Beltway and I-95 in Virginia to most limited-access highways in the region. The expanded system would also support new express bus service connecting Activity Centers, increasing the region's share of people who use transit:
    - The analysis showed that the Regional Express Lanes Network* would provide more reliable travel options to more of the region's residents, improve reliable access to intercity hubs and would have a positive impact in meeting goals associated with reducing bottlenecks, improving bus service, and reducing road congestion.
    - This initiative would reduce average highway times and vehicle hours of delay measurably without a large increase in VMT.
    - Results of this initiative included improving travel on reliable modes by 42 percent, reducing roadway daily vehicles hours of delay by 11 percent, reducing travel time by 5 percent for HOV, 2 percent for SOV, and 1 percent for transit. Results also included increasing access to jobs in the region by auto by 5 percent, and by transit by 2 percent.
    - The initiative showed a less than 1 percent increase in both daily VMT and VMT daily per capita.
- Operational Improvements and Hotspot Relief: this initiative included strategies such as the application of technology and enhanced system operations strategies, improved roadway design, and expanded regional incident management where appropriate.
    - This initiative demonstrated a 4 percent reduction in travel time for both SOV and HOV, and a 2 percent reduction for transit. Additional promising results included reducing roadway daily vehicles hours of delay by 8 percent, while increasing access to jobs in the region by auto by 8 percent and by transit by 2 percent.
    - Other results from this scenario demonstrated trends that conflicted with the TPB's goals. These trends resulted from making roadways more attractive by reducing delay, and therefore impacting mode choice- altering how people were forecasted to choose to travel. These results included reducing travel on reliable modes by 5 percent, reducing transit mode share by 4 percent, HOV mode share by 7 percent, and increasing SOV mode share by 3 percent.

In the LRPTF Phase 2 study, the roadway improvement scenarios had little impact, positive or negative, on transportation emissions relative to the 2040 "Planned-Build" CLRP from the 2015 baseline). The Regional Express Lanes Network initiative reported a small impact on all emissions, but also noted that overall effects were unclear based on the simplified tools that were utilized. The Operational Improvements and Hotspot Relief initiative reported a 1 percent decrease in GHG emissions, a 3 percent decrease in VOC, and no change in NOx emissions compared to the 2040 "Planned-Build" from the 2015 baseline.

The LRPTF Phase 2 study found that expanding the express highway network and express bus service (Initiative 1) did not change GHG emissions, but did leave GHG emissions unchanged while increasing daily VMT and daily VMT per capita each by less than one percent and decreasing daily Vehicle Hours of Delay (VHD) by 11 percent compared to the CLRP in 2040 (base-year 2015). In addition to express buses, the express lanes can be available to carpool and vanpool users without charge, increasing options for reliable non-single-occupant vehicle travel. The revenue generated by the tolls charged to SOVs could be invested in high-quality regional bus service.

The findings on operational efficiency strategies are mixed, likely due to the fact that, in the MSWG and LRPTF studies, all of the operational efficiency strategies under consideration are grouped into one strategy, unlike the transit strategies. Travel efficiency fared only a bit better in the MSWG study (TLU-7) than in the LRPTF study (Initiative 2), likely due to the inclusion of eco-driving, which promotes driving patterns to reduce rapid acceleration/deceleration and extended idling, and assumptions about system efficiency improvements though connected vehicles. Overall, though, operational efficiency improvements show only modest GHG reductions.

Findings in the CCMS show that the mode shift and transportation systems management and operations pathways results did not reflect the ability to meet either the 2030 or 2050 emissions reductions by themselves. As documented later in this report, vehicle technologies and fuels must change to make significant progress on the TPB's GHG reduction goals.

Table 2 provides an overview of the COG and TPB scenario studies that included strategies that were specific to roadways and automobiles.

Table 2 Scenarios that Considered Roadways

Report	Scenario(s)	To better understand
RVP	Combinations of variably-priced lanes	Managing congestion and raising revenue to improve transit services
WWIT	Improve roadway operational efficiency (traffic signal optimization, eco-driving, idling reduction, incident management)	Improving fuel efficiency, (use of) alternative fuels, and travel efficiency
MSWG	Roadway and personal vehicle policies (enhancing system operations, road pricing, Travel Demand Management, truck stop electrification)	Providing context for GHG emissions in the region and potential GHG reductions that might be achieved through regional policy actions
LRPTF Phase 1 Study	Scenarios were no build, planned build, and all build	Meeting the goals of the TPB Vision RTPP
LRPTF Phase 2 Study	Operational Improvements and Hotspot Relief Additional Northern Bridge Crossing/Corridor Express Lanes Network (HOT lanes) with transit	Meeting the goals of the TPB Vision and RTPP

CCMS	Optimized ITS/TSMO, with benefits from connected/automated vehicles (CAVs) by 2050	Impacts of individual and combined strategies on GHG reduction

3.2.1.2. Findings from Transit Strategies

Moving more people by transit – and making transit a more attractive and competitive option to people by increasing its frequency, reliability, and connections to destinations are indispensable TPB priorities. Numerous TPB and COG scenario studies examined strategies to encourage shifting auto trips to transit as single strategy scenarios and as part of combined-strategy scenarios. For example, the LRPTF Phase 2 study examined various transit initiatives, such as investing in core Metrorail improvements, commuter rail enhancements, adding BRT and Transitways throughout the region, Transit Rail extensions and transit fare policy changes, as well as other TDM strategies. As some transit vehicles operate on roadways, some of the other sections in the findings review also indicate results for transit outcomes.

The numerous scenarios that the TPB and COG have conducted that consider transit projects, policies and programs have resulted in the following summary findings:

- With findings reflecting a comparison to a long-range plan that was in effect at the time of the study (forecasts for outyear 2040): the LRPTF Phase 2 study showed that:
    - Regionwide BRT and Transitways (Initiative 4) perform well to address the regional challenges of inadequate bus service, and perform fairly well in improving access to bike/pedestrian facilities, encouraging development around Metrorail, and increasing the colocation of housing and jobs.
    - Metrorail Regional Core Capacity Improvements (Initiative 6) perform well to address the regional challenges of transit crowding, and to some degree minimize road congestion, improve access to bike/pedestrian facilities, reduce bottlenecks, and improve reliable access to intercity hubs.
    - Regional Commuter Rail Enhancements, while important to the region and in particular sub-areas of the region, had minimal impact in addressing the regional challenges identified in the study.
    - Transit Rail Extensions would catalyze more development around Metrorail stations and would improve access to bike/pedestrian facilities, support colocation of housing and jobs, and improve reliable access to intercity hubs.
    - Transit Fare Policy Changes, while they may be important to individuals and to equity considerations in the region, do not have a high or moderate impact in addressing the regional challenges examined in the LRPTF.
    - Overall, transit enhancement and fare strategies had modest impacts on GHG, impacts increased with the more extreme implementation levels. Mode shift and travel behavior strategies provide supporting GHG reductions but are less important when nearly all on-road vehicles are EVs and the electric grid is carbon neutral.

How did the TPB arrive at these findings?

- In the LRPTF Phase 1 study results showed that under the all-build scenario, that there would be an increase in the number of miles of High-Capacity Transit and transit ridership. The Phase 2

study showed a number of improvements possible through the initiatives that incorporated transit strategies, including:

- Transit Rail Extensions (Initiative 7) would catalyze more development around Metrorail and would positively impact access to bike/pedestrian, housing and job location, reliable access to intercity hubs. This initiative, which included an expansion of the transit system with 62 new stations, resulted in a VMT decrease of 1 percent, VHD decrease of 3 percent, and GHG decrease of 1 percent relative to the 2040 baseline.
- Each of the studies had multiple strategies that improved transit service, expanded transit service, or lowered the cost of transit service. The Metrorail core capacity improvements reduced daily VHD by 9 percent, daily VMT by 1 percent, daily VMT per capita by 1 percent, and increased transit commute mode share by 2.8 percentage points compared to the CLRP in 2040 (base-year 2015),(i.e., transit mode share increased from 24.6 percent to 27.4 percent).

The MSWG (TLU-11), LRPTF Phase 2 study (Initiative 9) and CCMS studies examined policies that reduce transit fares. The transit fare policies examined in the LRPTF Phase 2 study reduced daily VHD by 2 percent, daily VMT by 1 percent, and both GHG and daily VMT per capita by 1 percent compared to the CLRP in 2040 (base-year 2015). The CCMS (MS.3) examined what impacts free fares might have (studied with some additional strategies). It found that free transit and transit enhancements could generate additional mode shifts.

Each of the TPB/COG studies had multiple strategies for transit, such as improving transit service, expanding transit service, or lowering the cost of transit service. Overall, these strategies tended to do fairly well among the project-focused strategies in their respective studies but could be expensive to implement. For example, compared to the planned-build long-range transportation plan, the Metrorail regional core capacity improvements in the LRPTF Phase 2 study (Initiative 6) reduced GHG emissions by 2 percent, ranking it a distant third behind TDM (7 percent) and land use (4 percent) for GHG reduction, but ahead of other project-focused initiatives (which only reduce emissions by 1 percent or in the case of one initiative increased emissions by 1 percent).

