AN ASSESSMENT OF REGIONAL INITIATIVES FOR THE NATIONAL CAPITAL REGION - DRAFT

Technical Report on Phase II of the TPB Long-Range Plan Task Force

December 2017

National Capital Region
Transportation Planning Board

Draft

AN ASSESSMENT OF REGIONAL INITIATIVES FOR THE NATIONAL CAPITAL REGION: TECHNICAL REPORT ON PHASE II OF THE TPB LONG-RANGE PLAN TASK FORCE

Prepared by the Long-Range Plan Task Force
December 2017

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, 23 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).

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INTRODUCTION

This report summarizes analysis conducted under Phase II of the National Capital Region Transportation Planning Board's (TPB) Long-Range Plan Task Force during 2017 to compare the impacts of potential initiatives against the currently adopted Constrained Long-Range Transportation Plan (CLRP) for the year 2040. The purpose of this analysis was to conduct sketch-level planning analysis of ten potential initiatives to improve the long range performance of the regional transportation system. This report describes the background leading up to this study; discusses regional challenges and performance measures for assessing those challenges; and summarizes the technical methods used to evaluate the initiatives and the results of this analysis.

The ten initiatives identified for study by the task force fall into three major categories, as shown below:

Multimodal Initiatives	Transit-Focused Initiatives	Policy-Focused Initiatives
1. Regional Express Travel Network 2. Operational Improvements and Hotspot Relief 3. Additional Northern Bridge Crossing / Corridor	4. Regionwide Bus Rapid Transit and Transitways 5. Regional Commuter Rail Enhancements 6. Metrorail Regional Core Capacity Improvements 7. Transit Rail Extensions	8. Optimize Regional Land-Use Balance 9. Transit Fare Policy Changes 10. Amplified Employer-based Travel Demand Management

The primary focus of this study was to assess the potential of each of the ten initiatives to improve the performance of the regional transportation system relative to 2040 Financially Constrained Long-Range Transportation Plan (CLRP), as measured by a set of quantitative measures of effectiveness (MOEs) and in consideration of the regional challenges as defined by the task force.

This report describes the details and results of the sketch-level planning analysis for the assessment of the ten initiatives identified by the task force. First, each initiative is discussed individually, highlighting its major features and the assumptions underlying it, its performance in addressing the regional challenges and its performance relative to the CLRP based on a set of quantitative MOEs. Second, for each regional challenge identified by the task force a summary of how the initiatives compare to each other is presented. Finally, the report provides information on some other factors to consider (e.g., implementation costs, right-of-way impacts) in making comparisons among the initiatives, based on discussions by the task force.

BACKGROUND

Introduction to Long-Range Plan Task Force

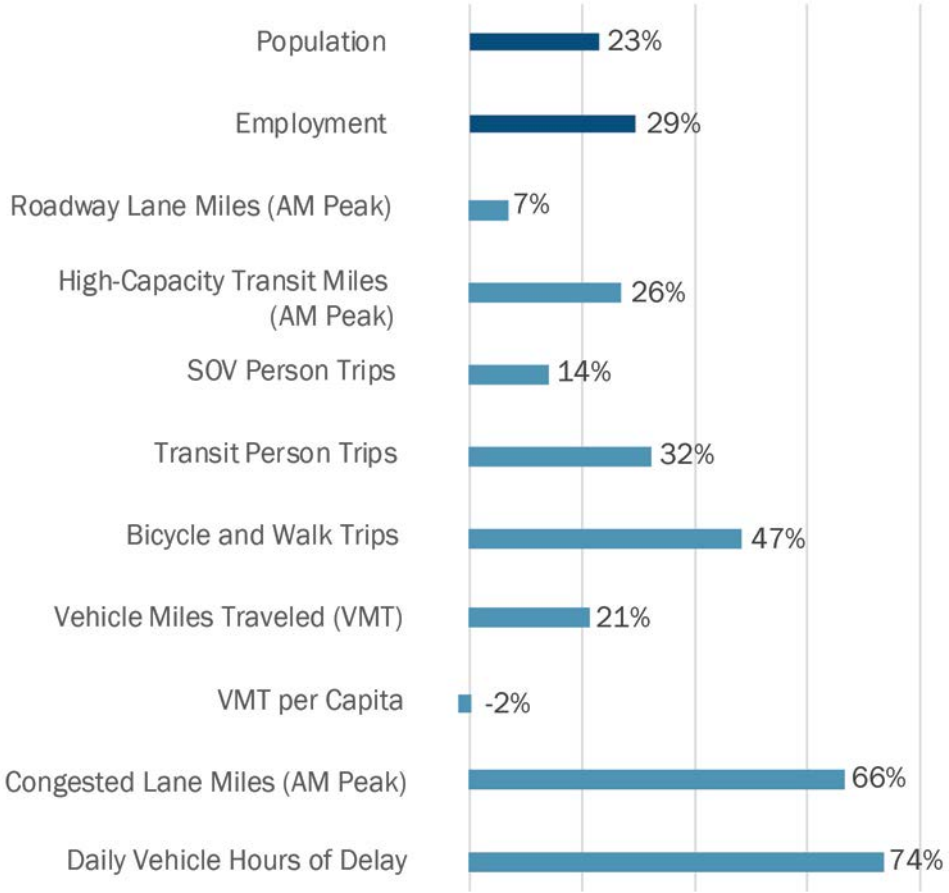
TPB DISSATISFACTION WITH FORECASTED PERFORMANCE OF CLRP

The TPB has observed that long-term forecasts indicate that the CLRP (the federally-required, fiscally constrained long-range transportation plan, or Constrained Long-Range Plan), while making progress towards achieving many regional policy goals and objectives, would provide less-than satisfactory long-term performance outcomes. It also does not meet the region's aspirations particularly with respect to congestion and a desired reduction in single-occupant vehicular travel. In review of the 2016 amendment to the 2040 CLRP's forecasted performance (see Table 1 for key forecasted measures of performance), TPB members voiced concerns about forecast growth in congestion (substantial increases in forecasted vehicle hours of delay and transit crowding), insufficient growth in transit mode share and continued disparity in accessibility between the eastern and western portions of the region..

The 2016 amendment of the 2040 CLRP assumes that approximately $250 billion in funding will be available to support the CLRP but most of that funding (83%) will be dedicated to system maintenance, leaving only about 17% ($42) billion for system expansions. The TPB has recognized that this level of capital funding over the planning horizon is insufficient for adequately addressing existing congestion/mobility needs while meeting the anticipated growth in travel demand. The TPB remains committed to advocating for additional investments in the region's transportation system. The board also remains committed to advancing other policy initiatives that would both better manage travel demand and affect people's travel decisions.

To address the less-than satisfactory performance of its current CLRP, the TPB convened the Long-Range Plan Task Force (LRPTF) to explore ways to improve the region's future transportation system performance by enhancing the current mix of projects, programs and policies that make up and underlie the region's long-range transportation plan.

Table 1: Summary of 2040 CLRP Performance Relative to 2016 Conditions



Source: Analyses performed by COG.

UNFUNDED CAPITAL NEEDS WORKING GROUP AND PHASE I ACTIVITIES (ALL-BUILD REPORT)

As a first step of this initiative, in September 2014, the TPB asked staff to compile an inventory of unfunded capital needs that encompassed transportation projects that have been included in the plans of TPB member jurisdictions but have not been submitted for the CLRP because of lack of anticipated funding. This effort was intended to take stock of the magnitude of long-term capital funding needs within the transportation sector in this region.

The Unfunded Capital Needs Working Group was established to 1) oversee the completion of the draft unfunded project inventory and 2) develop a scope of work for regional planning activities that would use the unfunded inventory as the basis for analysis and outreach. The list of unfunded transportation network improvement projects in the final project inventory comprised more than a thousand projects, including a large number of small-scale bicycle and pedestrian facility improvement projects, as well as over 550 highway and transit projects.

The working group developed a work plan, specifying three phases of work activities to be completed over three fiscal years between FY 2016 and FY 2018. Phase I of the work plan was to consist of a baseline report summarizing the transportation modeling analysis of three future (2040) scenarios,

which is described in the following section. Phase II of the work plan was to involve prioritizing unfunded regional priority projects, and Phase III was to begin the incorporation of those prioritized projects into the region's long-range transportation plan.

Phase I Report

The Phase I Report, called "From No-Build to All-Build: Analyzing a Continuum of Transportation Scenarios Including Unfunded Capital Needs," was a transportation modeling analysis that examined the transportation performance of three future (2040) scenarios. All three scenarios assumed the same land-use forecasts of population and job growth for 2040 (Round 8.4 Cooperative Forecasts), but had three very different transportation system configurations. These three transportation system configurations were:

- No-Build – Included only those projects that were on the ground in 2015. It included none of the capital improvements in the current CLRP (as of 2015).
- Planned-Build – Included planned projects to be built and implemented between 2015 and 2040 that are included in the current CLRP (as of 2015).
- All-Build – Included all of the unfunded capital improvements (above and beyond what was already included in the CLRP) inventoried by the TPB, in addition to projects included in the Planned-Build Scenario.

These three scenarios were intended to provide a "book-end" analysis of the plan, in terms of how the CLRP would perform relative to doing nothing and relative to building all 500+ unfunded projects. One of the key findings of the Phase I analysis was that the "All-Build" alternative yielded a substantial reduction in the level of future projected congestion (vehicle hours of delay) relative to the "Planned-Build" (2040 CLRP), but even if the region spent an additional $100 billion on new capital projects through 2040, over and above the $42 billion currently assumed in the CLRP, "the region would still face increased congestion, indicating that it will be impossible to build our way out of congestion with new infrastructure alone."[1]

The Phase I report was accepted by the TPB on December 21, 2016 and is intended to provide a context for future priority setting.[2]

Phase II of Long-Range Plan Task Force

PURPOSE/OBJECTIVE

The TPB passed Resolution R16-2017 Establishing the Mission and Tasks for Phase II of the Long-Range Plan Task Force to explore alternative ways to improve the region's transportation system and achieve TPB and COG policy goals by exploring projects, programs, and policies that go beyond what is currently included in the CLRP.[3] The task force was charged with developing a limited set (between six and ten) of projects, programs and policies. Once selected, these initiatives would be analyzed to evaluate how they might help address challenges the region faces in meeting its goals. The sections that follow describe the task force's activities leading up to and including the selection of the ten initiatives for analysis.

[1] Resolution R16-2017 Establishing the Mission and Tasks for Phase II of the Long Range Plan Task Force.

[2] Phase I Report of the Long-Range Plan Task Force **https://www.mwcog.org/committees/lrptf/**

[3] Resolution R16-2017 Establishing the Mission and Tasks for Phase II of the Long Range Plan Task Force

GOALS, CHALLENGES, AND PERFORMANCE MEASURES

As a first step, the task force reviewed its mission and agreed on a list of regional goals and challenges to guide its deliberations over the coming months. The task force's mission and tasks, as approved by the TPB, called for developing measurable goals and performance measures to aid in identifying impactful projects, programs, and policies. The mission and tasks also called for drawing directly from existing governing TPB and COG policy documents.

TPB staff presented a summary of established regional goals articulated in the TPB Vision, COG's Region Forward, and the TPB's Regional Transportation Priorities Plan. Task force members agreed to use the summary list as a starting point for their work because the goals are comprehensive, consensus-based, and recognized within COG and the TPB and across the region's jurisdictions. The task force agreed on a few changes to the goals, which are **bolded** in the list below: congestion relief was incorporated into an existing goal focused on providing a comprehensive range of transportation options, economic vitality was added as a component of that same goal, and another goal's focus was sharpened to focus on keeping the region's transit and highway systems in a state of good repair.

Long-Range Plan Task Force's Regional Goals:

- Provide a comprehensive range of transportation options **to promote a strong regional economy and address regional congestion, accessibility and mobility**
- Provide reasonable access at reasonable cost to everyone
- Develop and maintain an interconnected system, including a healthy regional core and dynamic activity centers with a mix of jobs, housing and services in a walkable environment
- **Prioritize state of good repair:** Give priority to **asset** management, performance, maintenance and safety of all modes and facilities
- Use the best available technology to maximize system effectiveness
- Plan and develop a system that enhances and protects natural environmental quality, cultural and historic resources and communities
- Achieve better inter-jurisdictional coordination of transportation and land-use planning
- Achieve enhanced funding for regional and local priorities that cannot be met with current/forecast funding sources
- Support inter-regional and international travel and commerce

The task force also recognized key challenges that stand in the way of achieving regional goals, and reviewed the 14 challenges identified in the Regional Transportation Priorities Plan. The final list of agreed-upon challenges is displayed next, This list was used as a guide to aid in the selection of performance measures. In the list below, **bold** changes are those made by the task force.

Long-Range Plan Task Force's Regional Challenges:

1. *Roadway Congestion*
   The region's roadways are among the most congested in the nation, making it harder for people and goods to **reliably** get where they need to go.
2. *Transit Crowding*
   The transit system currently experiences crowding during peak hours and lacks the capacity to support future population and job growth **without reducing ridership**.

3. *Inadequate Bus Service*
   Existing bus service is too limited in its **capacity**, coverage, frequency, and reliability, making transit a less viable option, especially for people with disabilities and limited incomes.
4. *Access to Bike/Ped Options (Unsafe Walking and Biking)*
   Too few people have access to safe pedestrian and bicycle infrastructure or live in areas where walking and bicycling are not practical options for reaching nearby destinations.
5. *Development Around Metrorail*
   Too many Metrorail stations, especially on the eastern side of the region, are surrounded by undeveloped or underdeveloped land, limiting the number of people who can live or work close to transit and leaving unused capacity in reverse-commute directions on several lines.
6. *Housing and Job Location*
   Most housing, especially affordable housing, and many of the region's jobs are located in areas outside of Activity Centers where transit, bicycling, and walking are not safe and viable options.
7. *Metrorail Repair Needs*
   Deferred Metrorail maintenance over the years has led to unreliability, delays, and safety concerns today, as well as higher maintenance costs.
8. *Roadway Repair Needs*
   Older bridges and roads are deteriorating and in need of major rehabilitation to ensure safe, reliable, and comfortable travel for cars, trucks, and buses.
9. *Incidents and Safety*
   Major accidents and weather disruptions on roadways and transit systems cause severe delays and inconvenience. **Reducing injuries and fatalities for all users of the transportation system must be prioritized, with particular focus on protecting vulnerable users.**
10. *Pedestrian and Bicyclist Safety*
    The number of bicycle and pedestrian fatalities each year is holding steady even as the number of vehicle fatalities has declined steadily.
11. *Environmental Quality*
    Increasing amounts of vehicle travel resulting from population and job growth could threaten the quality of our region's air and water.
12. *Open Space Development*
    Wildlife habitat, farmland, and other open spaces are threatened by construction of new transportation facilities and residential and commercial development.
13. *Bottlenecks*
    Bottlenecks on the highway and rail systems cause delays in interregional travel for both freight and passengers, hurting the region's economic competitiveness.
14. *Travel Time Reliability*
    Travel times to and from the region's airports are becoming less reliable for people and goods movement.

These challenges formed the basis for selection of performance measures (measures of effectiveness, or MOEs) for the evaluation provided in this document. A few of the challenges could be easily quantified and measured, but many of them could not – so staff recommended a framework in which the challenges would be used as a guide for selecting performance measures. This way, when reviewing the results of the analysis, task force members would be able to assess

whether the initiatives make "significantly better progress towards achieving the goals laid out in TPB and COG's governing documents" compared to the CLRP.

The MOEs were based on best practices in regional performance measures. In selecting and applying the MOEs, the research team sought a set of MOEs having the following characteristics:

1. The MOEs measure progress toward addressing the regional challenges and the desired long-term performance of the regional transportation system.
2. The MOEs apply to each initiative as measured at the regional level, and no MOEs are reported at a jurisdictional or sub-regional level. Due to the high-level nature of the analysis, the analysis is not precise enough to provide sub-regional evaluations.
3. The MOEs reflect best practices in measuring what matters to the public and for the transportation system's performance.
4. The number of MOEs were limited to facilitate comparisons and clearly communicate the most important issues to the region.
5. The MOEs are provided as a percentage change from the CLRP rather than reporting raw numbers, which can be difficult to interpret and compare.
6. Finally, the MOEs needed to be assessable within the context of the rapid sketch planning-level analysis and short timeframe of the project. Quantifiable measures that would take significant time to develop or calculate could not be calculated in the context of this study timeframe.

The study team, with input from the Long-Range Plan Task Force, selected MOEs to address the regional goals and challenges identified by the task force. While limited based on the sketch planning nature of this analysis, they represent the study team's best effort within the study constraints to provide quantitative assessments of the performance of each initiative across the challenges. More information on the quantitative MOEs can be found in Appendix B. The quantitative MOEs in some cases include multiple sub-measures, as shown below:

- Average Travel Time per Trip
    - Single-Occupant Vehicle (SOV)
    - High Occupancy Vehicle (HOV)
    - Transit
- Vehicle Hours of Delay
- Number of Jobs Accessible within 45 Commute
    - By Transit
    - By Auto
- Mode Share for Commuting
    - Single-Occupant Vehicle (SOV)
    - High Occupancy Vehicle (HOV)
    - Transit
    - Non-Motorized (Walking and Biking)
- Travel on Reliable Modes
- Vehicle Miles of Travel (VMT)
    - Daily VMT
    - Daily VMT per Capita
- Transit Options
    - Share of Households in High-Capacity Transit Zones
    - Share of Jobs in High-Capacity Transit Zones

- Motor Vehicle Emissions
  - Volatile Organic Compounds (VOCs)
  - Oxides of Nitrogen (NOx)
  - Carbon Dioxide (CO_2)

Table 2 below shows the relationship of each quantitative MOE to the 14 identified regional challenges. A checkmark represents a relationship between each MOE and challenge. Some relationships are more direct, while others are indirect or secondary relationships. No quantitative MOEs were developed that relate to four challenges: Transit Crowding, Metrorail Repair Needs, Roadway Repair Needs, and Open Space Development. For these, the research team instead applied various assessments to evaluate initiatives' performance. See the discussion of those challenges in the results section.

Table 2: Relationship Matrix for Quantitative MOEs and Regional Challenges

Quantitative Measures of Effectiveness (MOEs)	Regional Challenges													
	Roadway Congestion	Transit Crowding	Inadequate Bus Service	Access to Bike/Ped Options	Development at Metrorail	Housing and Job Location	Metrorail Repair Needs	Roadway Repair Needs	Incidents and Safety	Ped and Bike Safety	Environmental Quality	Open Space Development	Bottlenecks	Travel Reliability to Airports
Travel Time: average travel time per commute trip for each mode	✓		✓			✓							✓	✓
Vehicle Hours of Delay	✓										✓		✓	
Jobs Accessible by Transit: # of jobs accessible within 45 min transit commute	✓		✓		✓	✓							✓	
Jobs Accessible by Auto # of jobs accessible within 45 min car commute	✓					✓							✓	
Mode Share	✓		✓	✓					✓	✓	✓			
Travel on Reliable Modes: share of mileage on reliable modes (e.g., express lanes, BRT)	✓		✓										✓	✓
VMT and VMT per capita	✓					✓			✓		✓			
Share of households in high-capacity transit zones			✓		✓	✓								
Share of jobs in high-capacity transit zones			✓		✓	✓								
Emissions: Report separately on VOC, NOx, and CO_2											✓			

Some quantitative MOEs relate to multiple challenges, such as "vehicle hours of delay," which relates to the challenges of roadway congestion, environmental quality, and bottlenecks. This is because vehicle hours of delay is an indicator of roadway congestion and roadway bottlenecks, as well as increased levels of emissions per mile. Some challenges have several quantitative MOEs that are related. For example, the challenge of inadequate bus service is related to six MOEs, none of which is a perfect measure of inadequate bus services but each of which provides a potential indicator.

There are a few challenges with no quantitative MOEs that the study team could produce within the study timeframe. As a result, the study team developed a qualitative assessment for each challenge (not displayed in Table 2). For challenges with multiple quantitative MOEs, the study team considered how the various MOEs relate to the challenge and used a combination of the quantitative and qualitative information to assess the contribution of each initiative to each challenge. (See the section on the challenges to learn more about how the team developed those assessments.)

IDENTIFICATION OF INITIATIVES

The resolution charged the task force with "identifying for TPB's acceptance in July 2017 for further analysis approximately 6-10 projects, policies, or programs to determine if they make significantly better progress towards achieving the goals laid out in TPB and COG's governing documents."[4] Based on lessons learned in prior studies,[5] the task force and staff recognized that individual projects in the "All-Build" analysis would not yield the "significantly better progress" desired by the task force. Instead, broad initiatives that encompass substantial and ambitious packages of projects, programs, and/or policies would need to be explored. This report will refer to these packages as "initiatives."

Selection of Ten Initiatives for Analysis

The task force worked to identify a set of initiatives worthy for analysis, which started with identifying possible projects, programs, and policies for consideration. The task force members suggested more than 80 ideas for potential consideration, which ranged significantly in scope, cost, and technical and political feasibility.

To narrow this large list down to a set of six to ten for further analysis, the task force explored bundling individual projects, programs, and policies into packages, and ultimately came up with an approach that focused on defining a set of "initiatives" that include multiple components (projects, programs, or policies) within a common theme. These initiatives represented what might be considered mega-projects and/or sets of complementary mega-programs and policies of a regional scale.

To help the task force sift through the vast set of ideas, staff organized the projects, programs, and policies into topic areas, and provided suggested groupings of elements that, when enacted together, would have synergistic benefits. Task force members also submitted ideas for groupings of projects, programs and policies. Over the course of a few meetings the task force winnowed down the large list of ideas into a smaller set of initiative packages. Different methods were used,

[4] Resolution R16-2017 Establishing the Mission and Tasks for Phase II of the Long Range Plan Task Force

[5] "Item 2 - Past Scenario Analysis" and "Item 2 - Presentation - Past Scenario Analysis" https://www.mwcog.org/events/2017/4/19/long-range-plan-task-force/

including discussion, straw polling and voting. The task force settled on its final list of ten initiatives and the TPB approved the list for further analysis on July 19, 2017. See the chapter titled "Initiatives and Their Performance" for the ten initiatives and their descriptions as submitted to the TPB.[6]

Principles for Selecting Initiatives for Analysis

In recommending initiatives to advance for analysis, the task force recognized that members represent a wide variety of interests with different perspectives, and in deliberations put an emphasis on recommending a set of initiatives that are regionally significant, even if some of the initiatives are controversial. Task force members each had opportunities to identify and discuss their preferred initiatives, and the task force agreed on the following general principles in selecting initiatives to recommend to TPB for analysis:

- Each initiative selected goes beyond the existing CLRP.
- Each initiative selected is regional in nature and has the potential to make noticeable improvements in regional performance toward achieving the goals described in TPB and COG's governing documents.
- Considerations of the viability (e.g., political or financial) of initiatives were limited at the point of the process of proposing initiatives for further analysis. It was recognized that some initiatives generated significant controversy among task force members, but the task force concluded that it was important to analyze these projects.
- Where an initiative requires multiple components to achieve substantial improvements and those components all relate sufficiently to each other, they were considered one cohesive initiative (e.g., a mega-project/program/policy).
- Each initiative was assumed to include supporting elements. For example, transit initiatives will be accompanied by improvements in bicycle and pedestrian access, park-and-ride capacity if applicable, and supported by land-use policies that focus development around transit stations.

Recognition of the Importance of State of Good Repair

The task force recognized that state of good repair is a critical precursor to undertaking any of the initiatives that could enhance the performance of the CLRP. Consequently, funding for maintaining and preserving existing transit and highway systems must be a priority for the region.

In discussing potential initiatives for analysis, the task force agreed that state of good repair of the region's transit and highway assets is a critical foundation for any further initiatives. The task force debated including an initiative focused solely on bringing these existing assets into a state of good repair (SOGR). The task force recognized, however, that the existing CLRP assumes a state of good repair of all infrastructure, and the sketch-planning analysis and tools available for the analysis would not be able to assess the benefits of SOGR in the context of this study. Consequently, the task force agreed that transit and road infrastructure SOGR is a top priority for the region that must be addressed and that the initiatives to be explored for this study would be contingent upon the region first prioritizing the preservation and maintenance of the existing transportation system. Transit and road SOGR was therefore an underlying assumption of every initiative.

After considerable discussion and debate to narrow down a long list of potential ideas for projects, programs, and policies to consider, the Long-Range Plan Task Force selected 10 initiatives for

[6] "Item 8 - Action - Accept Long-Range Plan Task Force Initiatives for further analysis" https://www.mwcog.org/events/2017/7/19/transportation-planning-board/

analysis, generally falling into three categories (multimodal initiatives, transit-focused initiatives, and policy-focused initiatives). These ten initiatives as defined by the task force and approved by the TPB are summarized in below.

Table 3: Initiative Components

Multimodal Initiatives	
1. Regional Express Travel Network	• Express toll lanes network (free to HOV and transit vehicles) with added lanes where feasible on existing limited access highways (including remaining portion of the Capital Beltway, I-270, Dulles Toll Road, U.S. 50); includes expanded American Legion Bridge. • New express bus services on network (paid in part through tolls) connecting major Activity Centers.
2. Operational Improvements and Hotspot Relief	• Application of technology and enhanced system operations strategies, such as ramp metering, active traffic management, and integrated corridor management (including transit signal priority and enhanced multimodal travel information), plus targeted capacity enhancements where feasible to address top regional congestion hotspots and adjoining connections. • Improved roadway design (such as treatments of turning movements) and reversible lanes on major roadways, as appropriate (to be identified based on strong directional flows). • Expanded regional incident management where appropriate. • Technological integration of demand-responsive services for persons with disabilities and others with limited mobility to create efficiencies of scale and improve mobility of traditionally underserved populations.
3. Additional Northern Bridge Crossing/Corridor	• New northern bridge crossing of Potomac River, as a multimodal corridor. • New express bus services connecting existing Activity Centers in this new multimodal corridor.
Transit-Focused Initiatives	
4. Regionwide Bus Rapid Transit and Transitways	• Bus rapid transit (BRT)/transitway networks in Montgomery County, Prince George's County, Northern Virginia (TransAction 2040), DC, and transitway from Branch Ave to Waldorf; specifications according to jurisdiction plans. • Additional DC streetcar line (north-south) as complement to network. • Improved bicycle and pedestrian connections and access improvements to transit stations.
5. Regional Commuter Rail Enhancements	• VRE System Plan 2040, MARC Growth, and Investment Plan (including run-thru and two-way service on selected lines, increased frequency and hours of service).[7] • Long Bridge corridor improvements including at least 4 tracks and bicycle-pedestrian facilities. • Improved bicycle and pedestrian connections and access improvements to rail stations.

[7] Both the Virginia Railway Express (VRE) and Maryland Area Regional Commuter Train Service (MARC) have planned system and service improvements that are scheduled to be implemented by the year 2040. More details on these plans and how they overlap with this initiative can be found in Appendix C.

6. Metrorail Regional Core Capacity Improvements	• 100% 8-car trains. • Metrorail station improvements at high-volume stations in system core. • Second Rosslyn station to reduce interlining and increase frequency. • New Metrorail core line to add capacity across Potomac River (new Rosslyn tunnel) between Virginia and DC through Georgetown to Union Station toward Waterfront. • Improved bicycle and pedestrian connections and access improvements to rail stations.
7. Transit Rail Extensions	• Metrorail extensions to Centreville/Gainesville, Hybla Valley/Potomac Mills. • Can consider an extension(s) in MD, such as to National Harbor or north of Shady Grove (to be defined later). • Purple line extension to Tysons (west) and Eisenhower Avenue (east). • Improved bicycle and pedestrian connections and access improvements to rail stations.
Policy-Focused Initiatives	
8. Optimize Regional Land-Use Balance	• Optimize jobs/housing balance regionwide. • Increase jobs and housing around underutilized rail stations and Activity Centers with high-capacity transit. • Build more housing in the region to match employment (about 130,000 more households).
9. Transit Fare Policy Changes	• Reduced price Metrorail fare for off-peak direction during peak period and on underutilized segments. • Free transit for low-income residents.
10. Amplified Employer-based Travel Demand Management	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

In addition to those components, the task force conveyed to the team that the analysis should also make the following assumptions:

- **State of Good Repair.** All of the initiatives assume that Metrorail, other transit services, and all highway and bridge infrastructure are in a state of good repair. The task force recognized that a state of good repair for transportation infrastructure is critical to the performance of the transportation system and an underlying foundation that must be supported prior to implementing any new infrastructure-based initiatives.
- **Supportive Land-Use Policies.** The initiatives assume that land-use policies will support the significant new infrastructure investments. Specific land-use changes assumed for each initiative are discussed below.

- **Improvements in Bicycle and Pedestrian Infrastructure.** The initiatives assume that transit investments will be supported by improvements in bike/walk accessibility to access those transit services. Specifics can be found below.
- **Bold Assumptions to Achieve Regional Improvements on the Challenges.** These initiatives are intended to go above and beyond the CLRP to show whether it is worthwhile for the region to increase investment to implement projects, programs, and policies such as those contained in these initiatives. To demonstrate the full potential of each initiative, the research team selected bold assumptions to assess whether these initiatives could result in regional improvements.

TECHNICAL EVALUATION METHODOLOGY

The analysis of the ten initiatives was conducted using a sketch planning approach (simplified analysis techniques) reflecting the short time frame for the analysis and the conceptual nature of several of the initiatives (without details required for more in-depth, comprehensive analysis).

Given the wide array of different types of strategies that were analyzed for the initiatives, including transportation capacity projects, land-use strategies, demand management, and operational strategies, as well as policies related to pricing, no single tool could be used to capture all of them. The technical analyses therefore used a combination of methods, including:

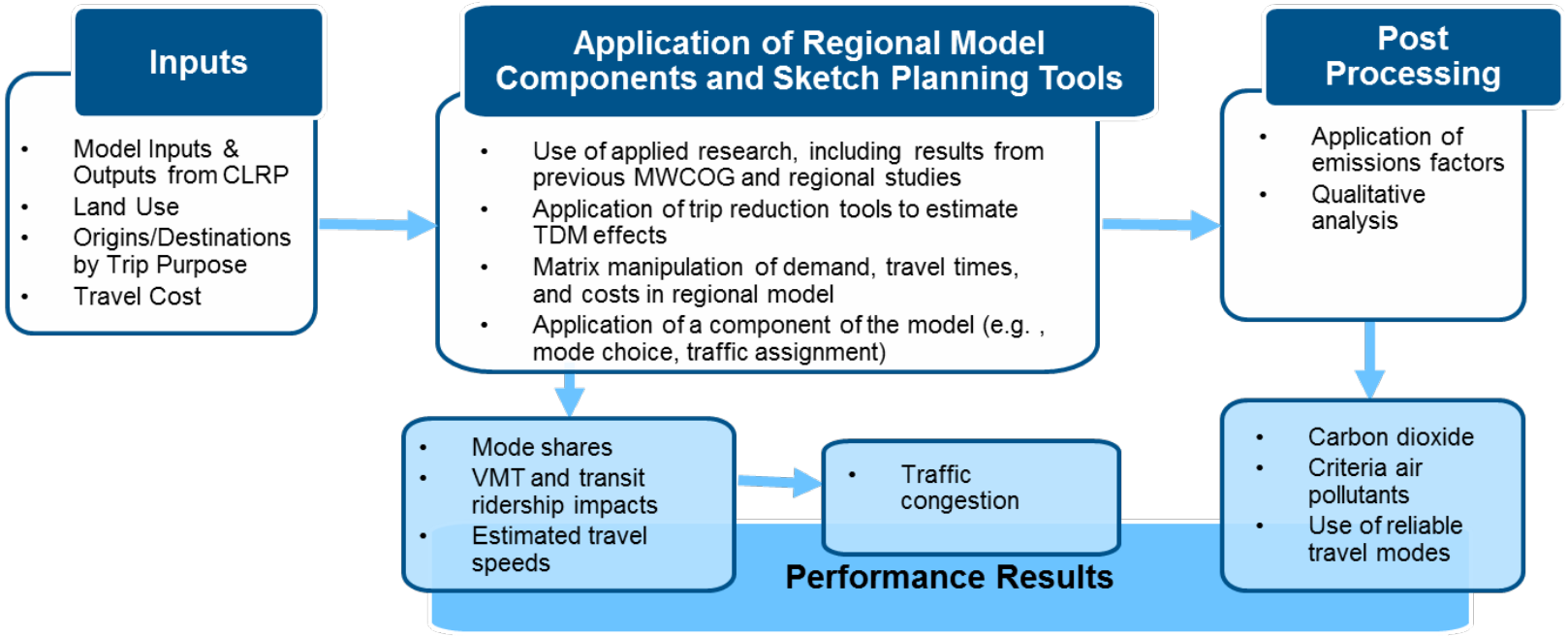
1) **Input assumptions regarding land-use, transportation system, and pricing changes** – The team utilized assumptions for population, land-use, and pricing that were consistent with the 2040 CLRP, but adjusted these inputs based on the specifics of the initiatives being analyzed. For instance, several of the initiatives included changes in transportation infrastructure and services, while some also involved changes in development patterns or policies such as transit fare pricing or parking pricing.

2) **Application of components of COG's regional travel model and sketch planning tools** - The sketch planning approach included geographic information systems (GIS) analysis, spreadsheet analysis, and the use of sketch planning tools, such as the TDM+ tool to determine mode shifts for travel demand management (TDM) strategies. In addition, analysis using components of MWCOG's regional model were conducted to capture the regional effects of strategies that make significant changes to land-use and transportation infrastructure, particularly to support analysis of assignment of trips to the network to estimate impacts on traffic congestion.

3) **Post-processing of travel-related metrics to estimate other performance outcomes (e.g., emissions) –** Finally, the results of sketch tools and modeling were post-processed to calculate some additional metrics, such as motor vehicle emissions and the share of travel on reliable travel modes,

This overall approach is shown in Figure 1 on the following page.

Figure 1 General Analysis Approach



Source: ICF

INITIATIVES AND THEIR PERFORMANCE

This section describes the assumptions made for each initiative and the results of the sketch planning analysis. Tables 5 and 6 summarize how the performance of the initiatives in 2040 compares in relation to the 2040 CLRP on the regional challenges and the quantitative MOEs (as a percentage change from the CLRP's performance), respectively.

Following these summary tables, this section includes a description of each initiative, beginning with the text of what the task force and TPB voted to include as components in that initiative, followed by a snapshot of the assumptions related to transportation, land-use, and other policies. (See Appendix C for a more detailed description of the assumptions for each initiative). Each section presents that initiative's performance on the regional challenges and the quantitative MOEs.

See this report's later section on the Challenges results for a challenge-by-challenge discussion of how the initiatives perform relative to each other.