The CCMS examined numerous transit strategies as part of mode shift combined pathway (MS1, 2, and 3), but did not examine the impact of transit strategies alone. Overall, it found that mode shift and travel behavior strategies provide supporting GHG reductions but are less important when nearly all on-road passenger vehicles are EVs and the electric grid is carbon neutral. The carbon content of the fuel used by transit vehicles also affects the GHG emissions and is considered under “vehicle technology” strategies later in this document.

Neither the mode shift and travel behavior pathway nor the transportation systems management and operations pathways results reflected the ability to meet either the 2030 or 2050 emissions reductions by themselves. Findings in the CCMS show that even with a clean electric power grid (100 percent carbon-free by 2035), the region would have to apply the aggressive scenarios to meet 2030 and 2050 targeted emissions reductions. The illustrative single pathway scenarios that made the largest impact are the two vehicle technology scenarios that convert the light, medium, and heavy-duty vehicle fleets to electric vehicles and use biofuels/renewable diesel. The more aggressive scenario of the two was found to meet the 2030 and 2050 emissions reductions. To this end, converting transit vehicles to “greener” technologies is a strategy that could potentially be implemented by the region’s transit agencies.

Table 3 provides an overview of the COG and TPB scenario studies that included strategies that were specific to transit.

Table 3 Scenarios that Considered Transit

Report	Scenario(s)	To better understand
RVP	Combinations of variably-priced lanes, including extensive transit service to the VPL networks	Managing congestion and raising revenue to improve transit services
WWIT	Increase transit and bike/ped use (13 measures improving bus service, Metrorail extension, park and ride lots, bike stations, bike sharing, ped paths to rail, regional bike-ped plan) Improve operational efficiency (traffic signal optimization, incident management)	Improving fuel efficiency and (use of) alternative fuels.
LRPTF Phase 2 Study	Examined transit-focused and policy-focused initiatives: • BRT and Transitways • Commuter Rail • Metrorail Core Capacity • Transit Rail Extensions • Transit Fare Policy Changes	What types of projects, programs, and policies best address the TPB goals.
CCMS	Nine of ten of the scenarios in the CCMS contain transit-related components. These components include reducing transit fares, and implementing transit enhancements.	Impacts of individual and combined strategies on GHG reduction

3.2.1.3. Findings from Bicycle and Pedestrian Strategies

The TPB policy framework has long communicated the need for and value of a comprehensive transportation system, that includes options for people to walk, bike, or take other "micromobility"[5] options as all or part of their trip. While bicycle and pedestrian modes could not typically be included in technical analysis, the need for high quality, safe and connected access to transit stations for people walking, biking or taking micromobility to transit was considered as an assumption in many studies.

A benefit of improved connections for people that walk, bike, or use micromobility as their entire trip, is the reduced demand for other modes of transportation. The TPB's Regional Travel Survey trends show that more people are walking and biking. Yet, while these modes are considered either zero or extremely low in emissions and energy use, one cannot reasonably assume that most trips can be replaced by biking, walking, or micromobility travel options. In the scenario studies, the improved access to transit was considered as part of the land-use and transit scenarios, which are discussed under those headings in the findings section of this summary report.

[5] Transportation using lightweight vehicles (some with motors) such as scooters. Some of these are provided by private companies as a shared service.

Bicycle and pedestrian considerations were included in several scenario studies as summarized below and in Table 4:

- The WWIT study studied an accelerated completion of the 2010 Bicycle and Pedestrian Plan compared to other local/state/regional strategies.
- The MSWG study did not analyze separate bicycle and pedestrian strategies. Instead, it simply assumed that safe and expanded bicycle and pedestrian infrastructure is essential to the success of the concentrated land use strategies.
- The LRPTF study assumed that transit investments will be supported by improvements in bike/walk infrastructure, facilitating access to those transit services.
- The CCMS scenarios included several scenarios that included assumptions about changes in non-motorized transportation (such as MS.1: Land use changes, including increased bicycle/pedestrian/micromobility) show the mode shift and transportation systems management and operations pathways results did not reflect the ability to meet either the 2030 or 2050 emissions reductions by themselves.

Table 4 summarizes bicycle and pedestrian considerations in the scenarios.

Table 4 Scenarios that Considered Bicycle/Pedestrian

Report	Scenario(s)	To better understand
WWIT	Short- and long-term regional actions include increasing bicycle and pedestrian use and improving the infrastructure, particularly to access transit	How to meet aggressive regional climate change mitigation goals in the transportation sector
CLRP Aspirations Study	Scenario includes increase bicycle and pedestrian infrastructure to transit stations	Better align land use and transportation planning with the goals of the TPB Vision and of the previous RMAS initiative
MSWG	EBE-3: Encourage development in Activity Centers includes improved bicycle and pedestrian infrastructure	Focused on incremental reduction in energy use
	Sustainable development patterns and urban design, including bicycle/pedestrian enhancements	Exploring reallocation of anticipated future growth into locations and configurations that are less auto-dependent to lower VMT levels
LRPTF Phase 1 Study	Scenarios explore bicycle and pedestrian capacity and access to transit and circulation in Activity Centers	Meeting the goals of the TPB Vision and RMAS initiative
LRPTF Phase 2 Study	Scenarios that examined rail and transit infrastructure included improvements to bicycle and pedestrian access to their station areas	Meeting the goals of the TPB Vision and RMAS initiative
CEAP	MSTB-1: Invest in infrastructure that increases transit, carpooling, and non-motorized travel.	Help move the region towards meeting its' 2030 climate mitigation and resiliency goals
CCMS	The mode shift and travel behavior scenarios studied bicycle/pedestrian/micromobility	How land use changed focused on redistributing growth to Activity Centers and High-Capacity Transit station areas can reduce GHG emissions

3.2.2. FINDINGS: POLICY AND LEGISLATION

Policy and legislation are two tools that the TPB members and other governmental bodies (depending on the authority of each) can use to impact transportation planning, programming, investment, and outcomes.

Many of the strategies discussed in this summary could be implemented more quickly with agencies, from all levels of government, adopting policies and legislation related to them. Intergovernmental cooperation and working together with the private sector will likely be critical to achieving regional goals.

Policy goals were incorporated into a number of the scenarios as one or more of the strategies, usually at defined levels of implementation for analysis purposes. Both the LRPTF and CCMS studies rely heavily on policy action to accomplish their goals. Findings on pricing, TDM and land use are summarized in the following discussions, but policy and legislation findings can be found throughout the other sections, including vehicle technologies. Table 5 provides an overview of the COG and TPB scenario studies that include strategies that were specific to policy/legislation.

Table 5 Scenarios that Consider Policy and Legislation

Report	Scenario(s)	To better understand
WWIT	Scenarios looked at large-scale, aggressive federal government action, and both short- and long-term state/regional/local actions	Improving fuel efficiency, use of alternative fuels, and travel efficiency
MSWG	Roadway and personal vehicle policies (low carbon fuel standard, improving fuel economy of light-duty vehicle fleet, enhancing system operations, road pricing, Travel Demand Management, truck stop electrification)	Providing context for GHG emissions in the region and potential GHG reductions that might be achieved through regional policy actions
LRPTF Phase 2	Examine a set of policy-focused initiatives	Examine impacts of potential initiatives against the currently adopted LRTP for the year 2040
CEAP	Study the impacts of strategies aimed at energy efficiency, mode shift, and travel behavior	Help move the region towards meeting its' 2030 climate mitigation and resiliency goals
CCMS	Scenarios that encourage adoption of policies to help mitigate GHG emissions	Impacts of individual and combined strategies on GHG reduction

3.2.2.1. Findings from Pricing Policy Strategies

Pricing is a tool that can be used to manage transportation demand, including when, where, and how people travel. Managing demand for the transportation system is an important strategy to help make progress on numerous TPB goals. Several scenario studies examined various pricing tools and policies to better understand the impact of these tools on the region's transportation system performance.

Summary Findings

Fuel Pricing

The most impactful pricing factor considered was a TDM strategy in the WWIT study and based on the 2009 Annual Energy Outlook's "High Price Case." That strategy included $7/gallon gasoline, which led to a 6 percent reduction in VMT between 2010 and 2030 compared to the CLRP baseline (2010). It should be noted that the 6 percent VMT reduction is a result from the national level models employed by the U.S. Department of Energy and for the WWIT study, it was assumed that the VMT reduction would correspond with roughly a 6 percent decrease in GHG emissions.

Roadway Pricing

In the RVP study, the toll rates on the variably-priced lane (VPL) network would have to vary significantly by segment, direction, and time-of-day in order to maintain free-flowing conditions. In terms of financial feasibility, a comparison of the forecasted revenues versus costs for each of the scenarios found that only the "DC and Parkways Restrained" scenario generated revenues close to covering the costs.