The purple tables in this report show how each initiative performs on the regional challenges, as compared to the baseline performance of the CLRP in the year 2040. The table scores reflect assessments of the relative contributions of each initiative to addressing the challenges. If an initiative scores as "high" on a given challenge, that score does not mean that the initiative is the best the region can do on the challenge. Rather, a "high" score means that the initiative performs against the CLRP considerably better (often an order of magnitude better) than those scoring "medium," which scored better than those scoring "low." Those scoring "neutral" may have some benefit, but the benefit is too small to reveal itself at the regional scale. The study team also sometimes used "neutral" where the effects of the initiative were indeterminate, as when multiple factors pushed in different directions on the challenge. "Negative" scores indicate where the study team determined that the initiative would perform worse than the CLRP on the given challenge. These assessments are reflective of a combination of quantitative analyses and expert judgment based on the challenges as defined by the task force. It is important to recognize that changes to the assumptions made for the initiatives or more detailed levels of analysis could result changes to these assessments.

The blue tables in this report (Table 5 and other initiative-specific tables) show how each initiative performs on the selected MOEs, as compared to the baseline performance of the CLRP in the year 2040. Results for initiatives that performed particularly well on an MOE compared to the CLRP are highlighted with a bright green background color, and results which performed well but not as strongly are highlighted with a pale green background color. Results for initiatives which performed negatively compared to the CLRP are highlighted with an orange background color.

Table 4: Summary of Performance Across Challenges Relative to 2040 CLRP

CHALLENGES	BASE: 2040 CLRP	I1: Express Travel Network	I2: Operational Improvements & Hotspot Relief	I3: Add'l Northern Bridge	I4: BRT and Transitways	I5: Commuter Rail	I6: Metrorail Core Capacity	I7: Transit Rail Extensions	I8: Optimize Regional Land-Use Balance	I9: Transit Fare Policy Changes	I10: Travel Demand Management
Road Congestion	BASELINE										
Transit Crowding											
Inadequate Bus Service											
Access to Bike/Ped											
Development around Metrorail											
Housing & Job Location											
Metrorail Repair Needs											
Roadway Repair Needs											
Incidents and Safety											
Pedestrian & Bicyclist Safety											
Environmental Quality											
Open Space Development											
Bottlenecks											
Reliable Access to Intercity Hubs											

KEY: High; Medium; Low; Neutral; Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

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Table 5: Summary of Performance Across Quantitative MOEs Relative to 2040 CLRP

QUANTITATIVE MEASURES OF EFFECTIVENESS	BASE	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
	2040 CLRP	Express Travel Network	Operational Improvements & Hot Spot Relief	Add'l North Bridge	BRT and Transitways	Commuter Rail	Metrorail Core Capacity	Transit Rail Extensions	Regional Land-Use Balance	Transit Fare Policy Changes	Travel Demand Management
Travel Time (SOV)	50.7	-2%	-4%	0%	-1%	-1%	-2%	-1%	-5%	0%	-4%
Travel Time (HOV)	58.9	-5%	-4%	-1%	-1%	-1%	-1%	-1%	-6%	<1%	-6%
Travel Time (Transit)	53.9	-1%	-2%	- <1%	-1%	<1%	-6%	- <1%	-5%	1%	<1%
Daily Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
Jobs Accessible by Transit	523,000	2%	2%	- <1%	4%	1%	19%	10%	10%	0%	0%
Jobs Accessible by Auto	876,000	5%	8%	1%	1%	<1%	2%	1%	10%	<1%	10%
Mode Share: SOV	58.1%	<1%	3%	<1%	-1%	-1%	-4%	-1%	-2%	<1%	-8%*
Mode Share: HOV	11.6%	-1%	-7%	0%	-1%	-1%	-5%	-3%	-4%	-2%	24%*
Mode Share: Transit	24.6%	1%	-4%	- <1%	4%	2%	11%	5%	<1%	2%	6%*
Mode Share: Non-Motorized	5.6%	0%	0%	0%	<1%	<1%	<1%	<1%	29%	0%	16%*
Travel on Reliable Modes**	11.5%	42%	-5%	-2%	6%	2%	9%	6%	0%	3%	-3%
VMT daily	141.91 million	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-3%	-1%	-6%
VMT daily per capita	21.17	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-6%	-1%	-6%
Share of Households in Zones with High-Capacity Transit	39.9%	0%	0%	- <1%	25%	<1%	<1%	17%	9%	0%	0%
Share of Jobs in Zones with High-Capacity Transit	57.7%	0%	0%	- <1%	15%	<1%	0%	13%	2%	0%	0%
VOC Emissions	18.9	0%	-3%	1%	-1%	0%	-2%	-1%	-4%	-1%	-8%
NOx Emissions	18.8	0%	0%	1%	0%	0%	-2%	-1%	-4%	-1%	-7%
CO_2 Emissions	47,082	0%	-1%	1%	-1%	0%	-2%	-1%	-4%	-1%	-7%

* Mode shares reflect trips taken. Due to telework, actual number of transit trips declines; bicycle/pedestrian stays flat; HOV increases slightly.

**Travel on reliable modes reflects the percentage of passenger miles on express lanes, Metrorail, bus rapid transit, commuter rail, walking, and biking; it does not reflect improvements in reliability due to reduced traffic congestion or programs that affect non-recurring delay, such as improved incident management.

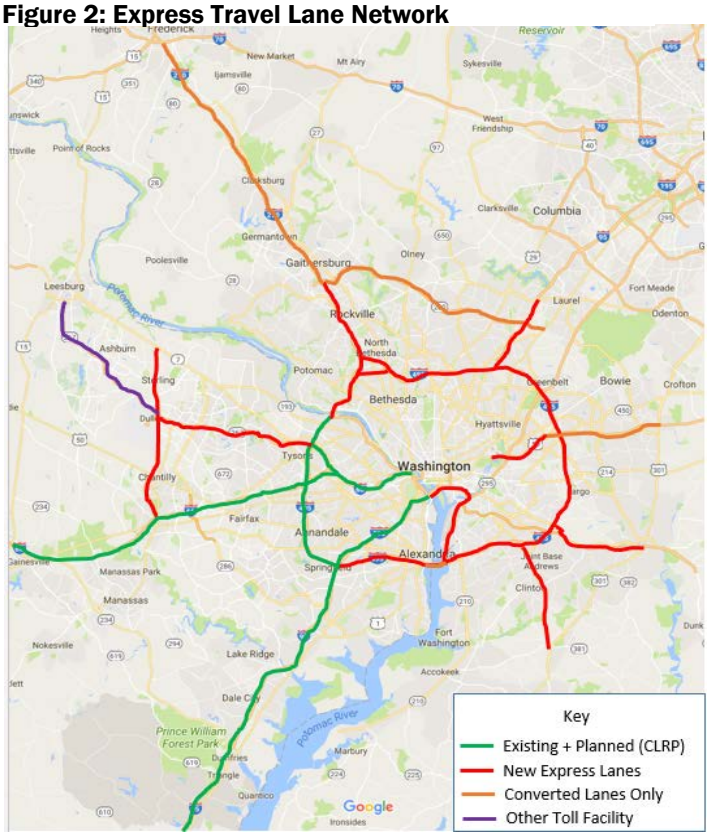
Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 1: Regional Express Travel Network

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- **Express toll lanes network** (free to HOV and transit vehicles) with added lanes where feasible on existing limited access highways (including remaining portion of the Capital Beltway, I-270, Dulles Toll Road, U.S. 50); includes expanded American Legion Bridge.
- **New express bus services** on network (paid in part through tolls) connecting major Activity Centers.

Figure 2: Express Travel Lane Network



Source: Sabra Wang & Associates

ASSUMPTIONS

Roadway Assumptions

- **Express Travel Lane Network** of high-occupancy toll (HOT) lanes on access-controlled facilities, as shown at right,[8] including:
  - Two new express lanes each direction on American Legion Bridge; on I-495 from bridge through I-270 south of MD-200 (conversion of HOV lane); on I-95 in MD; and VA-28 (conversion of HOV lane)
  - One new express lane each direction on other facilities, including remainder of I-495 Beltway, MD-4, MD-5, I-395, I-295, I-695, and VA-267

Transit Assumptions

- **Express bus services** on Express Travel Network, with stops in adjacent Activity Centers, and express buses to the core.
- **Frequent headways** of 10 minutes in the peak and 20 in the off peak.

Bicycle and Pedestrian Assumptions

No changes from 2040 CLRP.

Pricing Assumptions

- The following pricing assumptions apply throughout the express toll lanes network:[9]
  - Dynamic tolls to maintain desired travel speeds.
  - Free use for HOV3+ and transit vehicles
- Express bus fares using existing fare structures.

Land-Use Assumptions

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

[8] See Appendix C for list of segments.

[9] To conduct analysis within the limited time-frame for this study, some simplifying assumptions were applied such as coding some of the express lanes using fixed prices rather than dynamic pricing; however, the results are intended to reflect and should be generally consistent with the impacts of dynamic pricing.

FINDINGS

Table 6: Initiative 1's Performance on Challenges[10]

Challenges	Compared to CLRP
Road Congestion	
Transit Crowding	
Inadequate Bus Service	
Access to Bike/Ped Options	
Development around Metrorail	
Housing & Job Location	
Metrorail Repair Needs	
Roadway Repair Needs	
Incidents and Safety	
Pedestrian & Bicyclist Safety	
Environmental Quality	
Open Space Development	
Bottlenecks	
Reliable Access to Intercity Hubs	

KEY: High, Medium, Low, Neutral, Negative

The Regional Express Travel Network initiative increases highway capacity through new managed lanes with dynamic tolling, resulting in benefits to roadway reliability and congestion. The initiative also increases bus services significantly, particularly connecting areas with limited service, such as Activity Centers along the Beltway (e.g., Bethesda, Tysons, Springfield, National Harbor, Largo), resulting in an increase in transit use and transit mode share. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 1

- **Road Congestion** improves: peak period vehicle hours of delay would be 11% less than in the CLRPInitiative 1 produces the largest congestion benefits of the infrastructure-focused initiatives, but the policy-based initiatives do more (resulting a medium rating).
- **Bottlenecks** and **Reliable Access to Intercity Hubs** improve due to new, reliable road connections (for those who pay a toll) and by providing reductions in vehicle hours of delay that improve speeds on all lanes. This initiative directly addresses several of the region's most significant road bottlenecks, including the American Legion Bridge (#1 existing roadway bottleneck), I-95/I-495 in Maryland, and points along I-495, the I-270 spur, and DC-295.[11] It significantly increases the portion of travel occurring on reliable modes using the express lanes.
- **Inadequate Bus Service** improves from a significant amount of new, high quality, reliable bus service. Some of the new bus ridership, however, comes from riders shifting from commuter rail and Metrorail.
- **Incidents and Safety** may slightly improve as the overall system shifts to more reliable travel options that are less prone to major disruption.

Challenges Not Addressed by Initiative 1

- **Roadway Repair Needs** will increase with the addition of new infrastructure to maintain, leading to a negative rating. Tolls may support these new maintenance needs, and private sector investment might help to accelerate infrastructure state of good repair for connecting bridges and infrastructure (see the further section on Costs of Implementation).
- **Environmental Quality** effects are not determinable at this time. The initiative slightly increases VMT, which tends to increase emissions, but the significant congestion reductions may neutralize any effect from the VMT change.

[10] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

[11] For a list of the region's most significant highway bottlenecks, see the TPB's 2016 Congestion Management Process (CMP) Technical Report, available at: http://www1.mwcog.org/clrp/elements/cmp/.

- **Open Space Development** effects are not determinable at this time. The initiative will require some additional right of way, and this study did not assess the potential for encouraging more dispersed development.

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 1 seems to be compatible with all of the other initiatives, but its express bus service may compete for riders with enhanced commuter rail service and rail extensions that serve some of the same corridors.

Table 7: Summary of Initiative 1's Performance on Quantitative MOEs Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip (minutes)			
Single occupant vehicle (SOV)	50.7	49.8	-2%
High-occupancy vehicle (HOV)	58.9	55.7	-5%
Transit	53.9	53.1	-1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.64 million	-11%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	534,000	2%
Auto: # of jobs accessible within 45-min auto commute	876,000	917,000	5%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	58.2	<1%
High-occupancy vehicle (HOV)	11.6	11.5	-1%
Transit	24.6	24.8	1%
Bicycle/Pedestrian	5.6	5.6	0%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	16.3%	42%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	142.37 million	<1%
Daily VMT per capita	21.2	21.2	<1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	39.9%	0%
Share of jobs in zones with high-capacity transit	57.7%	57.7%	0%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	17.1	0%*
NOx Emissions (seasonal)	17.0	17.0	0%*
CO_2 Emissions	47,082	46,883	0%*

*Small impacts possible but overall effects are unclear based on simplified methods utilized.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 1 performed very well on reductions in vehicle hours of delay and share of passenger miles on reliable modes. It also is anticipated to improve travel times across all modes and increase the number of jobs accessible within a 45-minute commute by car and transit. Overall, limited changes in commute mode shares are anticipated. It would not perform worse than the CLRP on any MOE.

Initiative 2: Operational Improvements and Hotspot Relief

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- Application of technology and enhanced system operations strategies, such as ramp metering, active traffic management, and integrated corridor management (including transit signal priority and enhanced multimodal travel information), plus targeted capacity enhancements where feasible to address top regional congestion hotspots and adjoining connections.
- Improved roadway design (such as treatments of turning movements) and reversible lanes on major roadways, as appropriate (to be identified based on strong directional flows).
- Expanded regional incident management where appropriate.
- Technological integration of demand-responsive services for persons with disabilities and others with limited mobility to create efficiencies of scale and improve mobility of traditionally underserved populations.

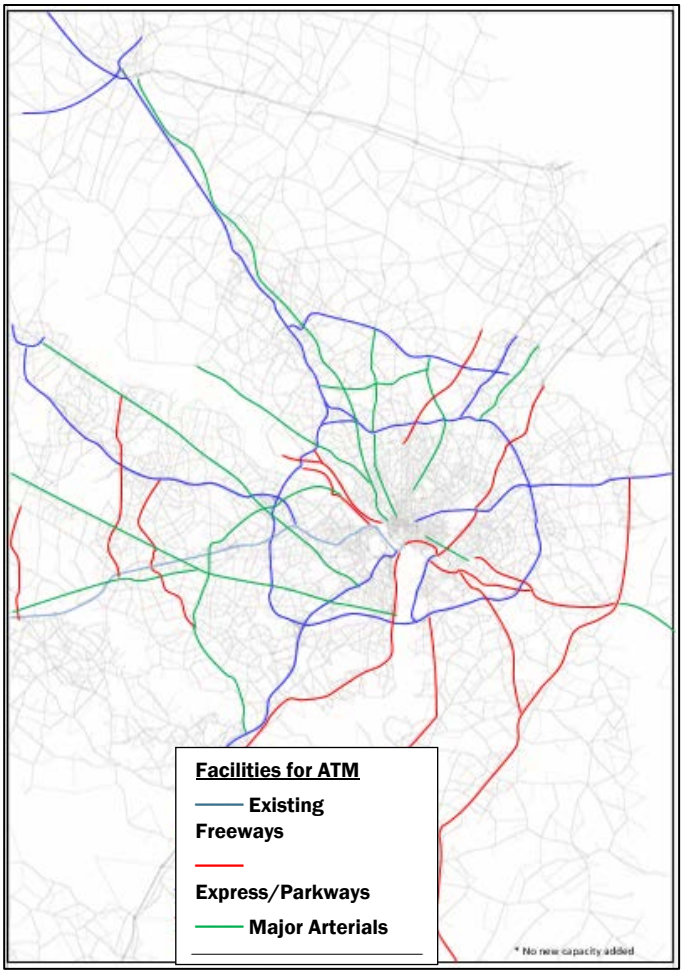
ASSUMPTIONS

Roadway Assumptions

See Appendix C for details, including lists of segments and maps showing locations where the analysis applied these general assumptions:

- Active Traffic Management (ATM)
  - Includes ramp metering, transit signal priority, enhanced traveler information and other design and operations strategies.
  - Identified candidate facilities among existing freeways, express and parkways, and major arterials.
  - Based on the literature review, applied a capacity increase of 5% on freeways and 6% on arterials selected for ATM
- Integrated Corridor Management (ICM)
  - Assumes corridors are integrated and managed for efficient multimodal operations.
  - Identified candidate facilities among existing freeways, expressways and parkways, and major arterials.
  - Based on the literature, a capacity increase of 3% was assumed for corridors with no other treatment and a 1% increase was assumed where other treatments were applied to these corridors and facilities.

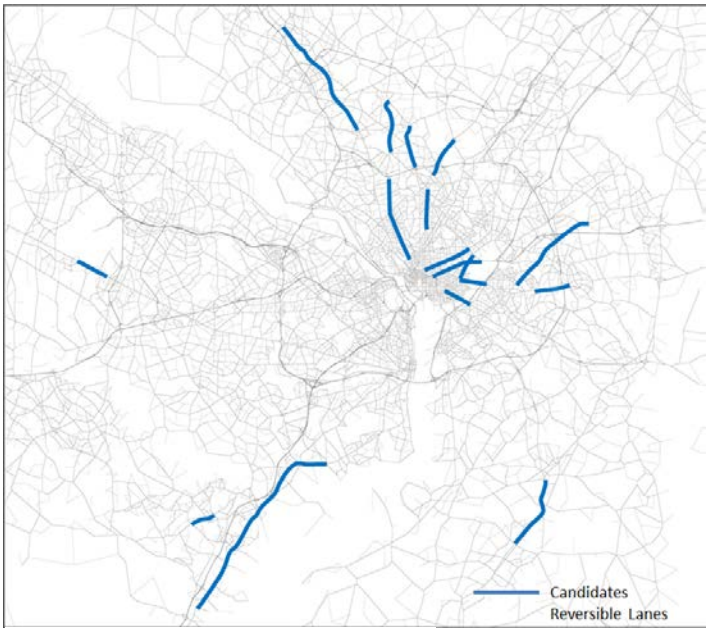
Figure 3: Candidate ATM Locations



Source: Sabra Wang & Associates

- Hotspot Relief
  - Identified a list of 22 key hotspot locations where the 2040 CLRP forecast volumes significantly exceed capacity.
  - The Hotspot relief strategy maximizes available capacity primarily using technological and operations management strategies. Additional roadway capacity is added only at limited hotspot locations. See Appendix C for details.
- Reversible Lanes
  - Identified locations that may be capable of accommodating reversible lanes: non-expressway segments with over three lanes and that have high volumes in the peak direction and significantly lower volume in the off-peak direction (as forecasted under 2040 CLRP).
  - Assumed reversible lanes on the 17 identified segments, shown on the map to the right, by changing number of lanes available in different periods.
- Regional Incident Management
  - Applied additional incident management to all expressways, parkways, and high-volume major arterials (> ~ 30,000 AADT).
  - Based on the literature, applied a capacity increase of 0.5% to these facilities.