The RVP also studied the addition of extensive transit service to the VPL networks. This addition resulted in increases in transit use, decreases in HOV use, small decreases in VMT, and decreases in total system revenue. Regarding land use patterns, very few zones experienced significant changes in accessibility to jobs by highways. Accessibility to jobs by transit improved in all the scenarios. Changes in accessibility to households by highways were minimal and gains in accessibility by transit were scene near major interchanges in the VPL network.

The road pricing strategy (TLU-12) in the MSWG study included a cordon price of $5/trip into downtown DC in 2040, and the cordon price plus a VMT tax of 10 cents/per mile everywhere in 2050. The analysis for this strategy showed significant VMT reductions (7.8 percent annually compared to the current policies forecast) in 2050 due to the VMT tax; however, it did not show significant GHG reductions due to the improved fuel efficiency of the fleet.

The LRPTF Phase 2 Study also examined tolling, results of the Initiative 1, Regional Express Lanes Network, can be found in the roadway and transit sections.

Parking Pricing

Past scenario studies have examined parking pricing policies such as pricing workplace parking in Activity Centers (MSWG, LRPTF, and CCMS). These policies were typically combined with TDM policies like employer-based transit/vanpool benefits or teleworking in the technical analysis, so the impact of parking pricing alone was not quantified. However, the technical report for the MSWG study notes that the cost of parking is a key determinate in travel choice.

Incentive-based

A strategy that is more incentive-based, such as pay-as-you-drive insurance in the WWIT study showed promise in reducing emissions among the automobile travel reduction strategies, although much less than fuel efficiency strategies.

Table 6 summarizes bicycle and pedestrian considerations in the scenarios.

Table 6 Scenarios that Considered Pricing Strategies

Report	Scenario(s)	To better understand
WWIT	2009 Annual Energy Outlook's "High Price Case". That strategy included $7/gallon gasoline.	How to meet aggressive regional climate change mitigation goals in the transportation sector
RVP	Examined toll rates on the variably-priced lane (VPL) network including the addition of extensive transit service to the VPL networks.	
MSWG	The road pricing strategy (TLU-12) included a cordon price of $5/trip into downtown DC in 2040 and the cordon price plus a VMT tax of 10 cents/per mile everywhere in 2050 Parking pricing policies such as pricing workplace parking in Activity Centers	Focused on incremental reduction in energy use by influencing transportation demand through policy
LRPTF Phase 2 Study	Parking pricing policies such as pricing workplace parking in Activity Centers	Meeting the goals of the TPB Vision and RMAS initiative
CCMS	Parking pricing policies such as pricing workplace parking in Activity Centers	

3.2.3. Travel Demand Management Findings

Transportation Demand Management (TDM) has been identified as a priority strategy to make progress on numerous TPB goals. TDM approaches are intended to help people find and use alternatives to driving alone. For example, Commuter Connections is the TPB's TDM program. Commuter Connections uses marketing, incentives, and employer-based programs to reduce congestion and improve air quality. The Commuter Connections network primarily promotes activities including ridesharing, using transit, bicycling, walking, teleworking, and employer services. Many local jurisdictions in the TPB region also have TDM programs.

A number of scenarios included aspects of TDM. The LRPTF Phase 2 study (Initiative 10) focused specifically on TDM, "Amplified Employer-based Travel Demand Management". It assessed new policies (e.g., employer trip reduction requirements) and programs (e.g., financial incentives) implemented at the local and regional scale to significantly reduce single-occupancy vehicle commute trip making, including:

- Employer-based parking cash-out
- Expanded employer-based transit/vanpool benefits
- Expanded telework and flexible schedule adoption
- Substantial increase in priced commuter parking in major Activity Centers (also a pricing strategy)

How did the TPB arrive at these findings?

In the LRPTF Phase 2 study, the TDM initiative examined the impacts of providing a transit/vanpool subsidy, parking pricing increases, and an increase in telework, regionally reducing the number of commute trips for all modes to achieve a 20 percent telecommute rate (i.e., an increase from the

overall pre-COVID telework rate for all jobs from 10 percent to 20 percent). This initiative resulted in a 24 percent reduction in VHD, 6 percent reduction in daily VMT, 6 percent reduction in daily VMT per capita, and 20 percent reduction in single-occupant vehicle work trips compared to the to the long-range plan that was in effect at the time of the study with forecasts for outyear 2040.

Both the MSWG (TLU-9) and LRPTF Phase 2 (Initiative 10) studies showed promising GHG reductions from employer-based TDM including transit subsidies and priced parking in Activity Centers. The LRPTF Phase 2 study showed a 7 percent reduction in GHG emissions. Because of the increase in teleworking, there was a 9 percent reduction in transit work trips relative to the CLRP in 2040 (base-year 2014) baseline.

3.2.4. Other TPB Scenarios

In preparation for the LRPTF Phase 2 modeling activities, the TPB examined some additional scenarios internally for purpose of testing the sensitivity of models that considered extreme and hypothetical strategies.

Table 7 provides the summary of the types of "extreme" and in some cases unrealistic scenarios originally designed to test how the model would respond to these types of policy assumptions. The comparisons presented in Table 7 show the differences between the 2040 scenarios and the 2015 baseline. The 2040 Transit Expansion scenario in particular is an interesting case study, because it shows the upper limits in terms of the maximum level of VMT reduction that transit projects could achieve. In this very aggressive (unrealistic) scenario that assumes that bus and rail frequency is going to be one minute for every single line, and that run times for the Metrorail and other High-Capacity Transit services are cut in half, VMT still increases by 17 percent in 2040 relative to today (2015), whereas the Planned Build shows a 21 percent increase in VMT. In other words, although this specific future characterized with extensive transit service would likely have favorable equity implications, these unrealistic assumptions that cannot be achieved with any mix of projects in the plan only resulted in a 4 percent difference in VMT relative to the Planned Build's performance against today's conditions (17 percent increase versus 21 percent increase relative to today).

Similarly, only two of these scenarios, which assume unprecedented levels of VMT tax and sustained reductions in trips due to technological advances (e.g., telework comparable to the levels observed during the height of the COVID-19 pandemic closures in spring of 2020), respectively, have the potential to significantly move the region toward reaching its GHG reduction goals.

It is important to note that the travel model was calibrated to observed travel conditions, which include far less variability than has been tested in these scenarios. Therefore, these tests were viewed more as a "thought experiment" with a goal of determining what it could take for the currently used tool to produce the desired outcome proposed by the TPB.

Table 7 Additional Policy Scenarios for Transportation Projects and Policies: Differences Compared to a 2015 Baseline

Internal Test Group	Scenario	Scenario Notes	Findings
Additional Analysis Planned Build	2040 Planned Build/ 2015 CLRP	This includes the projects in the updated long-range transportation plan.	Increases congested lane miles by 73 percent, daily vehicle hours of delay by 82 percent, and VMT by 21 percent in 2040 relative to 2015. It reduces GHG

and Policy Scenarios			emissions by 21 percent in 2040 relative to 2015.
	2040 Highway Expansion	All highway links in the regional highway network are expanded with an additional lane in both directions	Decreases congestion by approximately 20 percent and increases VMT by 30 percent in 2040 relative to 2015, but with most likely prohibitively high construction costs, since this scenario involves adding a lane to every link in the region. GHG emissions in 2040 decrease by 16 percent relative to 2015 (worse performance than 2040 Planned Build)
	2040 VMT Tax	VMT tax of $1 per mile is assessed for the entire modeled area; typical proposals studied elsewhere are between 1 and 2 cents per mile	Decreases congestion by more than 40 percent, VMT by 24 percent, and GHG emissions by 51 percent (significantly better than 2040 Planned Build) in 2040 relative to 2015, but perhaps costing a one-car household between $10,000 and $15,000 a year
	2040 Transit Expansion	All transit services operate with a one-minute headway: in addition, all Metrorail, commuter rail, light rail, BRT and streetcar running times are cut in half, the Metrorail constraint through the regional core is removed	This scenario is "less-worse" than Planned Build relative to today, with congestion increasing by 45-50 percent relative to today (instead of 70-80 percent in PB) and VMT increasing by 17 percent (instead of 21 percent in PB); transit trips double; GHG emissions in 2040 decrease by 24 percent relative to 2015 (better than 2040 Planned Build); this plan is not implementable for a number of reasons
	2040 High Parking Test	Daily commuter parking charge of $25 or more is assessed for each TAZ in the region; hourly rate of $5 or more is assessed for non-work trips throughout the region	This scenario is another "less-worse" case, with congestion increasing by 25-30 percent relative to today (instead of 70-80 percent) and VMT increasing by 14 percent (instead of by 21 percent); transit trips also double. GHG emissions decrease in 2040 by 26 percent relative to 2015 (better than Planned Build)
	Technology Substitution	2040 residential trip rates will be half of existing trip rates due to internet-based technologies (teleworking, e-commerce)	AM congested lane miles and VHD both decrease by about 50 percent in 2040 relative to 2015, while VMT decreases by 11 percent during the same time period. GHG emissions in 2040 decrease by 42 percent relative to 2015

			(two times greater reductions than 2040 Planned Build)
	Improved Peak Period Traffic Flow	Assumes that highway travel within the morning and evening peak periods will be evenly distributed throughout Examines flexible work hours, incentives to stagger working hours, and the use of technology and navigational aids to improve system flow and to minimize delay	AM congested lane miles decrease by 9 percent, while VHD increases by 29 percent relative to 2015. Number of congested lane miles decreases, but for those links where new congestion occurs, it is worse than today in terms of delay. VMT increases by 25 percent. GHG emissions decrease by 19 percent relative to 2015 (similar to the Planned Build reduction of 21 percent).
	Improved Traffic Flow Throughout the Day	Assumes that excessive traffic that would normally exist in the AM and PM peak periods will be displaced to off-peak periods, thereby improving peak period highway speeds and traffic flow	Decreases AM congested lane miles by 52 percent and VHD by 7 percent relative to 2015. Reduces overall congestion. VMT increases by 24 percent. GHG emissions decrease by 20 percent relative to 2015 (similar to the Planned Build reduction of 21 percent).

Table 8 provides the summary of findings using the assumptions from the latest 2022 Update to Visualize 2045. The analysis evaluated the 2045 No Build, Highway No Build (no new highway projects), Transit No Build (no new transit projects) and Planned Build scenarios against the 2023 baseline. One of the main findings from this analysis is that regardless of the project mix selected, land use has a far greater impact on VMT and emissions than the project mix. Along these lines, GHG emissions reductions estimates are within 3 percent from one another relative to 2023 (between -14 percent and -11 percent decrease in 2045 relative to 2023), depending on the scenario, and that the magnitude of possible GHG reductions resulting from using a different project mix, when using the projects that are currently in the plan, is fairly limited, especially when compared to the reductions needed to attain the regional GHG reduction goals (50 percent of 2005 levels by 2030 and 80 percent of 2005 levels by 2050).

Table 8 2022 Update to Visualize 2045: 2045 No Build Scenarios Analysis: Differences Compared to a 2023 baseline

Internal Test Group	Scenario	Scenario Notes	Findings
2022 LRTP Planned Build Scenarios Analysis	2045 Update - Build	All projects in the Visualize 2045 update are included in the analysis.	• Transit trips increase 28 percent = • SOV trips forecast to increase over 10 percent, with HOV/carpool to increase over 16 percent • VMT per capita expected to decrease 3 percent, VMT to increase 15 percent bike/walk trips increase 39 percent (increasing non-motorized mode share to 15 percent from 11 percent)

			• GHG emissions expected to decrease by 11 percent
2022 LRTP No Build Scenarios Analysis	2045 No Build	No new highway and transit projects after 2023, but the planned growth in jobs and population occurs	• highest percentage of congested lane miles • leads to most delay and congestion • VMT increases by over 13 percent relative to 2023 • GHG emissions decrease by 13 percent in 2045 relative to 2023
	2045 Highway No Build	No new highway projects after 2023, but the planned growth in jobs and population occurs	• Implementation of transit projects will decrease household auto ownership levels (regardless of build/no build highway projects) • highest increase in transit trips (30 percent relative to 2023) • lowest increase in HOV trips • SOV trips up over 10 percent • VMT expected to go up the least (13 percent) • GHG emissions expected to decrease by 14 percent (this is an improvement compared to the 2045 Update – Build)
	2045 Transit No Build	No new transit projects after 2023, but the planned growth in jobs and population occurs	• smallest increase in transit trips (21 percent compared to 2023) • highest increase in HOV trips • SOV trips up over 11 percent • VMT expected to go up the most (16) percent) • GHG emissions expected to decrease by 11 percent (similar to 2045 Update – Build)

3.2.5. LAND-USE FINDINGS

The TPB has examined land-use scenarios in nearly all of its scenario studies. The studies that included land-use as a factor are listed in Table 9.

The TPB has long-considered land-use a transportation strategy and has included land-use coordination in its policy framework. Land-use is an important factor in transportation because it influences the feasibility of travel options and travel behavior. It also impacts how goods and

services are distributed, the environment, health, community character, and economic vitality of a region.

The TPB has long encouraged jurisdictions throughout the region to concentrate residential and commercial development in dense, mixed-use Activity Centers and in High-Capacity Transit station areas to reduce the reliance on people driving alone for their daily needs. Connecting Activity Centers with High-Capacity Transit options and making it easier for people to move around within these areas can also help reduce reliance on driving alone. Coordinated land-use and transportation planning plays a key role in effectively making the most of existing facilities to achieve mobility and accessibility goals, continuing sustainable development, and maintaining global competitiveness.

The GHG reduction studies and their land-use scenarios included considerations of strategies related to energy and the built environment (EBE). This refers to energy utilization in the built environment to promote energy efficiency and reducing emissions. As the transportation system in integrated into the built environment and uses fuel/energy to function, these strategies are important considering for transportation-focused scenario planning.

The numerous scenarios that the TPB and COG have conducted that consider land-use have resulted in the following summary findings:

- The optimization of land-use by collocating housing and jobs and focusing more development around Metrorail reduces road congestion, improves access to bicycle/pedestrian facilities, and makes Metrorail a more viable option for more people.
- Balancing the region's East/West divide by reallocating jobs/housing more evenly across the region and overall and increasing the number of households in the region can reduce the long commute times, including for the workers currently living outside of the region.
- Creation of walkable, transit-oriented, and mixed-use Activity Centers directly allows for substantial bicycle and pedestrian trip increases and major transit use increases on the existing system, and planned BRT systems, which are necessary in some form to relieve existing and projected transit congestion.
- Land-use scenarios show that significant population growth can be accommodated smartly, without increasing road congestion, air pollution, or VMT.
- All scenarios that included land-use demonstrated a small positive impact on reducing GHG, but land-use shifts alone cannot make substantial reductions to meet the COG and TPB GHG reduction goals for 2030 and 2050.

HOW DID THE TPB ARRIVE AT THESE FINDINGS?

The following section provides a sampling of individual findings from several the scenarios to provide support for the summary findings noted in the previous section.

The 2010 CLRP Aspirations Scenario Study presented results of the analysis of a land-use sensitivity scenario consisting of only the smart growth assumptions[6] contained in the full CLRP Aspirations Scenario. This sensitivity scenario was run in order to control for land-use changes and better understand their potential effects on travel demand. Key findings for horizon year 2030 showed trends (comparing to the 2008 CLRP) that the land-use changes could support the reduction of VMT (0.5 percent decrease), VMT per capita (4.1 percent decrease) and reduce average auto trip length (2.5 percent decrease)

Both the MSWG (TLU-2) and LRPTF Phase 2 study (Initiative 8)[7] studies showed that shifting future projected growth to locate jobs and households closer together in regional Activity Centers and near High-Capacity Transit reduces automobile travel. The MSWG study specifically assumed bicycle and pedestrian enhancements. The MSWG study showed an 11.6 percent reduction in daily VMT compared to the "current policies" (CLRP) forecast in 2040 (base-year 2015).

The LRPTF Phase 2 study examined regional priority initiatives, comparing them to the long-range plan that was in effect at the time of the study (forecasts for outyear 2040). Many of these initiatives included land-use shifts, while one focused specifically on the optimization of land-use. It included optimizing jobs/housing balance regionwide; increasing jobs and housing around underutilized rail stations and Activity Centers with High-Capacity Transit, building more housing in the region to match employment (about 130,000 more households) and reducing the number of long-distance commuters outside of the region. Analysis showed that shifting land-use in this manner demonstrated positive travel trends for horizon year 2040 compared to the CLRP (base-year 2015), including reducing daily vehicle hours of delay by 18 percent, reducing daily VMT by 3 percent, daily VMT per capita by 6 percent (for all types of drivers) and a 29 percent increase in non-motorized trips compared to 2040.[8]

All studies showed that while land-use and transportation coordination is a key transportation strategy, and that it can help to reduce GHG emissions, land-use must be combined with other more effective GHG reduction strategies to make significant progress toward regional GHG reduction goals.

The LRPTF Phase 2 land-use scenario demonstrated a possible four percent GHG reduction.[9] The land-use strategies that COG and the TPB assume for the MSWG study were more aggressive and resulted in a 7 percent decrease in transportation emissions in 2040.

In the CCMS, there were two types of scenarios, ones exploring single pathways at different levels of implementation and ones combining the pathways at different levels of implementation. The

[6] A land use sensitivity scenario was also run in order to control for the effects of the land use portion of the full scenario. The sensitivity is the land use component of the Aspirations scenario, but with no change in transportation assumptions beyond the 2008 CLRP. It does not contain any of the new pricing, road capacity, or the BRT system that are in the full scenario. This sensitivity enables a more nuanced analysis and helps determine possible causes for a variety of travel demand effects.