Figure 4: Reversible Lanes Facilities



Source: Sabra Wang & Associates

- Demand-Responsive Services for Persons with Limited Mobility
  - New technologies may improve options for mobility in a similar manner as the current transportation network companies (TNC), such as Lyft or Uber, have done so.
  - Based on experience with TNCs, this service will likely increase VMT and congestion in the region while providing significant accessibility benefits to individuals who are underserved by the current transportation system.

Transit Assumptions
No changes from 2040 CLRP, but transit signal priority may improve transit speed and reliability.

Bicycle and Pedestrian Assumptions
No changes from 2040 CLRP.

Pricing Assumptions
No changes from 2040 CLRP.

Land-Use Assumptions
2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

FINDINGS

Table 8: Initiative 2's Performance on Challenges[12]

Challenges	Compared to CLRP
Road Congestion	High
Transit Crowding	Neutral
Inadequate Bus Service	Neutral
Access to Bike/Ped Options	Neutral
Development around Metrorail	Neutral
Housing & Job Location	Neutral
Metrorail Repair Needs	Neutral
Roadway Repair Needs	Negative
Incidents and Safety	Low
Pedestrian & Bicyclist Safety	Negative
Environmental Quality	Low
Open Space Development	Neutral
Bottlenecks	Medium
Reliable Access to Intercity Hubs	Low

KEY: High, Medium, Low, Neutral, Negative

The Operational Improvements and Hotspot Relief initiative increases effective roadway capacity on the road network, causing a decrease in vehicle hours of delay (VHD) while also increasing total road travel. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 2

- **Road Congestion** and **Bottlenecks** improve as daily VHD falls by 8 percent compared to the CLRP. The operational improvements and incident management allow for more reliable travel systemwide. The targeted operational and capacity improvements at congestion hotspots help to address roadway bottlenecks at locations including portions of the Beltway and other roadways such as VA-28.
- **Reliable Access to Intercity Hubs** improves due to general improvements in road congestion, as well as through operations strategies that target reliability improvements, such as enhanced incident management. In addition, demand-responsive services for persons with disabilities and others with limited mobility would improve reliable access to these hubs.
- **Environmental Quality** improves because emissions are reduced due to improvements in vehicle flow, including a reduction in stop-and-go conditions and hours of delay, which offset increases in VMT.
- **Incidents and Safety** improves because the strategies employed likely reduce secondary incidents by improving incident management and operational strategies may reduce roadway conflicts. This scores as low, however, because an increase in VMT may also contribute to an increase in incidents.

Challenges Not Addressed by Initiative 2

- **Roadway Repair Needs** may worsen because adding additional infrastructure and treatments such as reversible lanes and associated technologies would increase maintenance needs.
- **Pedestrian and Bicyclist Safety** may worsen under this initiative. Increases in VMT generally correlate with increases in vehicular crashes. Although the operations and incident management strategies will help manage and reduce overall crash effects on the highway system, some of the strategies may result in increased speeds or create challenges for bicycles and pedestrians, particularly on arterial roadways. For instance, arterials with new reversible lanes likely will require elimination of medians.

[12] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 2 is largely compatible with the other initiatives. Initiative 2 could benefit from the reduced trip making in Initiative 10 and from the higher transit share in Initiatives 4-7, which could reduce demand and congestion on the highway system.

Table 9: Summary of Initiative 2's Performance on Quantitative MOEs Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	48.5	-4%
High-occupancy vehicle (HOV)	58.9	56.5	-4%
Transit	53.9	52.6	-2%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.71 million	-8%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	532,000	2%
Auto: # of jobs accessible within 45-min auto commute	876,000	943,000	8%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	60.0	3%
High-occupancy vehicle (HOV)	11.6	10.8	-7%
Transit	24.6	23.7	-4%
Bicycle/Pedestrian	5.6	5.6	0%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	10.9%	-5%*
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	144.36 million	2%
Daily VMT per capita	21.2	21.5	2%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	39.9%	0%
Share of jobs in zones with high-capacity transit	57.7%	57.7%	0%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	16.7	-3%
NOx Emissions (seasonal)	17.0	17.0	0%
CO2 Emissions	47,082	46,597	-1%

*Although this initiative showed a reduction in the share of passenger miles on reliable modes, it is anticipated to improve overall system reliability on both auto and transit due to operational improvements, in particular those that address nonrecurring delay.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 2 performed very well on reducing vehicle hours of delay, improving average travel time per commute trip, and increasing the number of jobs accessible by auto commute. Improvements in transit speeds and reliability result in small improvements on average transit travel times and the number of jobs accessible by transit. Emissions are expected to decline due to reduced vehicle travel and reduced stop-and-go travel conditions. By improving auto travel times, Initiative 2 is anticipated to result in some travelers shifting from transit and carpools/vanpools to driving alone, resulting in an increase in VMT. Consequently, this initiative performs worse than the CLRP by shifting mode share to SOV. It also decreases the proportion of passenger miles on reliable modes by reducing the share of passenger miles on transit rail. However, operational improvements, particularly those addressing nonrecurring delay, should improve overall system reliability for both autos and buses.

Initiative 3: Additional Northern Bridge Crossing/Corridor

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

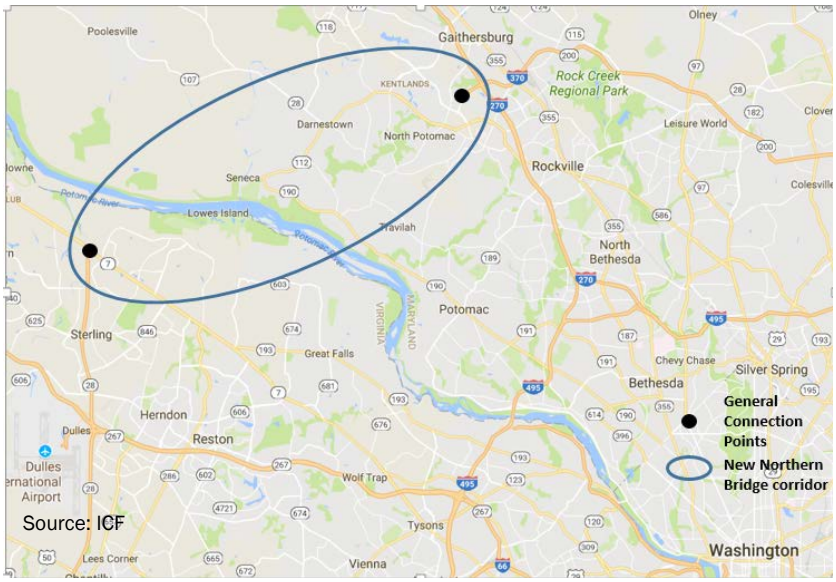
- New northern bridge crossing of Potomac River, as a multimodal corridor
- New express bus services connecting existing Activity Centers in this new multimodal corridor

ASSUMPTIONS

Roadway Assumptions

- Connection between VA28/VA 7 junction and I 270/I-370 junction (MD-200/Intercounty Connector) across Potomac River (approximately 14 miles long), as shown on the map to the right.
- 3-lanes each direction (to connect with existing 3-lane per direction facilities on each end)
- No interchanges between the above termini points of the new facility

Figure 5: General Connection Points for New Corridor



Transit Assumptions

Express bus service connecting activity centers along the corridor with 20-minute peak, 30-minute off-peak headways.

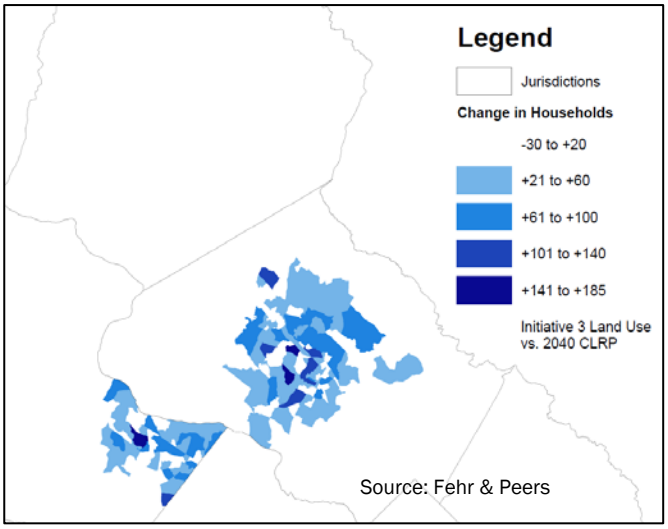
Bicycle and Pedestrian Assumptions

No changes from 2040 CLRP.

Pricing

- Vehicle tolls assume the per-mile toll rates from MD-200 (ICC).
- Express bus service fares assume existing fare pricing.

Figure 6: Location of Assumed Increase in Households



Land-Use Assumptions

Assumes some new development along the corridor:

- About 8,900 households and 16,200 jobs will be added to areas with existing development and that see travel time reductions due to the corridor.
- Proportionate decrease in other parts of the planning area. Approximately 60% of the job shift and 30% of the household shift are to Activity Centers in the corridor.

FINDINGS

Table 10: Initiative 3's Performance on Challenges[13]

Challenges	Compared to CLRP
Road Congestion	Low
Transit Crowding	Neutral
Inadequate Bus Service	Neutral
Access to Bike/Ped Options	Neutral
Development around Metrorail	Neutral
Housing & Job Location	Neutral
Metrorail Repair Needs	Neutral
Roadway Repair Needs	Negative
Incidents and Safety	Low
Pedestrian & Bicyclist Safety	Neutral
Environmental Quality	Negative
Open Space Development	Negative
Bottlenecks	Low
Reliable Access to Intercity Hubs	Low

KEY: High, Medium, Low, Neutral, Negative

Initiative 3 provides a new northern bridge crossing to create a new option for crossing between Virginia and Maryland besides the severely congested American Legion Bridge. Unlike many of the other initiatives, which have diffuse impacts across the region, this initiative's impacts target a specific corridor. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 3

- **Road Congestion** and **Bottlenecks** improve due to an estimated reduction of about 53,000 daily vehicle hours of delay from the CLRP, mostly along the American Legion Bridge/I-495 Beltway corridor. Roadways at the ends of the new highway corridor (VA-28 and MD-200 and vicinity) are anticipated to see an increase in traffic congestion due to increased volumes, with the new bridge anticipated to have approximately 100,000 daily trips (both directions).
- **Reliable Access to Intercity Hubs** improves due to the more direct connection between Upper Montgomery County and Dulles International Airport as well as between BWI Airport and parts of Northern Virginia.
- **Incidents and Safety** may improve as congestion reductions temper the increase in VMT, and the new bridge provides some redundancy to reduce disruptions to the system when incidents occur on the American Legion Bridge.

Challenges Not Addressed by Initiative 3

- **Inadequate Bus Service** may not improve despite the new bus service in the corridor because bus ridership regionwide did not increase.
- **Roadway Repair Needs** may worsen because adding a new highway corridor will create additional roadway maintenance needs, although tolls may help pay for these costs.
- **Environmental Quality** may worsen compared to the CLRP because the bridge will not only result in increases in VMT but construction will disrupt the riverine environment and increase impervious surface (and stormwater runoff, which negatively effects water quality).
- **Open Space Development** may worsen because the project will use some open space for the highway corridor and may induce additional demand for development in areas outside of Activity Centers, even if Montgomery County's agricultural reserve remains protected.

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 3 is likely compatible with the other multimodal/roadway initiatives (Initiatives 1 and 2) and the TDM initiative (Initiative 10), but fewer users might be interested in the new corridor under Initiative 10's significant reduction in trips. Initiative 3 could conflict with the optimized land-use initiative (Initiative 8) and other initiatives that focus development around transit, particularly in the region's core. It would conflict with Initiative 8's goal of achieving regional balance in the jobs to

[13] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

housing ratio because the increase in jobs in the western subregion would affect the jobs-housing balance achieved under Initiative 8.

Table 11: Summary of Initiative 3's Performance Measures of Effectiveness Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	50.7	0%
High-occupancy vehicle (HOV)	58.9	58.5	-1%
Transit	53.9	53.8	- <1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.80 million	-3%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	520,000	- <1%
Auto: # of jobs accessible within 45-min auto commute	876,000	885,000	1%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	58.3	<1%
High-occupancy vehicle (HOV)	11.6	11.6	0%
Transit	24.6	24.5	- <1%
Bicycle/Pedestrian	5.6	5.6	0%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	11.3%	-2%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	142.93 million	1%
Daily VMT per capita	21.2	21.3	1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	39.8%	- <1%
Share of jobs in zones with high-capacity transit	57.7%	57.6%	- <1%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	17.3	1%
NOx Emissions (seasonal)	17.0	17.1	1%
CO_2 Emissions	47,082	47,332	1%

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Overall Initiative 3 modestly effects the regional indicators, reflecting in part that the initiative only serves a portion of the region. Initiative 3 performs better than the CLRP on daily vehicle hours of delay but has limited effects on average travel times per commute trip. The increase in the number of jobs accessible within a 45-minute commute is also limited; even though travel times are significantly reduced from points at the two ends of the corridor, the travel times from home to work generally still exceed 45 minutes on average because of congestion on and accessing the corridor and because most jobs and housing require some time to access the corridor. The initiative is anticipated to increase daily VMT and is likely to increase emissions due to more vehicle trips and shifts from transit, although the impacts on emissions are uncertain without more detailed emissions modeling. The initiative performs slightly worse than the CLRP on the share of passenger miles on reliable modes, reflecting a small reduction in passenger travel on rail and increase in auto travel.

Initiative 4: Regionwide Transitways

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- Bus rapid transit (BRT)/transitway networks in Montgomery County, Prince George's County, Northern Virginia (TransAction 2040), DC, and transitway from Branch Ave to Waldorf; specifications according to jurisdiction plans
- Additional DC streetcar line (north-south) as complement to network
- Improved bicycle and pedestrian connections and access improvements to transit stations.

ASSUMPTIONS

Roadway Assumptions

No changes from 2040 CLRP.

Transit Assumptions

This initiative adds BRT, transitway, and streetcar routes that are in jurisdictions' plans but not yet in the CLRP, as shown at right. Frequent headways were assumed for the BRT and Transitways, as described in the related plans.[14]

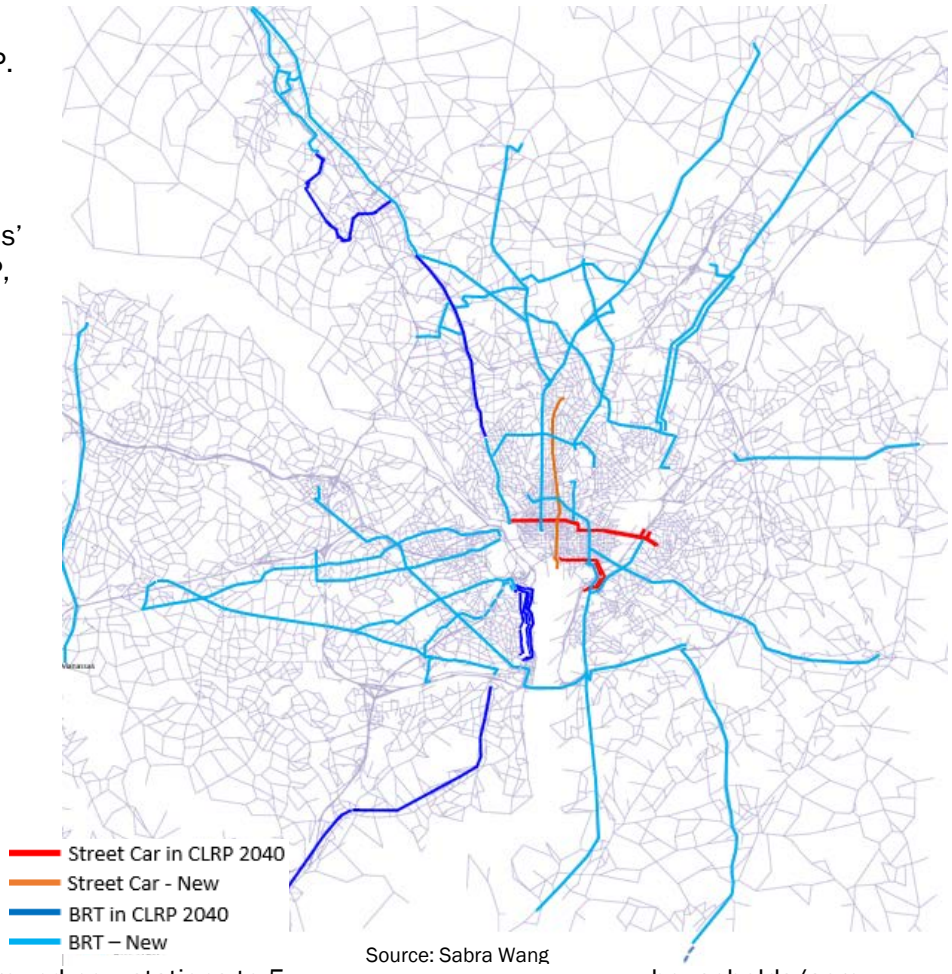
Bicycle and Pedestrian Assumptions

This initiative also considers improved bicycle and pedestrian connections and access improvements to transit stations.