[7] It should be noted that the land use strategies in the MSWG and LRPTF were evaluated using different assumptions and different modeling tools, which accounts for the difference in forecasted VMT and GHG reductions due to shifting future land use patterns. The MSWG analysis used a tool developed by the consultant while the LRPTF analysis used the TPB regional travel demand model and sketch planning tools.

[8] LRPTF Phase 2 Study, Summary presentation by Erin Morrow on 3/17/2021.

[9] LRPTF Phase 2 Study, Summary presentation by Erin Morrow on 3/17/2021.

pathways included 1) vehicle technology and fuel improvements, 2) mode shift and travel behavior, and 3) transportation systems management and operations, which included connected and automated vehicle assumptions. The CCMS study found that none of the individual or combined scenarios that included land-use strategies could meet the region's non-sector-specific 2030 GHG reduction goals (50 percent below 2005 levels).[10] In 2050, only the most aggressive combined scenarios could meet the GHG reduction goals for the on-road transportation sector (80 percent below 2005 levels). Land-use strategies included in these scenarios include adding new housing in the region.

While not meeting the TPB's GHG reduction goals, the CCMS findings for the mode shift pathways found that with the combination of land-use changes and other strategies that there would be VMT reductions in 2030 and 2050 compared to the baseline. While a large part of the reduction is due to the 25 percent telework level, the land-use and transit enhancements also see noticeable positive effects by 2050.

Table 9 provides an overview of the COG and TPB scenario studies that included strategies that were specific to land-use/built environment changes.

Table 9 Scenarios that Considered Land-Use

Report	Land Use Scenarios	To Better Understand
Regional Mobility and Accessibility Study: What If? (RMAS) (2006)	Concentrating jobs and households in regional Activity Centers and expanding the transit network	Explore actions the region's leaders might take to better meet the objectives of the TPB Vision, the TPB's first major policy document.
What Would it Take? Scenario (2010)	Align land-use and transportation planning, focusing growth around mixed-use development and adding more housing units in these locations	How to meet aggressive regional climate change mitigation goals in the transportation sector
CLRP Aspirations Scenario Study (2010)	Align land-use and transportation planning focusing growth in Activity Centers and High-Capacity Transit Stations and adding more housing units in these locations	Better align land use and transportation planning with the goals of the TPB Vision and of the previous RMAS initiative
Multi-Sector Working Group (2017)	Land-use shifts in population and employment to Activity Centers and High-Capacity Transit stations, together with sustainable urban design to reduce GHG emissions. Examines a number of strategies promoting energy efficiency and reducing emissions through improvements in the built environment, infrastructure, and non-road engines	Provides context for GHG emissions in the region and potential GHG reductions that might be achieved through regional policy actions.

[10] Note that the CCMS calculated on-road GHG emissions from both vehicle tailpipes and the electricity used to run electrical cars. Many other studies and GHG reduction targets calculate only tailpipe emissions. This would make it more challenging for the CCMS to meet the region's non-sector-specific GHG reduction goals.

LRPTF Phase 2 Study (2017)	Align land-use and transportation planning focusing growth in Activity Centers and High-Capacity Transit Stations and adding more housing units in these locations.	Examines impacts of potential initiatives against the currently adopted LRTP for the year 2040
2030 Climate Energy and Action Plan (2020)	Encourage shifts in population and employment to Activity Centers and High-Capacity Transit stations to reduce GHG emissions	Help move the region towards meeting its 2030 climate mitigation and resiliency goals
Climate Change Mitigation Study (2021)	Align land-use and transportation planning focusing growth in Activity Centers and High-Capacity Transit Stations and adding more housing units in these locations. One strategy focused on moving jobs and households withing jurisdictions, anther moved them across jurisdictional boarders.	Assess ways to reduce GHG emissions in the on-road transportation sector

3.2.6. VEHICLE TECHNOLOGY (ELECTRIFICATION AND ALTERNATIVE FUELS)

The TPB policy framework has for many years endorsed using the most effective technologies. Over time, technologies that are implemented by the public and private sector continue evolve to serve various end goals such as system efficiency, mobility, safety, fuel efficiency, and GHG mitigation. Vehicle technologies and fuel efficiency are important technological advances that are often effective at making progress on the TPB's goals, but, are outside the TPB members' authority.

The TPB and COG scenarios that considered vehicle technologies and fuels resulted in the following summary findings:

- Findings in the CCMS show that even with a clean electric power grid (100 percent carbon-free by 2035), and the region applying the aggressive combinations of strategies, it would not meet the 2030 targeted emissions reductions of 50 percent below 2005 levels. The 2050 targeted emissions reductions of 80 percent below 2005 levels could potentially be met with aggressive combinations of strategies and a significantly cleaner electric power grid.
- The mode shift and travel behavior and the transportation systems management and operations single pathway scenario results did not reflect the ability to meet either the 2030 or 2050 emissions reductions by themselves. Findings in the CCMS show that even with a clean electric power grid (100 percent carbon-free by 2035), the region would have to apply the aggressive scenarios to meet 2030 and 2050 targeted emissions reductions.
- The single pathway (largely illustrative) scenarios that made the largest impact are the two vehicle technology scenarios that convert the light, medium, and heavy-duty vehicle fleets to electric vehicles and use biofuels/renewable diesel. The more aggressive scenario of the two was found to meet the 2030 and 2050 emissions reductions. The mode shift and transportation systems management and operations pathways results did not reflect the ability to meet either the 2030 or 2050 emissions reductions by themselves.

How did the TPB arrive at these findings?
The MSWG study examined the potential impacts that could result from improvements in light-duty vehicles, the public sector fleet, lowering carbon fuel standards, and truck stop electrification. A summary of primary findings includes the following:

- In 2012, the MSWG study found that passenger vehicles are estimated to be responsible for 84 percent of VMT and 72 percent of on-road GHG emissions in the region. The TLU-3 strategy, to improve fuel economy of the light-duty vehicle fleet, aimed to increase light-duty ZEVs to 25 percent of the fleet by 2050. To reach this goal it suggested speeding up the replacement rate of older, less fuel-efficient vehicles, incentivizing the purchase of electric vehicles and charging equipment, implementing disincentives for inefficient vehicle purchase, and adopting new low emission vehicle standards.

- The MSWG study showed a significant GHG emissions reduction from the light-duty CAFE standards that were phased in with model years 2012-2025 and the MHDV fuel efficiency standards that were phased in with model years 2014-2018. The analysis showed that emissions within the transportation sector would be 46 percent lower in 2040 compared to a future where these federal fuel efficiency policies had not been enacted.

- The low-carbon fuel standard (TLU-6) was the most impactful transportation-only strategy studied by the MSWG. The low-carbon fuel standard contributed a 5 percent reduction (compared to) in GHG emissions from the transportation sector total in 2040.

- Additional accelerated deployment of zero-emission vehicles examined in the MSWG (TLU-3) was the most impactful transportation-only strategy studied. TLU-3 contributed a 3 percent reduction in GHG emissions from the transportation sector's forecast for 2040. Electric vehicles do not have tailpipe GHG emissions that would be included in on-road vehicle emissions inventories; however, there are GHG emissions from the electric generation needed for charging the vehicles.[11] In the MSWG study and the CEAP 2030 analysis, the GHG emissions produced to generate the electricity needed to charge electric vehicles were accounted for, thus reducing the net GHG reduction benefit of electric vehicles.

The CCMS explored vehicle technology and fuels strategies to reduce the carbon-intensity of vehicle travel by shifting to electric vehicles (EVs), lower carbon fuels, and increasing the fuel efficiency of vehicles. The analysis looked at the current vehicle stock and GHG emissions and estimated what level of EVs in the fleet would be necessary to achieve the 50 percent and 80 percent GHG reduction goals without any changes in forecast VMT. The study analyzed strategies using three different electric grid assumptions based on existing and potential state and national policies (Reference Case, Modified Reference Case, Clean Grid Case).[12] The reference case used as a baseline electric

[11] US Environmental Protection Agency (EPA). "Greenhouse Gas Emissions from a Typical Passenger Vehicle." EPA Office of Transportation and Air Quality. EPA-420-F-18-008. March 2018. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100U8YT.pdf

[12] Reference Case: All "on-the-books" policies, including renewable portfolio standards in the District of Columbia, Maryland, and Virginia. These policies include those defined in Virginia's Clean Economic Act, Maryland's Renewable Portfolio Standard, and DC's Renewable Portfolio Standard. Modified Reference Case: Slightly more aggressive Reference Case, resulting in a near zero carbon grid by 2040 based on enhanced clean energy policies in Maryland that more closely match those from DC and Virginia. Clean Grid Case: Assumes a 100 percent carbon free grid by 2035.

grid and the clean grid assuming a 100 percent carbon free grid by 2030. A summary of primary findings includes the following:

- The CCMS found that the average emissions rate across all vehicles would need to be reduced by 56 percent compared to the 2018 level to reach the 2030 goal. The baseline forecast found that emission rates are expected to decline by 25 percent over this period meaning that the average vehicle fuel economy of vehicles must more than double between 2018 and 2030. To reach this, approximately 44 percent of vehicles on the road would need to be EVs in 2030 (in the Reference Case grid). This number does not account for emissions from electricity used to charge the EVs, when considering electricity and charging stations approximately 75 percent of the fleet would need to be EVs.
- In 2050, under the Reference Case grid, it was found that achieving the 2050 goal level of an 80 percent GHG emissions reduction is not attainable in either of the vehicle technology scenarios. The average emission rate across all vehicles would need to be reduced by 84 percent compared to the 2018 level. The baseline forecast found that emission rates are expected to decline 32 percent over this period. To reach the 2050 goal, the region would need to have a carbon free electric grid and 79 percent of vehicles on the road would need to be EVs by 2050.
- **As a point of reference, as of 2018, EVs make up less than 1 percent of the vehicle fleet.** The required level of fleet change by 2030 is extremely ambitious and would likely require immediate shifts to all new vehicles sold as EVs, aggressive incentives to accelerate vehicle turnover, and/or carbon or fuel pricing increases.