Pricing Assumptions

Assume existing local bus/streetcar fare pricing.

Figure 7: Proposed and Planned BRT and Transitways



Source: Sabra Wang

Land-Use Assumptions

Increase jobs and housing around new stations to 5 households/acre and 30 jobs/acre by pulling some housing and jobs from the same jurisdiction's areas outside of Activity Centers.

[14] The BRT and Transitways in this Initiative mimic the transit coding (including the headways) from various plans and models: - 2040 CLRP, 2040 All Build, Aspirational Scenarios, MNCPPC Montgomery County Travel Model, Northern Virginia TransAct and Southern Maryland Rapid Transit Project. See Appendix C for Details.

FINDINGS

Table 12: Initiative 4's Performance on Challenges[15]

Challenges	Compared to CLRP
Road Congestion	Low
Transit Crowding	Neutral
Inadequate Bus Service	High
Access to Bike/Ped Options	Medium
Development around Metrorail	Medium
Housing & Job Location	Medium
Metrorail Repair Needs	Neutral
Roadway Repair Needs	Neutral
Incidents and Safety	Low
Pedestrian & Bicyclist Safety	Neutral
Environmental Quality	Neutral
Open Space Development	Neutral
Bottlenecks	Neutral
Reliable Access to Intercity Hubs	Low

KEY: High, Medium, Low, Neutral, Negative

Initiative 4 adds a significant amount of high-quality bus transit and light rail in the region, significantly increasing access to high-capacity transit. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 4

- **Inadequate Bus Service** improves with significant increases in capacity, coverage, frequency, and reliability throughout the region, which results in an increase of about 100,000 additional bus trips daily.
- **Development Around Metrorail, Housing & Job Location,** and **Access to Bike/Ped Options** all improve under Initiative 4. The shares of households and jobs in high-capacity transit zones increase 25% and 15%, respectively, compared to the CLRP, which indicates progress toward all three of these challenges. The initiative also increases bicycle and pedestrian access to rail stations. While development around underutilized Metrorail stations is somewhat difficult to assess, several of the transitway routes feed into these stations, and were assumed to support development in these locations.
- **Road Congestion** improves with an estimated reduction of about 37,000 vehicle hours of delay per day, about a 2% reduction from the CLRP level.
- **Reliable Access to Intercity Hubs** improves with the reduction in VHD and the increase in travel on reliable modes.
- **Incidents and Safety** improves due to a reduction in VHD and the shifting of mode share to safer modes.

Challenges Not Addressed by Initiative 4

- **Transit Crowding** may or may not improve. The analysis could not determine whether the increase in bus transit trips was relieving pressure from portions of the transit system that experience crowding. However, overall Metrorail ridership was estimated to have limited change.
- This initiative does not appear to address the other challenges to a notable degree.

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 4 would be compatible with the roadway strategies tested in Initiative 2 and the policy strategies of Initiatives 8 and 10. Initiative 4 could have beneficial interactions where the new transitways feed into the new rail services of other initiatives, but it could also lose ridership if the lines are redundant with rail services. Initiative 9's rail fare reductions would also likely draw ridership away from the services provided in Initiative 4.

[15] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Table 13: Summary of Initiative 4's Performance on Quantitative Measures Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	50.4	-1%
High-occupancy vehicle (HOV)	58.9	58.6	-1%
Transit	53.9	53.4	-1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.82 million	-2%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	542,000	4%
Auto: # of jobs accessible within 45-min auto commute	876,000	882,000	1%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	57.4	-1%
High-occupancy vehicle (HOV)	11.6	11.5	-1%
Transit	24.6	25.5	4%
Bicycle/Pedestrian	5.6	5.6	<1%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	12.2%	6%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	141.35 million	- <1%
Daily VMT per capita	21.2	21.1	- <1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	49.9%	25%
Share of jobs in zones with high-capacity transit	57.7%	66.5%	15%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	17.1	-1%
NOx Emissions (seasonal)	17.0	17.0	0%
CO2 Emissions	47,082	46,835	-1%

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 4 performs significantly better than the CLRP (and other initiatives) on increasing access to transit as measured by the share of households and jobs that are in transportation analysis zones with high-capacity transit. It also improves upon the CLRP's performance by reducing vehicle hours of delay and increasing the number of jobs accessible in transit commutes, the transit mode share, and the share of passenger miles on reliable modes.

Initiative 5: Regional Commuter Rail Enhancements

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- VRE System Plan 2040, MARC Growth, and Investment Plan (including run-thru and two-way service on selected lines, increased frequency and hours of service).[16]
- Long Bridge corridor improvements including at least 4 tracks and bicycle-pedestrian facilities.
- Improved bicycle and pedestrian connections and access improvements to rail stations

ASSUMPTIONS

Roadway Assumptions

No changes from 2040 CLRP.

Transit Assumptions[17]

- **Improve headways**: Upgrade all 60- minute, peak time headways n the CLRP to 30-min headways and 30-minute headways in CLRP to 20-minute headways.
- **Establish off-peak service** on 60-minute headways
- **Run-through service at Union Station** to provide a direct one-seat ride from parts of Maryland along the Penn and Camden lines to/from Alexandria, Virginia.

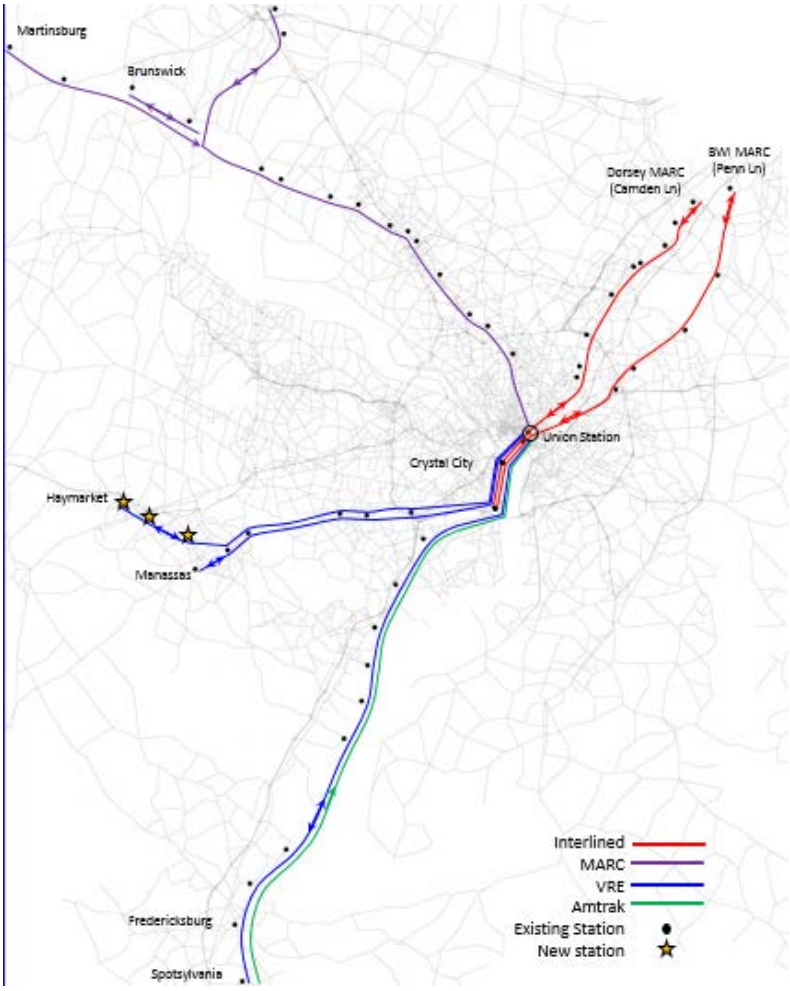
Bicycle and Pedestrian Assumptions

This initiative also considers improved bicycle and pedestrian connections and access improvements to transit stations.

Pricing Assumptions

Assume existing fare structures and pricing.

Figure 8: Commuter Rail System



Source: Sabra Wang

Land-Use Assumptions

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

[16] Both the Virginia Railway Express (VRE) and Maryland Area Regional Commuter Train Service (MARC) have planned system and service improvements that are scheduled to be implemented by the year 2040. More details on these plans and how they overlap with this initiative can be found in Appendix C.

[17] This initiative was analyzed including three additional VRE stations connecting to Haymarket, VA, based on plans for the new stations in the 2040 CLRP. Due to low ridership forecasts, these additional stations will no longer be included in the next version of the CLRP. These stations, however, do not have a notable impact on the results.

FINDINGS

Table 14: Initiative 5's Performance on Challenges[18]

Challenges	Compared to CLRP
Road Congestion	Low
Transit Crowding	Neutral
Inadequate Bus Service	Neutral
Access to Bike/Ped Options	Low
Development around Metrorail	Neutral
Housing & Job Location	Neutral
Metrorail Repair Needs	Neutral
Roadway Repair Needs	Neutral
Incidents and Safety	Low
Pedestrian & Bicyclist Safety	Low
Environmental Quality	Neutral
Open Space Development	Neutral
Bottlenecks	Neutral
Reliable Access to Intercity Hubs	Low

KEY: High, Medium, Low, Neutral, Negative

Regional Commuter Rail Enhancements provide increased service frequency and hours of operation, as well as a one-seat ride for more patrons due to run-through service between Maryland and Virginia. Unlike many of the other initiatives where impacts are diffuse across the region, this initiative's improvement benefits are more targeted toward several key corridors with existing MARC and VRE services. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 5

- **Road Congestion** improves with an estimated reduction of about 43,000 vehicle hours of delay per day, about a 2% reduction from the CLRP level. While these delay improvements affect an array of roadways they are targeted toward several key corridors, including the I-95 corridors in Maryland and Virginia.
- **Access to Bike/Ped Options** and **Pedestrian & Bicycle Safety** both improve due to investments in bicycle and pedestrian access to stations.
- **Incidents and Safety** improve as VHD declines and some travel shifts to safer, more reliable modes, which are less prone to disruptions.
- **Reliable Access to Intercity Hubs** improves as the share of passenger miles on reliable modes increases. In particular, improved frequency of commuter rail service and run-through service improves reliable options for accessing Union Station, BWI Airport, and Reagan National Airport, but the number of travelers accessing these hubs by commuter rail may remain relatively low.

Challenges Not Addressed by Initiative 5

Initiative 5 is not expected to have much influence over the remaining initiatives.

Potential Synergies or Conflicts with Other Initiatives

Initiative 5's improvements to commuter rail service could supplement other transit service, but the different modes of transit could also draw ridership from each other. For instance, commuter rail service may draw some of the same riders served by new Metrorail extensions under Initiative 7.

[18] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Table 15: Summary of Initiative 5's Performance on Measures of Effectiveness Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	50.4	-1%
High-occupancy vehicle (HOV)	58.9	58.5	-1%
Transit	53.9	54.0	<1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.81 million	-2%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	528,000	1%
Auto: # of jobs accessible within 45-min auto commute	876,000	878,000	<1%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	57.8	-1%
High-occupancy vehicle (HOV)	11.6	11.5	-1%
Transit	24.6	25.1	2%
Bicycle/Pedestrian	5.6	5.6	<1%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	11.8%	2%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	141.52 million	- <1%
Daily VMT per capita	21.2	21.1	- <1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	40.1%	<1%
Share of jobs in zones with high-capacity transit	57.7%	57.9%	<1%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	17.1	0%*
NOx Emissions (seasonal)	17.0	17.0	0%*
CO_2 Emissions	47,082	46,882	0%*

*Small impacts were estimated but overall effects are unclear based on simplified methods utilized.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Overall the effects of Initiative 5 on most regional indicators are modest, reflecting in part that the initiative is targeted primarily to a few key corridors. The most significant effects would occur in the corridors serviced by existing MARC and VRE services. This initiative improves VHD, transit mode share, and the share of passenger miles on reliable modes. In particular, it is estimated to yield about a 50% increase in commuter rail riders compared to the CLRP, or about 30,000 additional person-trips on commuter rail per day. A portion of those additional trips are estimated to come from those who otherwise would have used Metrorail and/or buses, as well as HOVs. Still, the overall increase in transit mode share for commuting reduces daily VMT and vehicle hours of travel. In addition, the improved services reduce VMT not only during peak hours but also during midday and nighttime hours.

Initiative 6: Metrorail Regional Core Capacity Improvements

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- 100% 8-car trains
- Metrorail station improvements at high-volume stations in system core
- Second Rosslyn station to reduce interlining and increase frequency
- New Metrorail core line to add capacity across Potomac River (new Rosslyn tunnel) between Virginia and DC through Georgetown to Union Station toward Waterfront.
- Improved bicycle and pedestrian connections and access improvements to rail stations.

ASSUMPTIONS

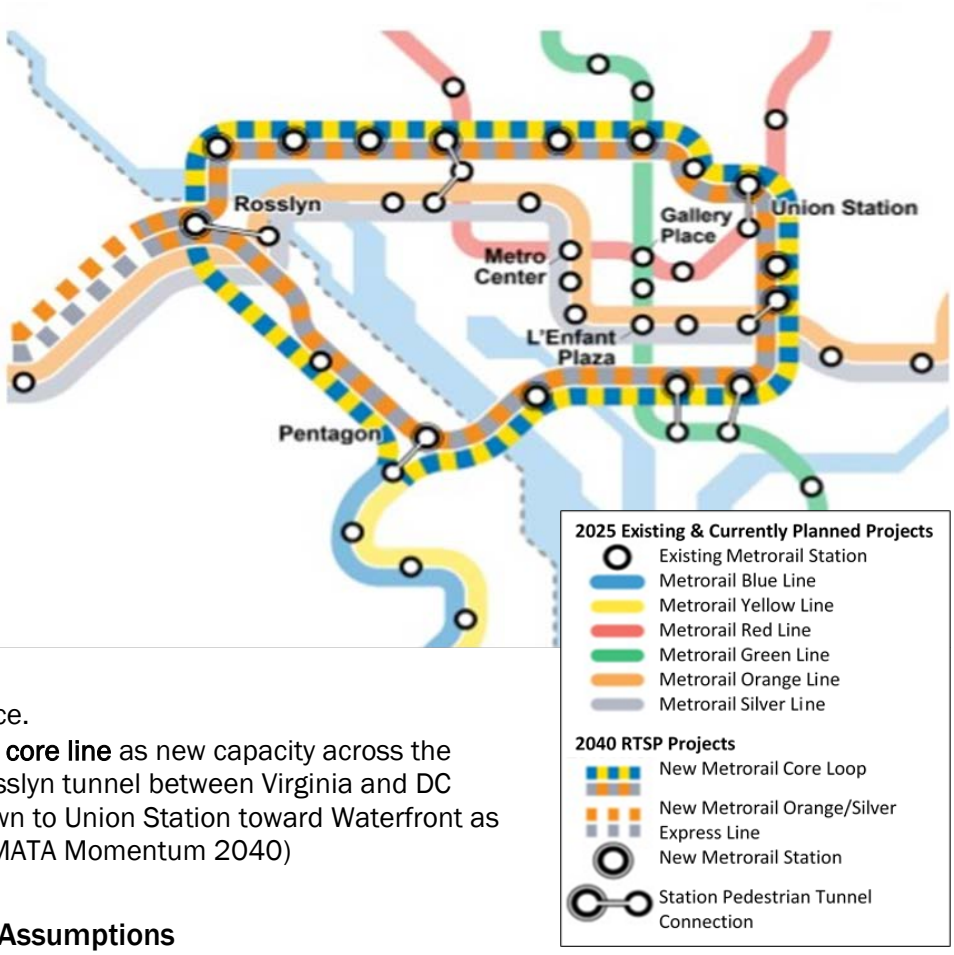
Roadway Assumptions

No changes from 2040 CLRP.

Transit Assumptions

- **Remove capacity constraints** in place for Metrorail core.
- **Increase station access and transfers** to reflect capacity improvements.
- **Add a second Rosslyn station**, with reductions in interlining and increases in frequency of service.
- **Add new Metrorail core line** as new capacity across the Potomac (New Rosslyn tunnel between Virginia and DC through Georgetown to Union Station toward Waterfront as loop, based on WMATA Momentum 2040)

Figure 9: Metrorail Core Capacity Improvements (Source: WMATA)



Bicycle and Pedestrian Assumptions

This initiative also considers improved bicycle and pedestrian connections and access improvements to transit stations.

Pricing Assumptions

Assume existing fare structures and pricing.