Table 10 provides an overview of the COG and TPB scenario studies that include strategies that were specific to vehicle technology.

Table 10 Scenarios that Considered Vehicle Technology

Report	Scenario(s)	To better understand
WWIT	Scenarios looked at large-scale, aggressive federal government action, and both short- and long-term state/regional/local actions. These included CAFE 55 mpg by 2030; doubling current heavy duty fuel efficiency by 2020; local tax incentives for fuel efficient vehicle purchase, the current (at the time) renewable fuel standard	Improving fuel efficiency, (use of) alternative fuels, and travel efficiency
MSWG	Roadway and personal vehicle policies (low carbon fuel standard, improving fuel economy of light-duty vehicle fleet, truck stop electrification).	Providing context for GHG emissions in the region and potential GHG reductions that might be achieved through regional policy actions
CEAP	Study the impacts of strategies aimed at energy efficiency, mode shift, and travel behavior	Help move the region towards meeting its' 2030 climate mitigation and resiliency goals
CCMS	Ten scenarios that all contain roadway and automobile components in them. Six of these scenarios are focused on a particular pathway: • Vehicle technology (VT) and fuels including converting the bus fleet to EVs • Mode shift and travel behavior (MSTB) • Transportation Systems Management and Operations (TSMO)	Impacts of individual and combined strategies on GHG reduction

4. CONCLUSION

The TPB has conducted approximately one scenario study every 16 months over the last 15 years. The findings from these studies have been incorporated into local planning, policy development, and investment programs. The region still faces many challenges which could be exacerbated by growth in population and employment, and impacted by other factors such as a changing climate, new technologies and changes in the global economy. As the TPB updates its plan (2024 update) sponsor agencies should continue to focus on investing in and implementing the priority strategies (projects, programs, and policies) that have been identified through the scenario studies described herein, as well as the foundational strategies for the scenarios, such as more complete bicycle and pedestrian networks and a state of good repair.

When implemented by TPB member agencies, some strategies **must** be documented in the constrained element of the long-range transportation plan and TIP. These include any project, program or policy that impacts roadway or transit capacity—and could, therefore, affect air quality. Any project or program slated to receive federal funding must also be included.

But, the TPB's priority strategies cannot all be reflected in the constrained element, examples include most projects for walking and biking, land-use policies, and electrical vehicle charging stations. Many such strategies are reflected in the unconstrained policy element of the plan and in other manners, such as in the TPB Bicycle and Pedestrian Plan, in regional electrical vehicle coordination activities, electric vehicle infrastructure plans and other planning activities and investments documented at the state, regional, transit agency, and local level. The TPB will continue supporting priority strategies through feasible means.

APPENDIX A – SCENARIO DESCRIPTIONS

SCENARIO DESCRIPTIONS

This section summarizes the various scenario studies and related work activities of TPB and COG. Included in the Appendix are oversight or ownership of the work, relevant dates/completion date (for completed work) or most recent analysis (for on-going work), and any planned updates to the work.

Regional Mobility and Accessibility Study

Date Completed: October 2006
Oversight: TPB
Documentation: Final Report: Regional Mobility and Accessibility Scenario Study

Study Purpose

The Regional Mobility and Accessibility Study (RMAS) grew out of the dissatisfaction expressed by members of the TPB in voting to approve a fiscally Constrained Long-Range Transportation Plan (CLRP) that showed congestion on the region's highway and transit networks continuing to worsen over the next 25 years. The desire of the TPB in authorizing this study was to examine additional transportation improvements beyond those that currently could be included in the region's long-range transportation plan, together with potential changes in future land use.

The concept underlying the Regional Mobility and Accessibility Study is that creative new options for improving the performance of the region's transportation system may emerge from the examination of additional transportation improvements together with potential future changes in land use. If stakeholders in the regional transportation planning process reach a consensus on these options, the region could move forward in pursuing additional funding to implement the most promising of these transportation improvements and making the necessary changes in local land use plans.

Major Findings

The scenarios had positive impacts regionwide on the transportation network with improved travel conditions throughout the region. All of the scenarios use different means to achieve the same objectives of bringing people and jobs closer together, and improving the transportation connections between them. The scenarios are not mutually exclusive; in many ways they are similar and complementary.

Regional Value Pricing Study

Date Completed: February 2008
Oversight: TPB
Documentation: Final Report: Evaluating Alternative Scenarios for a Network of Variably Priced Highway Lanes in the Metropolitan Washington Region

Study Purpose

The TPB has had an active interest in variably priced highway lanes since June of 2003 when the TPB, in conjunction with the Federal Highway Administration and the Maryland, Virginia, and District Departments of Transportation, sponsored a successful one-day conference on value pricing for the Washington region. Following the conference, the TPB created a Task Force on Value Pricing to

examine how value pricing could benefit the region. The Task Force developed a set of regional goals for a system of variably priced lanes which were adopted by the TPB in April of 2005. The goals were designed to "help guide the regional development of variably-priced lanes that work together as a multi-modal system, while addressing the special policy and operational issues raised by the multi-jurisdictional nature of this region." As the framing of the regional goals proceeded at the TPB, three major variably-priced highway facilities were being developed through project planning studies for inclusion in the region's financially constrained Long Range Transportation Plan (CLRP): the Inter-County Connector in suburban Maryland, the Northern Virginia Capital Beltway HOT lanes project, and the I-95/395 HOT lanes project.

In order to place these three new projects into a regional context and to assess the potential for a more extensive network of variably priced lanes, the TPB developed and analyzed several different scenarios of variably priced lane networks. The study was conducted under a grant from the Federal Highway Administration's Value Pricing Pilot Program, and was overseen by the TPB's Task Force on Value Pricing.

Major Findings

The toll rates on the variably-priced lane (VPL) network would have to vary significantly by segment, direction, and time-of-day in order to maintain free-flowing conditions. In terms of financial feasibility, a comparison of the forecasted revenues versus costs for each of the scenarios found that only the "DC and Parkways Restrained" scenario generated revenues close to covering the costs.

The addition of extensive transit service to the VPL networks resulted in increases in transit use, decreases in HOV use, small decreases in VMT, and decreases in total system revenue.

Regarding land use patterns, very few zones experienced significant changes in accessibility to jobs by highways. Accessibility to jobs by transit improved in all the scenarios. Changes in accessibility to households by highways were minimal and gains in accessibility by transit were scene near major interchanges in the VPL network.

National Capital Region Climate Change Report

Oversight: COG
Date Completed: November 12, 2008
Documentation: National Capital Region Climate Change Report[13]

Study Purpose

On April 11, 2007, as part of its 50th anniversary year, the COG Board adopted Resolution R31-07, creating a climate change initiative. Part of the climate change initiative included a call for developing a GHG inventory, setting regional goals, and identifying best practices for reducing GHG emissions. Beginning with a base year of 2005, the analysis looked at a "business as usual" future

[13] National Capital Region Climate Change Report. Washington, D.C.: Prepared by the Climate Change Steering Committee for the Metropolitan Washington Council of Governments Board of Directors. November 12, 2008. https://www.mwcog.org/documents/2008/11/12/national-capital-region-climate-change-report-climate-change/

through 2050 where no actions beyond current policies and programs are implemented to reduce GHG emissions.

Major Findings

The most notable outcome from this report was the three targets that the Climate Change Steering Committee chose for reducing GHG emissions. Those reduction targets have been the framework for subsequent GHG and climate change work. The targets were adopted by the COG Board with the adoption of the report:

- By 2012, GHG emissions 10 percent below "business as usual"
- By 2020, GHG emissions 20 percent below 2005 levels
- By 2050, GHG emissions 80 percent below 2005 levels

The Climate, Energy, and Environment Policy Committee (CEEPC) was created by the COG Board on April 8, 2009, through Resolution R18-09 and is responsible for managing implementation of the *National Capital Region Climate Change Report.*

"What Would it Take?" (WWIT) Scenario Study

Date Completed: May 18, 2010
Oversight: TPB
Documentation: Final Report: What Would It Take? Transportation and Climate Change in the National Capital Region[14]
Study Base-Year and Comparison Year:

Study Purpose

The "What Would it Take?" Scenario Study was one of two scenario studies that were undertaken under the purview of the Scenario Study Task Force that the TPB established in September 2007. The WWIT Scenario Study was the TPB's first step toward answering some major questions about climate change mitigation, specifically in the transportation sector in the Washington metropolitan region. The study examined what types of projects / programs / policies it would take in the transportation sector to meet the regional aspirational GHG reductions targets established in the National Capital Region Climate Change report and adopted by the COG Board in November 2008. The study developed the baseline GHG emissions in the transportation sector and tested the potential reductions in GHG emissions from various projects/programs/policies would generate in the transportation sector. The intent was to determine the nature and scope of actions that would be necessary to reduce GHG in the transportation sector in the target amounts noted below.

- By 2012, 10 percent below "business as usual" (of the transportation sector)
- By 2020, 20 percent below 2005 levels (of the transportation sector)

[14] Final Report: What Would It Take? Transportation and Climate Change in the National Capital Region. Washington, D.C.: Metropolitan Washington Council of Governments. May 18, 2010. https://www.mwcog.org/documents/2010/05/18/what-would-it-take-scenario-land-use-projects/

- By 2050, 80 percent below 2005 levels (of the transportation sector)

Major Findings

In order to meet the region's goals, strategies will need to be adopted across all levels of government and across the three categories of fuel efficiency, alternative fuels and travel efficiency. Systemwide measures implemented at the national level can provide substantial and dependable GHG reductions; however, near-terms goals will not be met just with systemwide measures – state, regional, and local actions are needed.

CLRP Aspirations Scenario Study

Date Completed:	September 8, 2010
Oversight:	Scenario Study Task Force of the Transportation Planning Board
Documentation:	CLRP Aspirations Scenario https://www.mwcog.org/documents/2010/09/08/clrp-aspirations-scenario/

Study Purpose

In 2008, the TPB began developing the Constrained Long-Range Plan (CLRP) Aspirations Scenario Study to integrate the best components of the RMAS and RVP studies into a comprehensive scenario that could offer a promising path forward for the region. This "CLRP Aspirations" scenario, was one of two scenarios in the TPB Scenario Study. This scenario examines the effects of a long-range land use and transportation vision for the National Capital Region out to horizon year 2030. The scenario consists of a smart growth land use strategy, a network of variably priced lanes, and an extensive BRT network running on priced lanes.

Major Findings

The study providing insights as to the benefits of align land-use and transportation planning including focusing growth in Activity Centers and High-Capacity Transit Stations and adding more housing units in these locations.

Multi-Sector Working Group (MSWG) / TPB Affirmation of the Region's GHG Reduction Goals

Date Completed:	January 18, 2017
Oversight:	TPB/MWAQC/CEEPC
Documentation:	Final Technical Report: Multi-Sector Approach to Reducing Greenhouse Gas Emissions in the Metropolitan Washington Region[15] Recommendation of the Multi-Sector Working Group[16]

[15] Final Technical Report: Multi-Sector Approach to Reducing Greenhouse Gas Emissions in the Metropolitan Washington Region. Washington, D.C.: Metropolitan Washington Council of Governments (submitted by ICF International). January 31, 2016. https://www.mwcog.org/documents/2016/08/01/multi-sector-approach-to-reducing-greenhouse-gas-emissions-in-the-metropolitan-washington-region-final-technical-report/

[16] Recommendation of the Multi-Sector Working. Washington D.C.: Metropolitan Washington Council of Governments. January 18, 2017. https://www.mwcog.org/documents/2017/01/18/multi-sector-working-group-greenhouse-gas-emission-reducing-strategies-air-quality-climate-mitigation-greenhouse-gas-multi-sector-working-group/

Study Purpose

In December 2014, the TPB and the Metropolitan Washington Air Quality Committee (MWAQC) affirmed COG's adopted voluntary GHG reduction goal of 80 percent below 2005 levels by 2050,[17] and committed staff and resources to support a multi-sector, multi-disciplinary professional working group to be convened by COG to:

- Identify viable, implementable local, regional, and state actions to reduce GHG emissions in four sectors (Energy, the Built Environment, Land Use, and Transportation) in accordance with the voluntarily adopted goals;
- Quantify the benefits, costs and implementation timeframes of these actions;
- Explore specific GHG emission reduction targets in each of the four sectors; and
- Jointly develop an action plan for the region

Major Findings

The MSWG work was directly related to the GHG reduction targets laid out in the National Capital Region Climate Change Report. The technical analysis showed that policies implemented between 2005 and 2015 made a significant contribution to reducing future GHG emissions in the region. The analysis then looked at 22 strategies – nine in the Energy/Built Environment (EBE) Sector and twelve in the Transportation/Land Use (TLU) Sectors, along with one strategy focused on community engagement, which cross-cuts all of the sectors. The additional regional strategies could further reduce GHG emissions significantly, but still not achieve the 80 percent reduction goal by 2050. The analysis identified potential national-level strategies that could get the region to the 80 percent reduction goal; however, those strategies would likely require significant breakthrough improvements in existing technology.

Long-Range Plan Task Force (LRPTF)

Date Completed:	December 20, 2017
Oversight:	TPB
Documentation:	An Assessment of Regional Initiatives for the National Capital Region: Technical Report on Phase II of the Long-Range Plan Task Force[18] R-8 2018: TPB Resolution endorsing initiatives recommended by the LRPTF[19]

[17] TPB R10- 2015: Resolution on the Metropolitan Washington Council of Governments' Regional Multi-Sector Goals for Reducing Greenhouse Gases. Washington, D.C.: National Capital Region Transportation Planning Board. December 17, 2014. https://www.mwcog.org/file.aspx?&A=NQRpyfkLR1A9O4KiCx0%2bhAVEs%2fYo7kI1bNCWYEItoHU%3d

[18] An Assessment of Regional Initiatives for the National Capital Region: Technical Report on Phase II of the Long-Range Plan Task Force. Washington, D.C.: National Capital Region Transportation Planning Board (prepared by ICF International). December 20, 2017. https://www.mwcog.org/documents/2017/12/20/long-range-plan-task-force-reports-projects-regional-transportation-priorities-plan-scenario-planning-tpb/

[19] TPB R-8 2018; TPB Resolution endorsing initiatives recommended by the LRPTF. Washington, D.C.: National Capital Region Transportation Planning Board (prepared by ICF International). December 20, 2017. https://www.mwcog.org/documents/2017/12/20/r8-2018---resolution-endorsing-initiatives-recommended-by-the-long-range-plan-task-force/

Study Purpose

TPB Resolution R16-2017, adopted on March 15, 2017, directed the Long-Range Plan Task Force to identify a limited set (6-10) of projects, policies, or programs that would have the potential to improve the performance of the region's transportation system. All phases of the analysis used 2015 as the base-year and examined scenarios with a future year of 2045. The first phase included the development of a baseline report that focused on an analysis of three future alternative scenarios in 2040. The second phase included the selection and analysis of a set of unconstrained transportation improvements (project, policies, or programs) to determine if they make significantly better progress towards achieving the goals laid out in TPB and COG's governing documents. Each analysis produced results compared to a 2015 baseline. As a part of this study, among other measures, GHG impacts of each initiative were analyzed in relationship to the Planned Build. TPB endorsed five analyzed initiatives with greatest potential to significantly improve the performance of the region's transportation system for future concerted TPB action and directed staff to include these initiatives in the aspirational element of the TPB's LRTP, Visualize 2045 (two "non-motorized" initiatives were subsequently added to the aspirational element for a total of seven aspirational initiatives).

While the ten initiatives could provide for substantial improvements to the region's transportation system, the task force stressed that the success of any or all initiatives would be dependent upon pre-requisite conditions or assumptions. These assumptions include state of good repair, supportive land-use policies and improvements in bicycle and pedestrian infrastructure.

Major Findings

While the work of the Long-Range Plan Task Force was not specifically focused on climate change, two of the initiatives, Initiative 8 (Optimize Regional Land-Use Balance) and Initiative 10 (Amplified Employer-Based Travel Demand Management), stood out as strategies that improve the performance of the transportation network as well as have a notable impact on GHG emissions.