Land-Use Assumptions

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

FINDINGS

Table 16: Initiative 6's Performance on Challenges[19]

Challenges	Compared to CLRP
Road Congestion	
Transit Crowding	
Inadequate Bus Service	
Access to Bike/Ped Options	
Development around Metrorail	
Housing & Job Location	
Metrorail Repair Needs	
Roadway Repair Needs	
Incidents and Safety	
Pedestrian & Bicyclist Safety	
Environmental Quality	
Open Space Development	
Bottlenecks	
Reliable Access to Intercity Hubs	

KEY: High, Medium, Low, Neutral, Negative

Initiative 6 significantly increases Metrorail's core capacity, currently a major constraint on transit use into the core of the region. These investments result in the most significant improvements in the number of jobs accessible by transit within a 45-minute commute – 19% more than in the CLRP – without making any changes to land-use. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 6

- **Transit Crowding** and **Bottlenecks** significantly improve because of the large increase in core capacity, where most transit crowding and bottlenecks occur. In particular, this initiative addresses the Rosslyn bottleneck where the Orange, Blue, and Silver lines converge, and eases crowding at some of the most crowded stations. It rated slightly lower on the bottlenecks challenge than congestion because it mainly focuses on rail bottlenecks, although it also has some benefits for roadway bottlenecks into the core of the region.[20]
- **Road Congestion** improves as VHD decreases by 9% relative to the CLRP, a reduction of about 165,000 vehicle hours daily.
- **Reliable Access to Intercity Hubs** improves because the significant core improvements improve reliable access particularly to Union Station, as well as Reagan National Airport and Dulles International Airport served by Metrorail. The share of passenger miles on reliable modes also improves, which indicates that riders have more reliable options for reaching destinations.
- **Access to Bike/Ped Options** and **Pedestrian & Bicycle Safety** improve as the initiative improves the bicycle and pedestrian infrastructure for accessing rail stations.
- **Incidents and Safety** also improve due to shifts from driving to Metrorail, which is expected to reduce the number of roadway crashes.

Challenges Not Addressed by Initiative 6

- **Metrorail Repair Needs** may worsen because the significant level of new infrastructure will add to maintenance needs.
- **Housing and Job Location** does not improve because the initiative assumes that land-use in these areas is already built out in 2040 and, therefore, did not increase development at the new stations. Even so, it improves the number of jobs accessible by a 45-minute transit commute.

[19] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

[20] Based on the analysis approach used, VHD declines significantly, but a full model analysis might show less of a reduction in vehicle travel as some vehicles travel would like take back some of the roadway capacity freed up by the VHD reductions, such as through additional trip-making.

Potential Compatibilities or Conflicts with Other Initiatives

Given the crowding in the core, Initiative 6 is almost a necessary precondition for any initiative that produces additional Metrorail ridership in the core, such as Initiatives 7 and 8. Initiative 6 would likely pair well with any of the other initiatives to address the regional challenges.

Table 17: Summary of Initiative 6's Performance on Quantitative Measures Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	49.8	-2%
High-occupancy vehicle (HOV)	58.9	58.2	-1%
Transit	53.9	50.8	-6%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.69 million	-9%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	621,000	19%
Auto: # of jobs accessible within 45-min auto commute	876,000	893,000	2%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	56.0	-4%
High-occupancy vehicle (HOV)	11.6	11.0	-5%
Transit	24.6	27.4	11%
Bicycle/Pedestrian	5.6	5.6	<1%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	12.6%	9%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	139.99 million	-1%
Daily VMT per capita	21.2	20.9	-1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	40.0%	<1%
Share of jobs in zones with high-capacity transit	57.7%	57.7%	0%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	16.8	-2%
NOx Emissions (seasonal)	17.0	16.8	-2%
CO_2 Emissions	47,082	46,171	-2%

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 6 performs exceptionally well on increasing the number of jobs accessible within a 45-minute transit commute, while providing significant improvements on transit mode share and VHD. Although the new core capacity generally serves existing areas in the District of Columbia that are Metro-accessible, it would reduce crowding on existing services while improving transit access to locations such as Georgetown, Thomas Circle, and the Supreme Court that are not directly served or require bus transfers/walk time. By encouraging some trips to shift from driving to Metrorail, this initiative also improves upon the CLRP on most of the other MOEs: travel times for all modes, the number of jobs accessible by car, the share of passenger miles on reliable modes, VMT, and emissions. Although it reduces HOV mode share, those travelers are shifting to even higher occupancy modes via transit. Overall, the initiative increases daily transit trips by about 200,000.

Initiative 7: Transit Rail Extensions

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- Metrorail extensions to Centreville/Gainesville, Hybla Valley/Potomac Mills.
- Can consider an extension(s) in MD, such as to National Harbor or north of Shady Grove (to be defined later).
- Purple line extension to Tysons (west) and Eisenhower Avenue (east)
- Improved bicycle and pedestrian connections and access improvements to rail stations.

ASSUMPTIONS

Roadway Assumptions

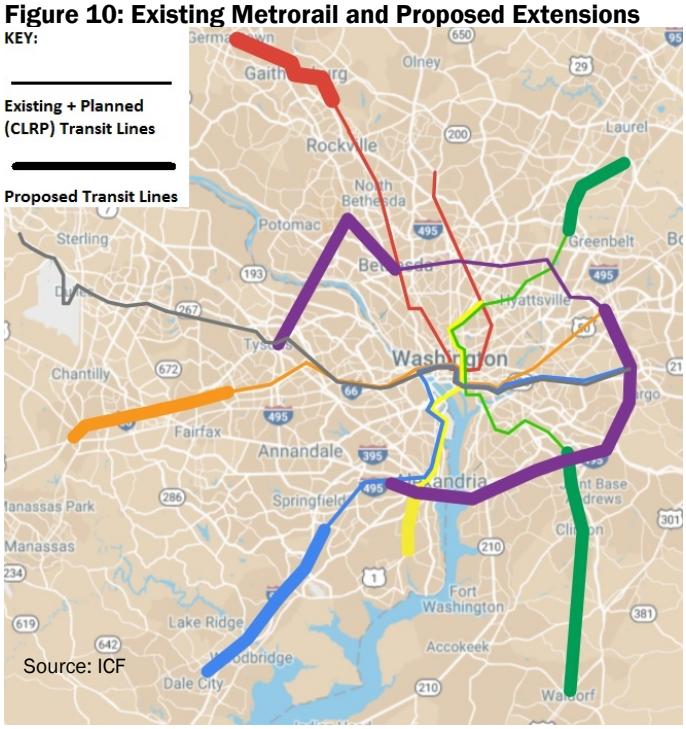
No changes from 2040 CLRP.

Transit Assumption

Extensions to Metrorail and light-rail transit (62 new stations) on the following extensions:

- **Orange Line**: Extend west beyond Vienna-Fairfax to Centreville (5 stations)
- **Blue Line:** Extend south beyond Franconia-Springfield to Potomac Mills (5 stations)
- **Yellow Line:** Extend south beyond Huntington to Hybla Valley (2 stations)
- **Red Line:** Extend northwest beyond Shady Grove to Germantown (3 stations)

Figure 10: Existing Metrorail and Proposed Extensions



- **Green Line:** Extend north beyond Greenbelt to South Laurel (4 stations)
- **Purple Line Light Rail:** Extend west beyond Bethesda to Tysons and east beyond New Carrollton to Eisenhower Avenue (with stops at Branch Avenue and National Harbor, adding 32 new stations)
- **Light-Rail to Waldorf**: Add new light-rail line south from Branch Ave to Waldorf (11 stations)

Bicycle and Pedestrian Assumptions

This initiative also considers improved bicycle and pedestrian connections and access improvements to transit stations.

Pricing Assumptions

Assume existing fare structures and pricing.

Land-Use Assumptions

Increase employment and housing densities in zones with new services by relocating employment and housing from outside Activity Centers within the jurisdiction. Increase jobs and housing around new LRT stations to 5 household/acre and 30 jobs/ acre. Increase jobs and housing around new Metrorail stations to 15 household/acre and 90 jobs/acre.

FINDINGS

Table 18: Initiative 7's Performance on Challenges[21]

Challenges	Compared to CLRP
Road Congestion	Low
Transit Crowding	Negative
Inadequate Bus Service	Low
Access to Bike/Ped Options	Medium
Development around Metrorail	High
Housing & Job Location	Medium
Metrorail Repair Needs	Negative
Roadway Repair Needs	Neutral
Incidents and Safety	Low
Pedestrian & Bicyclist Safety	Low
Environmental Quality	Low
Open Space Development	Neutral
Bottlenecks	Neutral
Reliable Access to Intercity Hubs	Medium

KEY: High, Medium, Low, Neutral, Negative

The Transit Rail Extensions initiative provides significant expansions of the Metrorail system and light-rail (Purple line), providing a faster and more direct transit ride for many travelers. It is important to note that the lack of expansion of Metrorail core capacity to deal with the increase in ridership brought onto the system, however, limits the potential of this initiative. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 7

- **Development Around Metrorail** improves significantly. With land-use concentrations increasing around the 62 new stations, the share of households and jobs within a zone with high-capacity transit increases by 17% and 13%, respectively.
- **Access to Bike/Ped Options** and **Pedestrian & Bicycle Safety** improve as the initiative improves the bicycle and pedestrian infrastructure for accessing rail stations. The safety measure had slightly lesser improvements because the initiative did little to reduce VMT, which has an inverse correlation with safety.
- **Housing and Job Location** improves as land-use concentrates around the 62 new stations and the number of jobs accessible within 45 minutes increases by 10%.
- **Reliable Access to Intercity Hubs** improves as VHD goes down, the share of travel on reliable modes increases, and travel times to the hubs declines.
- **Inadequate Bus Service** even improves somewhat as feeder buses reroute or are added to serve new rail stations.
- **Incidents and Safety** shows an improvement as VMT and VHD decline and travel shifts to more reliable modes, which are less prone to incidents (when in a state of good repair).
- **Environmental Quality** improves with modest reductions in VMT and emissions and an increase in transit mode share.

Challenges Not Addressed by Initiative 7

- **Transit Crowding** may worsen on Metrorail as new ridership arrives in the congested core.
- **Metrorail Repair Needs** may worsen because the new lines add significant amounts of new infrastructure for Metro to maintain.
- **Open Space Development** was indeterminate; right of way acquisition needs for new rail lines and stations may impact open space in suburban areas, but this may be offset by increasing concentrations of housing and jobs in Activity Centers around stations.
- **Bottlenecks** was indeterminate; bottlenecks on the roads might decrease as VHD declines, but rail bottlenecks might increase due to crowding in the core.

[21] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 7 would create significant problems for the Metrorail core if not accompanied by improvements similar to those described in Initiative 6, and Initiative 7's performance would improve from that pairing. It also might see improvements if paired with the policy initiatives. The rail riders in Initiative 7 also may have some overlap with those who would benefit from the multimodal initiatives such as express bus services on the Express Travel Network and transit initiatives, such as commuter rail enhancements and transitway development, as these services compete for the same users.

Table 19: Summary of Initiative 7's Performance on Measures of Effectiveness Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	50.3	-1%
High-occupancy vehicle (HOV)	58.9	58.3	-1%
Transit	53.9	53.7	- <1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.79 million	-3%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	576,000	10%
Auto: # of jobs accessible within 45-min auto commute	876,000	880,000	1%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	57.3	-1%
High-occupancy vehicle (HOV)	11.6	11.3	-3%
Transit	24.6	25.8	5%
Bicycle/Pedestrian	5.6	5.6	<1%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	12.2%	6%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	140.74 million	-1%
Daily VMT per capita	21.2	21.0	-1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	46.5%	17%
Share of jobs in zones with high-capacity transit	57.7%	65.1%	13%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	17.0	-1%
NOx Emissions (seasonal)	17.0	16.9	-1%
CO_2 Emissions	47,082.3	46,590.0	-1%

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 7 performed very well on increasing the number of jobs accessible within a 45-minute transit commute and the shares of households and jobs in zones with high-capacity transit. It also performed better than the CLRP on VHD, transit mode share, share of passenger miles on reliable modes, and VMT. While the rail extensions reduce mode share on HOVs, those travelers are shifting to even higher occupancy modes via transit.

Initiative 8: Optimize Regional Land-Use Balance

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- Optimize jobs/housing balance regionwide
- Increase jobs and housing around underutilized rail stations and Activity Centers with high-capacity transit.
- Build more housing in the region to match employment (about 130,000 more households).

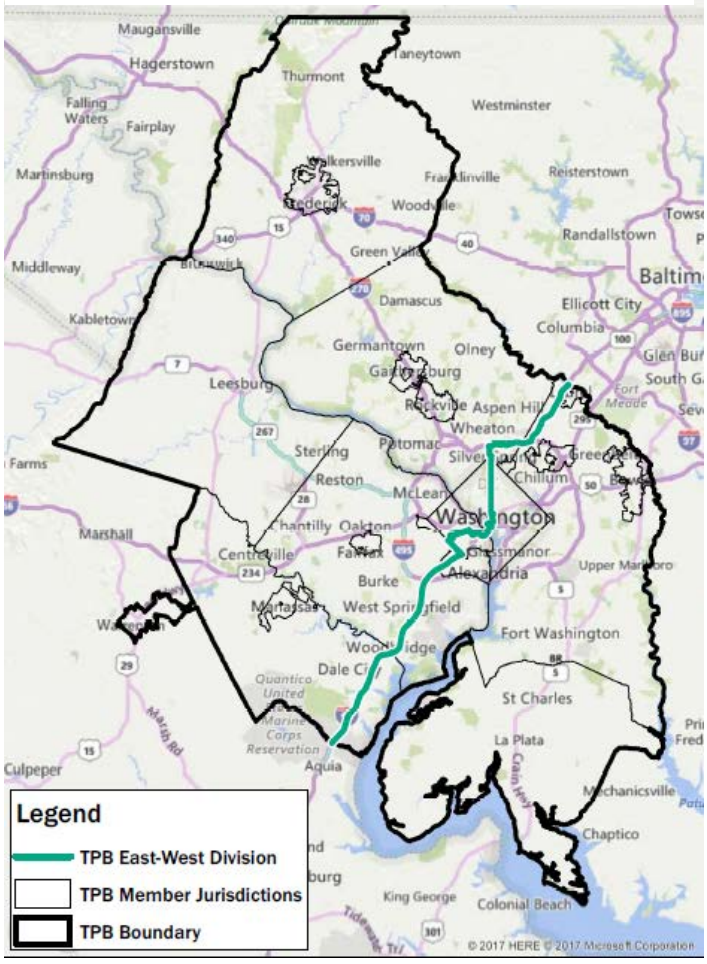
ASSUMPTIONS

No changes from 2040 CLRP.

LAND-USE ASSUMPTIONS

- **Add 130,000 households to the region** to reduce daily long-distance "in-commuters" living beyond the region's boundaries.
- **Allocate the employment and household growth outside of Activity Centers for the period 2025 to 2040 to balance jobs/household ratio between the eastern and western subregions** to achieve 1.54 jobs-housing ratio (regionwide, in the eastern portion, and in the western portion). See map at right for the East-West Division (note that the eastern subregion includes portions of the City of Alexandria, Arlington County, Fairfax County, Prince William County, the District of Columbia, and Montgomery County, in addition to Charles County and most of Prince George's County).
- **Allocate growth within each subregion** to counties to support movement toward the 1.54 regional average.
- **Shift growth within jurisdictions** to underutilized rail stations and Activity Centers with high-capacity transit.

Figure 11: TPB East-West Division and Jurisdictions



Source: COG

Table 20 Regional Job and Household Summary

	2040 CLRP			Initiative 8 Land-Use		
	Households	Jobs	Ratio	Households	Jobs	Ratio
Eastern Subregion	1,054,764	1,604,039	1.52	1,107,094	1,702,578	1.54
Western Subregion	1,513,958	2,546,274	1.68	1,591,628	2,447,735	1.54
TPB Planning Region Total	2,568,722	4,150,313	1.62	2,698,722	4,150,313	1.54

FINDINGS

Table 21: Initiative 8's Performance on Challenges[22]

Challenges	Compared to CLRP
Road Congestion	High
Transit Crowding	Negative
Inadequate Bus Service	Neutral
Access to Bike/Ped Options	High
Development around Metrorail	High
Housing & Job Location	High
Metrorail Repair Needs	Neutral
Roadway Repair Needs	Neutral
Incidents and Safety	Medium
Pedestrian & Bicyclist Safety	Low
Environmental Quality	Medium
Open Space Development	Medium
Bottlenecks	Medium
Reliable Access to Intercity Hubs	Low

KEY: High, Medium, Low, Neutral, Negative

Initiative 8 extends upon regional efforts toward concentrating growth in Activity Centers and around transit and adds a significant number of households as it balances the regional jobs-housing ratio. Due to the significant land-use shifts, the analysis of Initiative 8 used a full model run to determine the effects, which show Initiative 8 to provide significant improvements beyond the CLRP without having any additional investment in infrastructure. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 8

- **Road Congestion** improves significantly with an 18% reduction in daily vehicle hours of delay, about 325,000 hours saved each day due to shorter vehicle trips and increases in bicycling and walking.
- **Access to Bike/Ped Options** improves significantly because housing and jobs are moving closer to each other and to transit, resulting in a 29% increase, the largest of any initiative.
- **Development Around Metrorail** and **Housing & Job Location** improve significantly as the initiative intentionally brought development to Metrorail and brought housing and jobs closer together, with related improvements in travel times, number of jobs accessible, and share of households with access to high-capacity transit.
- **Incidents and Safety** improve because VMT and VHD both decline, leading to a reduction in incidents (from the decline in VMT) and improved resiliency in the system when incidents occur (from the VHD and congestion reductions).
- **Pedestrian & Bicyclist Safety** improves also because VMT decreased, but the improvement is moderated by the increasing exposure as non-motorized mode share increases.
- **Environmental Quality** improves due to significant VMT, VHD, and emissions reductions.
- **Open Space Development** improves as development shifts to Activity Centers away from areas outside Activity Centers.
- **Bottlenecks** on roadways improved significantly because of the significant VHD reductions, but rail bottlenecks may worsen given changes in transit patterns.
- **Reliable Access to Intercity Hubs** improves with reduced roadway congestion, but the share of trips on reliable modes did not change under this initiative.

Challenges Not Addressed by Initiative 8

- **Transit crowding** may worsen due to an expected significant increase in Metrorail ridership without new capacity in Metrorail's crowded core. While some of the transit trips may be in the off-peak direction, it is likely that increasing the amount of housing in some corridors, such as the Orange and Silver lines in Virginia will increase crowding traveling into the core.

[22] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 8 may be synergistic with all the other initiatives. Optimizing land-use balance paired with transit and/or multimodal investments or other policies could dramatically improve overall system performance.

Table 22: Summary of Initiative 8's Performance Measures of Effectiveness Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	48.2	-5%
High-occupancy vehicle (HOV)	58.9	55.4	-6%
Transit	53.9	51.4	-5%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.53 million	-18%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	577,000	10%
Auto: # of jobs accessible within 45-min auto commute	876,000	962,000	10%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	57.0	-2%
High-occupancy vehicle (HOV)	11.6	11.2	-4%
Transit	24.6	24.6	<1%
Bicycle/Pedestrian	5.6	7.2	29%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	11.5%	0%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	137.44 million	-3%
Daily VMT per capita	21.2	19.9	-6%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	44.3%	9%
Share of jobs in zones with high-capacity transit	57.7%	59.0%	2%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	16.4	-4%
NOx Emissions (seasonal)	17.0	16.4	-4%
CO2 Emissions	47,082.3	45,058.3	-4%

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 8 performed better than the CLRP on many MOEs including reductions in VHD, increases in number of jobs accessible by transit and by auto, increases in bicycle and pedestrian mode share, and reductions in VMT. It also performed very well on reducing travel times for all modes, increasing the share of households and jobs with access to high-capacity transit, and reducing emissions.

Initiative 9: Transit Fare Policy Changes

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

- Reduced price Metrorail fare for off-peak direction during peak period and on underutilized segments.
- Free transit for low-income residents.

ASSUMPTIONS

Roadway Assumptions
No changes from 2040 CLRP.

Transit Assumptions
No changes from 2040 CLRP.

Bicycle and Pedestrian Assumptions
No changes from 2040 CLRP.

Pricing
- Charge off-peak fares during the peak period for trips in the off-peak direction, for instance, for AM peak-period travel from Bethesda to Rockville or Tysons Corner to Reston.
- Reduce fares to zero for low-income residents (those falling in the lowest income quartile from the MWCOG model).

Land-Use Assumptions

2040 CLRP Round 9.0 Cooperative Forecasts were used without any change.

FINDINGS

Table 23: Initiative 9's Performance on Challenges[23]

Challenges	Compared to CLRP
Road Congestion	
Transit Crowding	
Inadequate Bus Service	
Access to Bike/Ped Options	
Development around Metrorail	
Housing & Job Location	
Metrorail Repair Needs	
Roadway Repair Needs	
Incidents and Safety	
Pedestrian & Bicyclist Safety	
Environmental Quality	
Open Space Development	
Bottlenecks	
Reliable Access to Intercity Hubs	

KEY: High, Medium, Low, Neutral, Negative

The Transit Fare Policy Changes analyzed will increase transit ridership due to eliminating fares for the lowest income quartile and by reducing peak fares in underutilized directions. These policy changes are anticipated to result in about 128,000 additional transit person trips by day, reflecting a combination of increases in transit use for both work and non-work trips and increased use of all modes of transit. These fare policy changes provide significant benefits to low-income individuals and to those with reverse commutes, and the challenges and MOEs may not adequately capture these distributional effects. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 9

- **Road Congestion** and **Bottlenecks** on roadways improves slightly with a 2% reduction in VHD, or about 45,000 vehicle hours saved daily. Bottlenecks on rail might worsen due to the increase in ridership resulting from eliminating fares for low-income riders, although other fare changes are targeted toward travel in the off-peak direction where there is excess rail capacity.
- **Incidents and Safety** improves somewhat as VMT and VHD are reduced slightly (reducing incidents) and users shift to more reliable modes (reducing disruptions caused by incidents).
- **Environmental Quality** somewhat improves due to the slight VMT and VHD reductions.

Challenges Not Addressed by Initiative 9

- **Transit Crowding** may worsen due to the significant increase in new transit trips. These new trips are not only in the underutilized directions but are system wide due to the elimination of fares for low-income riders.
- **Metrorail Repair Needs** will not increase with this initiative; however, the funding available to address repair needs will decline due to the reduced fare revenue from riders – with annual revenue reductions of more than $100 million anticipated.
- This initiative is not anticipated to address the other challenges to a notable degree.

Potential Compatibilities or Conflicts with Other Initiatives

The fare reductions of Initiative 9 will draw new riders onto the transit system, which could benefit many of the transit initiatives.

[23] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Table 24: Summary of Initiative 9's Performance on Measures of Effectiveness Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	50.7	0%
High-occupancy vehicle (HOV)	58.9	58.7	<1%
Transit	53.9	54.2	1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.81 million	-2%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	523,000	0%
Auto: # of jobs accessible within 45-min auto commute	876,000	878,000	<1%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	57.9	<1%
High-occupancy vehicle (HOV)	11.6	11.4	-2%
Transit	24.6	25.2	2%
Bicycle/Pedestrian	5.6	5.6	0%
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	11.9%	3%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	141.08 million	-1%
Daily VMT per capita	21.2	21.1	-1%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	39.9%	0%
Share of jobs in zones with high-capacity transit	57.7%	57.7%	0%
Emissions (metric tons per day)			
VOC Emissions (seasonal)	17.2	17.0	-1%
NOx Emissions (seasonal)	17.0	16.9	-1%
CO_2 Emissions	47,082	46,730	-1%

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 9 generally results in modest changes from the CLRP on the quantitative MOEs. It provides some reductions in VHD and VMT, increases in transit mode share, and increases the share of passenger miles on reliable modes, as well as reductions in emissions. Although HOV mode share declines, these travelers are generally opting for higher occupancy modes in the form of transit.

It is important to note that these quantitative MOEs fail to capture Initiative 9's primary benefits associated with regional equity and affordability; those topics are discussed as other factors to consider within this report.

Initiative 10: Amplified Employer-based Travel Demand Management

INITIATIVE COMPONENTS APPROVED BY TASK FORCE AND ACCEPTED BY TPB

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

ASSUMPTIONS

Roadway Assumptions

No changes from 2040 CLRP.

Transit Assumptions

No changes from 2040 CLRP.

Bicycle and Pedestrian Assumptions

No changes from 2040 CLRP.

Pricing Assumptions

- **Transit/Vanpool Subsidy**: Transit subsidies averaging $50 per month for 80% of employees[24]
- **Parking Pricing Increase**: Charge for 90% of parking for work-trips in Activity Centers[25] with average parking costs of $6 per day (higher in the core and lower in areas not currently charging for parking). These parking prices could reflect actual parking costs or employer-provided parking cash out, in which employers pay employees who do not drive to work

These changes in pricing result in shifts of trips from SOV to HOV and transit with proportion shifted varying by land-use context and proximity to the core.

Land-Use Assumptions

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

Other Assumptions

Increase in telework. Regional reduction in the number of commute trips for all modes to achieve a 20% telecommute rate.[26] Given that about half of workers in the Washington region may be classified as "office" workers, this equates to about a 40% share telecommute for jobs that may be conducive to telework, or an average of about 2 days of telework per week.

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[24] 2016 MWCOG State of the Commute Survey Report showed the following percentage of employers currently being offered a transit/vanpool subsidy: Inner core – 57%, Middle ring – 25%, Outer ring – 10%. https://www.mwcog.org/documents/2016/06/21/state-of-the-commute-survey-report--carsharing-state-of-the-commute-travel-surveys/

[25] 2016 MWCOG State of the Commute Survey Report showed the following percentage of employees not offered on-site free parking (assume employee-paid parking): Inner core: 69%; Middle ring – 17%; Outer ring – 10%.

[26] 2016 MWCOG State of the Commute Survey Report showed 10.2% telework. Note that the COG model used for analysis is calibrated based on the 2007/08 period, which reflects a 5.7% telework share. Consequently, this analysis assumed an increase in telework share from about 6% to 20%, rather than 10% to 20%, and therefore accounts for some of the telework that is already occurring but not accounted for in the 2040 CLRP.

FINDINGS

Table 25: Initiative 10's Performance on Challenges[27]

Challenges	Compared to CLRP
Road Congestion	High
Transit Crowding	Medium
Inadequate Bus Service	Neutral
Access to Bike/Ped Options	Neutral
Development around Metrorail	Neutral
Housing & Job Location	Neutral
Metrorail Repair Needs	Neutral
Roadway Repair Needs	Neutral
Incidents and Safety	High
Pedestrian & Bicyclist Safety	Low
Environmental Quality	High
Open Space Development	Neutral
Bottlenecks	High
Reliable Access to Intercity Hubs	Low

KEY: High, Medium, Low, Neutral, Negative

Amplified travel demand management performed very well on many of the MOEs due to its significant reduction in the number of commuters traveling to work each day due to telework and financial incentives that encourage use of transit and HOV modes. This page discusses performance on the challenges, and the next page shows the quantitative MOE results.

Challenges Addressed by Initiative 10

- **Road Congestion** and **Bottlenecks** improve the most out of all initiatives with a dramatic 24% reduction in VHD, or about 440,000 hours of delay saved daily. This significant improvement results from about a 6% reduction in overall VMT, reflecting over a 20% reduction in SOV work trips, which are focused during the peak commuting times. Due to significant assumptions about the increase in telework, both SOV and transit work trips are reduced (with transit work trips reduced by about 9%). The significant reduction in commute trips across all modes alleviates both highway and transit bottlenecks.
- **Incidents and Safety** and **Environmental Quality** also improve significantly due to the significant reductions in VMT, with an estimated 8+ million vehicle miles traveled reduced daily. VMT has a strong inverse relationship to safety and environmental quality. The VHD reductions would lead to a decline in disruptions related to incidents and additional savings on VMT-related emissions.
- **Transit Crowding** also improves significantly due to the reduction in transit commute trips during peak periods as more people telework. Although these reductions do not target bottlenecks, they would occur system-wide.
- **Pedestrian and Bicyclist Safety** may improve as VMT declines, but effects are very dependent on the impacts on travel in areas with significant bicycle and pedestrian activity. Without a more detailed, location-specific analysis, this is therefore only rated as low.
- **Reliable Access to Intercity Hubs** improves with declines in VHD, but this benefit is tempered because the initiative does not improve the share of travel occurring on reliable modes.

Challenges Not Addressed by Initiative 10

- Initiative 10 does not appear to result in any negative impacts to the challenges, and has limited effects on a significant number of them.

Potential Compatibilities or Conflicts with Other Initiatives

Initiative 10 would be very compatible with all the other initiatives and could result in dramatic results if paired with other initiatives that have a high impact.

[27] Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Table 26: Summary of Initiative 10's Performance on Measures of Effectiveness Compared to 2040 CLRP

Quantitative MOEs	2040 CLRP	Initiative	Change from CLRP
Travel Time: average travel time per commute trip			
Single occupant vehicle (SOV)	50.7	48.5	-4%
High-occupancy vehicle (HOV)	58.9	55.2	-6%
Transit	53.9	54.1	<1%
Vehicle Hours of Delay			
Daily vehicle hours of delay	1.85 million	1.39 million	-24%
Jobs Accessible			
Transit: # of jobs accessible within 45-min transit commute	523,000	523,000	0%
Auto: # of jobs accessible within 45-min auto commute	876,000	922,000	10%
Commute Mode Share			
Single occupancy vehicle (SOV)	58.1	53.2*	-8%*
High-occupancy vehicle (HOV)	11.6	14.3*	24%*
Transit	24.6	26.0*	6%*
Bicycle/Pedestrian	5.6	6.5*	16%*
Travel on Reliable Modes			
Share of passenger miles on reliable modes	11.5%	11.2%	-3%
Vehicle Miles Traveled (VMT)			
Daily VMT	141.91 million	133.61 million	-6%
Daily VMT per capita	21.2	19.9	-6%
Transit Options			
Share of households in zones with high-capacity transit	39.9%	39.9%	0%
Share of jobs in zones with high-capacity transit	57.7%	57.7%	0%
Emissions			
VOC Emissions	17.2	15.9	-8%
NOx Emissions	17.0	15.9	-7%
CO2 Emissions	47,082.3	43,575.3	-7%

* Mode shares reflect trips taken. Due to telework, actual number of transit trips declines; bicycle/pedestrian stays flat; HOV increases slightly.
Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Initiative 10 performs exceptionally well on reducing VHD, VMT, emissions, and travel times; and on increasing HOV mode share. The mode shares for commute trips increase for HOVs, transit, and bicycle/pedestrian modes. Given the significant amount of telework, however, the overall number of work trips drops significantly, resulting in an actual reduction in all motorized trip types. This initiative appears slightly worse than the CLRP on the share of passenger miles occurring on reliable modes due to the overall reduction in work trips, which have a higher transit share than non-work trips; but in actuality, overall reliability would be expected to improve. Given the significant increases in telework that have occurred over the past decade in the region, particularly among federal employees, it is worth noting that a portion of the benefits demonstrated for this initiative may reflect increases in telework that are expected compared to what is assumed in the 2040 CLRP forecast. Still, this initiative demonstrates the possibilities of significant changes in travel through policy decisions; market forces and other factors will also influence adoption of these employee benefits.

OVERALL FINDINGS BY CHALLENGE

The purpose of this study was to identify initiatives to help the region make progress on regional challenges and improve anticipated system performance. This section discusses each of the regional challenges defined by the task force, providing qualitative assessments and related quantitative MOEs, as well as a discussion of how the research team assessed the initiatives' performance. As seen in the table below, all of the initiatives improved performance on the challenges of road congestion, incidents and safety, and reliable access to intercity hubs. The initiatives varied greatly in their performance on the other challenges, with scores ranging from negative to high.

Table 27: Summary of Performance Across Challenges Relative to 2040 CLRP

CHALLENGES	BASE: 2040 CLRP	I1: Express Travel Network	I2: Operational Improvements & Hotspot Relief	I3: Add'l Northern Bridge	I4: BRT and Transitways	I5: Commuter Rail	I6: Metrorail Core Capacity	I7: Transit Rail Extensions	I8: Optimize Regional Land-Use Balance	I9: Transit Fare Policy Changes	I10: Travel Demand Management
Road Congestion	BASELINE	High	High	Low	Low	Low	High	Low	High	Low	High
Transit Crowding		Neutral	Neutral	Neutral	Neutral	Neutral	High	Negative	Negative	Negative	Medium
Inadequate Bus Service		Medium	Neutral	Neutral	High	Neutral	Neutral	Low	Neutral	Neutral	Neutral
Access to Bike/Ped		Neutral	Neutral	Neutral	Medium	Low	Medium	Medium	High	Neutral	Neutral
Development around Metrorail		Neutral	Neutral	Neutral	Medium	Neutral	Low	High	High	Neutral	Neutral
Housing & Job Location		Neutral	Neutral	Neutral	Medium	Neutral	Neutral	Medium	High	Neutral	Neutral
Metrorail Repair Needs		Neutral	Neutral	Neutral	Neutral	Neutral	Negative	Negative	Neutral	Neutral	Neutral
Roadway Repair Needs		Negative	Negative	Negative	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Incidents and Safety		Low	Low	Low	Low	Low	Low	Low	Medium	Low	High
Pedestrian & Bicyclist Safety		Neutral	Negative	Neutral	Neutral	Low	Low	Low	Low	Neutral	Low
Environmental Quality		Neutral	Low	Negative	Neutral	Neutral	Low	Low	Medium	Low	High
Open Space Development		Neutral	Neutral	Negative	Neutral	Neutral	Neutral	Neutral	Medium	Neutral	Neutral
Bottlenecks		High	High	Low	Neutral	Neutral	High	Neutral	High	Low	High
Reliable Access to Intercity Hubs		High	Low	Low	Low	Low	High	High	Low	Neutral	Low

KEY: High; Medium; Low; Neutral; Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Roadway Congestion

Table 28 shows how each initiative performs compared to the 2040 CLRP on roadway congestion (as a qualitative measure) and on the quantitative MOEs that relate to roadway congestion.

"The region's roadways are among the most congested in the nation, making it harder for people and goods to reliably get where they need to go."

Table 28: Summary of Performance on Congestion and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Roadway Congestion Overall		Medium	Medium	Low	Low	Low	Medium	Low	High	Low	High
Daily Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
Travel Time (SOV): average travel time per trip	50.7	-2%	-4%	0%	-1%	-1%	-2%	-1%	-5%	0%	-4%
Travel Time (HOV): average travel time per trip	58.9	-5%	-4%	-1%	-1%	-1%	-1%	-1%	-6%	<1%	-6%
Jobs Accessible by Auto (45 minutes)	876,000	5%	8%	1%	1%	<1%	2%	1%	10%	<1%	10%
VMT daily	141.91 million	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-3%	-1%	-6%

KEY: High; Medium; Low; Neutral; Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

All initiatives provided some reductions in daily VHD, the traditional measure of roadway congestion, while also improving users' experience of delay on the system by reducing commute travel times and the number of jobs accessible by car within 45 minutes.

- **High Rating.** The policy-based initiatives, 8 and 10, reduced congestion the most with significant reductions in VHD, partially due to VMT reductions. Initiative 10 reduced VMT by reducing the number of commute trips and providing financial incentives to use non-SOV modes for commutes. Initiative 8, which optimized regional land-use balance and adds households to the region, reduces congestion by shortening trip distances.
- **Medium Rating.** The best infrastructure-based initiatives focus on relieving existing congestion in the system: in Initiative 1, by providing toll lanes where pricing manages congestion; in Initiative 2, by using technological improvements and targeted hot spot relief to improve capacity on major roads; and in Initiative 6, by relieving the current constraints on the Metrorail system, enabling more people to take transit. These initiatives all achieved significant reductions in VHD of an order of magnitude less than Initiatives 8 and 10.
- **Low Rating.** The other initiatives provided relatively small regional improvements to VHD and travel times. In some cases, specific corridors may see improvements even though the region as a whole does not see much reduction in delay. These initiatives may have better performance if paired with those with high or medium ratings.