Climate Change Mitigation Study of 2021 (CCMS)
Date Completed: January 7, 2022
Oversight: TPB
Documentation: Numerous reports can be found at: https://www.mwcog.org/tpb-climate-change-mitigation-study-of-2021/

This scenario study assessed ways to reduce GHG emissions in the on-road transportation sector, building upon the work of the WWIT and MSWG studies. The study assessed the types of transportation-related actions, and their levels of implementation, that would be needed to reduce GHG emissions to meet regional multisectoral GHG reduction goals for 2030 and 2050. In 2020, the region's officials approved a new goal to reduce non-sector-specific GHG emissions by 50 percent in 2030.[20] Prior to that, in 2008, the region's officials had approved a goal to reduce non-sector-

[20] "Metropolitan Washington 2030 Climate and Energy Action Plan" (Washington, D.C.: Metropolitan Washington Council of Governments, November 18, 2020), https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/.

specific GHG emissions by 80 percent in 2050 relative to 2005 levels.[21] Following this study, the TPB adopted these same goals/targets, but specifically for the on-road transportation sector.

Congestion Reduction Test (by 25 Percent Relative to 2030)

Date Completed: March 24, 2017
Oversight: TPB (Internal Staff Testing)
Documentation: Internal Staff Documentation
Study Base-Year and Comparison Year: 2015, 2040

Study Purpose

At the January 18, 2017, TPB meeting, a board member proposed a draft resolution establishing the mission and tasks for Phase II of the Long Range Plan Task Force (Item 11). The resolution "charges the Task Force and staff to utilize the Phase I Report as a resource and benchmark in the development of an alternative plan that analyzes creative and innovative combinations of projects, programs and policies that will (a) result in a reduction of peak hour congestion, notwithstanding projected future regional growth, by at least 25 percent over the 25-year investment horizon, and (b) establishes measurable metrics for other congestion, mobility and access goals."

In preparation for the modeling activities for the Phase II of the Long-Range Plan Task Force, staff completed a scenario analysis to explore how a 25 percent congestion reduction, relative to today (2015), might be attained with the implementation of "extreme" project and policy scenarios in 2040. While the scenarios tested were admittedly impossible to implement, the analysis demonstrated that a 25 percent reduction in congestion could be attained, but only with highly unrealistic measures (massive system expansion or very aggressive demand pricing measures). While the language in subsequent draft Long-Range Plan Task Force resolutions evolved and the charge to reduce congestion by 25 percent relative to today was ultimately removed from the resolution(s), staff's tests provide valuable information regarding the levels of congestion reduction that could be achieved with various types of projects and policies.

Major Findings

While some of the 2040 scenarios reach the 25 percent congestion reduction target relative to today (2015) or come close to it, it could be argued that none of them are feasible to implement (e.g., adding a lane to every roadway in the region, having two-car households pay more than $20,000 annually in VMT tax, implement levels of telework that were subsequently observed only during the height of the COVID-19 Pandemic-related closures in Spring of 2020).

Also, although measuring impacts of these scenarios on climate change was not the main focus of these tests, some of the project-focused scenarios show just how challenging it is to achieve further GHG reductions through project implementation. For example, the 2040 Transit Expansion scenario assumes one-minute service frequencies on every transit line in the region and a 50 percent transit time reduction on every high-capacity transit line (including Metrorail). And yet GHG emissions in this 2040 test decreased relative to 2015 by 24 percent, whereas the 2040 Planned Build showed a 21

[21] Climate Change Steering Committee for the Metropolitan Washington Council of Governments Board of Directors, "National Capital Region Climate Change Report," Final Report (Washington, D.C.: Metropolitan Washington Council of Governments, November 12, 2008), https://www.mwcog.org/file.aspx?A=R8%.

percent reduction (in other words, three percentage points were gained with a scenario with an impact that no project mix from the constrained element could replicate).

It is important to note that the travel model was calibrated to observed travel conditions, which include far less variability than has been tested in these scenarios. Therefore, these tests were viewed more as a "thought experiment" with a goal of determining what it could take for the currently used tool to produce the desired outcome proposed by the TPB.

OTHER ON-GOING WORK ACTIVITIES THAT CONDUCT ANLAYSIS OF A SINGLE-SCENARIO

Performance Analysis of the TPB's Long Range Plan

Oversight: TPB
Recent Analysis: June 15, 2022, prior: October 17, 2018
Documentation: Visualize 2045 Update: A Long-Range Plan for the National Capital Region[22]
Study Base-Year and Comparison Year: 2023, 2045

Study Purpose

A federally-required conformity analysis is conducted every time the long-range plan is updated or amended. Therefore, a conformity analysis has been typically conducted at least every other year. Since 2010, in addition to the mandatory air quality conformity analysis, the TPB has voluntarily estimated GHG emissions for the constrained element of its LRTP. Greenhouse gas emissions are estimated for the analysis years required for the conformity analysis and are calculated each time a conformity analysis is conducted. Historic GHG emissions estimates for 2005 and 2012 are also typically included in the analysis.

Update to Emissions Estimates: Greenhouse gas emissions estimates will be updated with the next major update to the LRTP in 2024.

Long-Range Transportation Plan 2022 Update: No Build Tests

Date Completed: April 2022
Oversight: TPB (Internal Staff Testing)
Documentation: Internal Staff Documentation
Study Base-Year and Comparison Year: 2023, 2045

Study Purpose

The main purpose of this internal staff exercise was to try to estimate the impacts of different components of the TPB's Long-Range Transportation Plan (LRTP), i.e., highway projects, transit projects, and land-use, on the transportation system performance. This included testing a set of 2045 no-build and build scenarios and comparing the results with the 2023 model outputs, based

[22] Visualize 2045: A Long-Range Plan for the National Capital Region. Washington D.C.: National Capital Region Transportation Planning Board. June 15, 2022. https://www.visualize2045.org

on the 2022 Update to Visualize 2045 Long-Range Transportation Plan. The analyzed scenarios included:

- 2045 Highway No-Build (new transit projects, but no new highway projects)
- 2045 Transit No-Build (new highway projects, but no new transit projects)
- 2045 No Build (no new transit and highway projects), and
- 2045 Planned Build (from 2022 Update to Visualize 2045.

All 2045 no build and build scenarios were based on the same land-use data, assuming that the household and employment growth will occur as currently planned (Round 9.2 Cooperative Forecasts).

Major Findings

Consistent with findings from prior studies, this analysis showed that land-use is likely to have a far larger impact on VMT and GHG emissions than any combination of highway and transit projects.

GHG emissions in these 2045 scenarios are expected to decrease by 11 percent to 14 percent relative to 2023, with largest reductions forecast for the 2045 Highway No Build scenario. However, it could be argued that these project-mix scenarios are having a relatively modest impact on GHG emissions reductions (within 3 percent of one another), especially given the magnitude of TPB/COG GHG reduction goals (50 percent of 2005 levels by 2030 and 80 percent of 2005 levels by 2050).

Climate, Energy, and Environment Policy Committee (CEEPC) Climate and Energy Action plan

Oversight:	CEEPC
Most Recent Analysis:	November 18, 2020
Documentation:	Regional Climate and Energy Action Plan (2030 Plan)[23] and appendices
Study Base-Year and Comparison Year:	

Study Purpose

The Climate, Energy and Environment Policy Committee (CEEPC) was created by the COG Board on April 8, 2009, through Resolution R18-09 as its principal policy adviser on climate change, energy, green building, alternate fuels, solid waste and recycling policy issues, and other environmental issues that the board may assign. CEEPC is responsible for managing implementation of the National Capital Region Climate Change Report adopted by the COG Board of Directors in 2008. This responsibility includes development of a regional climate change strategy to meet the regional GHG reduction goals adopted by the board.

CEEPC updates its Climate and Energy Action Plan, which addresses all sectors, every three years. The plan includes a measurement of progress towards reaching the region's GHG reduction goals. The most recent plan covers years 2017-2020. The 2017-2020 plan reports mobile source GHG emissions for 2005, 2012, 2015, and 2016.

[23] Regional Climate and Energy Action Plan (2017-2020 Plan). Washington D.C.: Metropolitan Washington Council of Governments. March 23, 2017. https://www.mwcog.org/documents/2017/03/23/regional-climate-and-energy-action-plan-climate--energy-climate-change-energy/

CEEPC is currently developing the 2030 Climate and Energy Action Plan, which is scheduled for approval on November 18, 2020. Related to this plan, CEEPC is also in the process of updating the non-sector-specific climate goals, introducing a proposed interim climate mitigation goal of 50 percent GHG emission reductions below 2005 levels by 2030. In addition to the 2030 GHG reduction goal, the COG Board Resolution (R45-2020), adopted on October 14, 2020, also places focus on resiliency and equity.

On-road GHG inventory calculations are mainly developed by TPB staff, with some post-processing conducted by COG-DEP staff. Regional inventories for all sectors are documented in the final report The 2030 Climate and Energy Action Plan included development of 2018 GHG emissions inventories for the first time, as well as re-estimation of 2005, 2012 and 2015 historic estimates to ensure that a consistent set of modeling tools and assumptions was used for all analysis years.