- **Negative Rating.** No initiative performed worse than the CLRP on this challenge.

Future studies can explore options for measuring person hours of delay, which is a best practice in measuring congestion, as well as comparative assessments of impacts along specific corridors.

Transit Crowding

The research team is providing a qualitative assessment of how each initiative would perform in terms of addressing the challenges of transit crowding relative to the CLRP because a quantitative MOE was not developed to address this factor given the time-frame of this study. The study team examined analysis results related to transit ridership, particularly on Metrorail, as a basis for the assessment.

"The transit system currently experiences crowding during peak hours and lacks the capacity to support future population and job growth without reducing ridership."

Table 29: Summary of Performance on Transit Crowding

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Transit Crowding		○	○	○	○	○	◉	●	●	●	◒

KEY: ◉ High ◒ Medium ◒ Low ○ Neutral ● Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

These assessments depend upon the assumption that existing transit infrastructure is in a state of good repair. Inadequate maintenance of transit assets may first increase transit crowding as fewer vehicles are available for use by transit riders, but then it will reduce crowding as the transit system loses ridership to more reliable modes of transportation.

- **High Rating.** I6 (Metrorail Core Capacity Improvement) is the only initiative that significantly targets transit crowding, if only for the rail system, by addressing severe crowding forecast at stations in the core of the region.
- **Medium Rating.** I10 (Employer-based Travel Demand Management) is anticipated to reduce crowding significantly due to an overall reduction in transit ridership for work purposes due to increased telework. These reductions in crowding result from a reduction in the overall number of transit trips rather than through service improvements.
- **Neutral Rating.** I4 (Transitways) and I5 (Commuter Rail) would see increases in overall transit ridership (possibly increasing crowding), but those riders would largely be using new services that supplement existing, crowded routes (possibly relieving crowding). Initiatives 1-3 neither relieve existing crowding nor create enough new ridership to worsen crowding.
- **Negative Rating.** Transit crowding will likely worsen in initiatives that add additional transit riders without providing capacity expansion in the core, as in initiatives 7, 8, and 9.

Future studies can explore:

- Combining initiatives that provide Initiative 6's core capacity expansions with the initiatives that add transit ridership from outside the core; and
- Developing a quantitative measure of rail transit crowding, which the research team considered but could not sufficiently develop and test under the current study's compressed timeframe.

Inadequate Bus Service

Table 30 shows how each initiative performs compared to the 2040 CLRP in addressing the challenge of inadequate bus service (as described in the definition at right) and on related quantitative MOEs.

"Existing bus service is too limited in its capacity, coverage, frequency, and reliability, making transit a less viable option, especially for people with disabilities and limited incomes."

Table 30: Summary of Performance on Inadequate Bus Service and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Inadequate Bus Service		Medium	Neutral	Neutral	High	Neutral	Neutral	Low	Neutral	Neutral	Neutral
Daily Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
Travel Time (Transit)	53.9	-1%	-2%	- <1%	-1%	<1%	-6%	- <1%	-5%	1%	<1%
Jobs Accessible by Transit	523,000	2%	2%	- <1%	4%	1%	19%	10%	10%	0%	0%
Mode Share: Transit	24.60%	1%	-4%	- <1%	4%	2%	11%	5%	<1%	2%	6%*
Share of Households in Zones with High-Capacity Transit	39.90%	0%	0%	- <1%	25%	<1%	<1%	17%	9%	0%	0%
Share of Jobs in Zones with High-Capacity Transit	57.70%	0%	0%	- <1%	15%	<1%	0%	13%	2%	0%	0%

KEY: High, Medium, Low, Neutral, Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

The above assessments assume that transit and roadway infrastructure is in a state of good repair; inadequate maintenance will worsen bus service reliability and travel times.

- **High Rating.** Initiative 4 (Transitways) makes significant progress on improving all aspects of this challenge: capacity, coverage, frequency, and reliability of bus service. It increases the number of households and jobs within high-capacity transit zones by 25% and 15%, respectively, which is the most of any initiative and is solely due to improvements in bus service coverage. It also shows improvements in transit mode share, jobs accessible by transit, transit travel times, and daily VHD. Although these improvements may seem modest when compared to other initiatives, remember that these measures also include transit and roadway users, which this initiative did not target; the percentage improvements for bus riders, if measured in isolation, would be much larger.

- **Medium Rating**. Initiative 1 also improves the adequacy of bus service, but not as much as Initiative 4. Initiative 1 involves significant expansion of express bus services within the region using the Express Travel Network, and many of these new express bus services would connect Activity Centers along the Beltway and other major corridors where there is currently limited or no direct transit connections. The Express Travel Network also supports bus service reliability through the use of managed lanes, and improves the number of jobs accessible within a 45-minute transit commute. The analysis assumed frequent express bus service on the express lane network with 10-minute headways in peak periods and 20-minute headways in off-peak, resulting in an increase in bus trips.
- **Low Rating.** Initiative 7 (Transit Rail Extensions) is anticipated to indirectly result in improvements in the adequacy of bus service because it significantly increases the share of households in areas with high-capacity transit. Many of these high-capacity transit zones serve as bus collectors and stops, letting bus riders access a broader transit system – and the housing and jobs near those high-capacity transit stops.
- **Neutral Rating.** Although Initiatives 2 and 3 would offer improvements to bus reliability (from Initiative 2's operational improvements) or service coverage (through Initiative 3's new service), these benefits do not seem to improve the viability of the bus system -- the analysis results showed a small decline in bus ridership under both initiatives.
- **Negative Rating.** No initiatives performed negatively on this challenge because no initiatives reduced bus service.

Future studies can explore whether it is worthwhile to subdivide the transit MOEs into measures for the different kinds of transit, such as bus and Metrorail.

Access to Bike/Ped Options (Unsafe Walking and Biking)

Table 31 shows how each initiative performs compared to the 2040 CLRP in addressing the challenge of improving access to bicycle and pedestrian options (as defined at right) and related quantitative MOEs.

"Too few people have access to safe pedestrian and bicycle infrastructure or live in areas where walking and bicycling are not practical options for reaching nearby destinations."

Table 31: Summary of Performance on Access to Bike/Ped Options and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Access to Bike/Ped Options (Unsafe Walking and Biking)		Neutral	Neutral	Neutral	Medium	Low	Medium	Medium	High	Neutral	Neutral
Mode Share: Transit	24.60%	1%	-4%	- <1%	4%	2%	11%	5%	<1%	2%	6%*
Mode Share: Non-Motorized	5.60%	0%	0%	0%	<1%	<1%	<1%	<1%	29%	0%	16%*
Share of Households in Zones with High-Capacity Transit	39.90%	0%	0%	- <1%	25%	<1%	<1%	17%	9%	0%	0%
Share of Jobs in Zones with High-Capacity Transit	57.70%	0%	0%	- <1%	15%	<1%	0%	13%	2%	0%	0%

KEY: High · Medium · Low · Neutral · Negative

* Mode shares reflect trips taken. Due to telework, actual number of transit trips declines; bicycle/pedestrian stays flat; HOV increases slightly.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

- **High Rating.** Initiative 8 (Optimize Regional Land-Use Balance) does the most to increase bicycle mode share – an increase of 29% -- and deliberately moved households and jobs into Activity Centers, which means that more destinations would be close enough to reach by walking and bicycling.
- **Medium Rating.** Initiatives 4, 6, and 7 would likely increase access to bicycle and walking options more than Initiative 5 but less than Initiative 8. All three would increase transit mode share (primarily accessed by walking), especially in Initiative 6. Initiatives 4 and 7 did not produce as large an increase in transit mode share as Initiative 6, but the shares of households and jobs occurring in high-capacity transit zones increased significantly, which creates new opportunities for walking and bicycling. These initiatives also improved bicycle and pedestrian access to stations.

- **Low Rating.** Initiative 5 (Commuter Rail) would produce some improvements for bicycling and walking access because it increased bicycle and pedestrian access to stations and led to a slight increase in transit mode share, but these changes were less significant than those seen in the higher-rated initiatives.
- **Neutral Rating.** The remaining initiatives (1, 2, 3, 9, and 10) are not expected to result in noticeable changes in bicycle and pedestrian access. Although Initiative 10 increases the transit and non-motorized mode shares, it is through reductions in travel on other modes rather than increases in transit and non-motorized trips, which actually decrease under that initiative.
- **Negative Rating.** No initiatives performed worse than the CLRP on this challenge.

Development Around Metrorail

Table 32 shows how each initiative performs compared to the 2040 CLRP on "development around Metrorail" as described in TPB's definition of the challenge (at right) and on related quantitative MOEs.

"Too many Metrorail stations, especially on the eastern side of the region, are surrounded by undeveloped or underdeveloped land, limiting the number of people who can live or work close to transit and leaving unused capacity in reverse-commute directions on several lines."

Table 32: Summary of Performance on Development Around Metrorail and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Development Around Metrorail		○	○	○	◒	○	◒	●	●	○	○
Jobs Accessibility by Transit	523,000	2%	2%	- <1%	4%	1%	19%	10%	10%	0%	0%
Share of Households in Zones with High-Capacity Transit	39.90%	0%	0%	- <1%	25%	<1%	<1%	17%	9%	0%	0%
Share of Jobs in Zones with High-Capacity Transit	57.70%	0%	0%	- <1%	15%	<1%	0%	13%	2%	0%	0%

KEY: ● High ◒ Medium ◒ Low ○ Neutral ● Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

These assessments largely rely on the assumption that Metro is in a state of good repair; if not, interest in developing around Metrorail may decline.

- **High Rating.** Of the initiatives that significantly increase households and jobs in high-capacity transit zones, Initiatives 7 (Transit Rail Extensions) and 8 (Optimize Regional Land-Use Balance) do so by concentrating development around Metro stations. Initiative 8 particularly focuses on adding development at underdeveloped Metro stations.
- **Medium Rating.** Initiative 4 (Transitways) shows the greatest increase in the share of households and jobs in high-capacity transit zones, but a significant portion of that development is occurring at the transitway stations, not at Metrorail, which is why it is not as "high" as Initiatives 7 and 8. It scored higher than low, though, because many of the transitway stations in Initiative 4 are also Metrorail stations.
- **Low Rating.** Initiative 6's Metrorail Core Capacity Improvements significantly increase the number of jobs accessible in a 45-minute transit commute. Although this initiative did not change land-use assumptions, its dramatic improvements in jobs accessibility would likely increase demand for development adjacent to other Metrorail stations in the system, but it did not actually increase development around Metrorail stations under the assumptions used for this study.

- **Neutral Rating.** The other initiatives are neutral because they neither target development to Metrorail stations nor make much change in the number of jobs accessible by transit.
- **Negative Rating.** No initiatives reduce development around Metrorail.

Housing and Job Location

Table 33 shows how each initiative performs compared to the 2040 CLRP in addressing the challenge of "housing and job location" as described in TPB's definition of the challenge (above) and on related quantitative MOEs.

"Most housing, especially affordable housing, and many of the region's jobs are located in areas outside of Activity Centers where transit, bicycling, and walking are not safe and viable options."

Table 33: Summary of Performance on Housing and Job Location and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Housing and Job Location		○	○	○	◒	○	○	◒	◉	○	○
Travel Time (SOV)	50.7	-2%	-4%	0%	-1%	-1%	-2%	-1%	-5%	0%	-4%
Travel Time (transit)	53.9	-1%	-2%	- <1%	-1%	<1%	-6%	- <1%	-5%	1%	<1%
Jobs Accessibility by Transit	523,000	2%	2%	- <1%	4%	1%	19%	10%	10%	0%	0%
Jobs Accessibility by Auto	876,000	5%	8%	1%	1%	<1%	2%	1%	10%	<1%	10%
VMT daily	141.91 million	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-3%	-1%	-6%
VMT daily per capita	21.17	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-6%	-1%	-6%
Share of Households in Zones with High-Capacity Transit	39.90%	0%	0%	- <1%	25%	<1%	<1%	17%	9%	0%	0%
Share of Jobs in Zones with High-Capacity Transit	57.70%	0%	0%	- <1%	15%	<1%	0%	13%	2%	0%	0%

KEY: ◉ **High** ◒ **Medium** ◒ **Low** ○ **Neutral** ● **Negative**

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

- **High Rating.** Initiative 8 (Optimize Regional Land-Use Balance) specifically focuses on addressing this challenge by moving housing and jobs into Activity Centers and balancing the jobs-housing ratio across the region so that households are closer to jobs. Several MOEs reflect Initiative 8's shortened distances between housing and jobs: reductions in travel

times for all modes; increases in the number of jobs accessible within a 45-minute commute (by car and by transit); and VMT reductions.

- **Medium Rating.** Initiatives 4 (Transitways) and 7 (Transit Rail Extensions) add a significant number of new high-capacity transit options and increase development intensity around these new transit stations, resulting in dramatic increases in the share of households and jobs in zones that have high-capacity transit. Both initiatives increase the number of jobs accessible by transit. While these initiatives made significant improvements, they were less significant than Initiative 8's.
- **Neutral Rating.** The other initiatives (1, 2, 3, 5, 6, 9, and 10) did not have any notable effect on this challenge.
- **Negative Rating.** No initiatives performed worse than the CLRP.

Metrorail Repair Needs

Table 34 shows how each initiative performs compared to the 2040 CLRP on "Metrorail repair needs" based on a qualitative assessment.

"Deferred Metrorail maintenance over the years has led to unreliability, delays, and safety concerns today, as well as higher maintenance costs."

Table 34: Summary of Performance on Metrorail Repair Needs

Challenge and Related MOEs	BASE: 2040 CLRP	I1: Express Travel Network	I2: Operational Improvements & Hotspot Relief	I3: Add'l Northern Bridge	I4: BRT and Transitways	I5: Commuter Rail	I6: Metrorail Core Capacity	I7: Transit Rail Extensions	I8: Optimize Regional Land-Use Balance	I9: Transit Fare Policy Changes	I10: Travel Demand Management
Metrorail Repair Needs		○	○	○	○	○	●	●	○	○	○

KEY: ◉ High ◒ Medium ◒ Low ○ Neutral ● Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

This study assumed that existing transit infrastructure is in a state of good repair. Adding new Metrorail infrastructure therefore increases Metrorail repair needs by increasing the required maintenance for that new infrastructure, leading to negative ratings for Initiative 6's new downtown line and Initiative 7's extensions of Metrorail.

Roadway Repair Needs

Table 35 shows how each initiative performs compared to the 2040 CLRP on "roadway repair needs" based on a qualitative assessment.

"Older bridges and roads are deteriorating and in need of major rehabilitation to ensure safe, reliable, and comfortable travel for cars, trucks, and buses."

Table 35: Summary of Performance on Roadway Repair Needs

Challenge and Related MOEs	BASE: 2040 CLRP	I1: Express Travel Network	I2: Operational Improvements & Hotspot Relief	I3: Add'l Northern Bridge	I4: BRT and Transitways	I5: Commuter Rail	I6: Metrorail Core Capacity	I7: Transit Rail Extensions	I8: Optimize Regional Land-Use Balance	I9: Transit Fare Policy Changes	I10: Travel Demand Management
Roadway Repair Needs		●	●	●	○	○	○	○	○	○	○

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

The analysis assumed that existing road and bridge infrastructure is in a state of good repair; therefore, adding new infrastructure increases maintenance needs rather than bringing the system into a state of good repair. Tolls collected under Initiatives 1 and 3 may help offset these new maintenance costs or lead to private sector interest in taking on the maintenance needs, but these initiatives would still be adding to roadway repair needs.

Incidents and Safety

Table 36 shows how each initiative performs compared to the 2040 CLRP on "incidents and safety" as described in TPB's definition of the challenge and on related quantitative MOEs.

"Major accidents and weather disruptions on roadways and transit systems cause severe delays and inconvenience. Reducing injuries and fatalities for all users of the transportation system must be prioritized, with particular focus on protecting vulnerable users."

Table 36: Summary of Performance on Incidents and Safety and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Incidents and Safety											
Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
Travel on Reliable Modes*	11.50%	42%	-5%	-2%	6%	2%	9%	6%	0%	3%	-3%
VMT Daily	141.91 million	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-3%	-1%	-6%

KEY: High · Medium · Low · Neutral · Negative

**Travel on reliable modes reflects the percentage of passenger miles on express lanes, Metrorail, bus rapid transit, commuter rail, walking, and biking; it does not reflect improvements in reliability due to reduced traffic congestion or programs that affect non-recurring delay, such as improved incident management.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

The research team interpreted this challenge as reflecting a desire to reduce the number of crashes (which is most correlated with VMT) and to improve the resilience of the system when incidents occur (which is related to VHD and the share of travel occurring on reliable modes).

- **High Rating.** Initiative 10 (Employer-based Travel Demand Management) yields the most significant reduction in VMT, which is the largest variable correlating with number of crashes. It also dramatically decreases VHD, meaning that the system has room to absorb some delay from nonrecurring incidents, such as crashes or weather disruptions.
- **Medium Rating.** Initiative 8 (Optimize Regional Land-Use Balance) also results in a measurable decline in VMT, which suggests a likely reduction in crashes, and a significant reduction in VHD, which would make the system more resilient when disruptions occur. While high relative to most initiatives, these benefits were an order of magnitude less than in Initiative 10.
- **Low Rating.** Initiative 1 (Express Travel Network) may slightly increase VMT, which may increase the number of incidents, but it offers significant improvements in reliable travel and VHD, which increase the system's resilience to disruptions. Initiative 2 (Operational Improvements and Hotspot Relief) is the most likely to increase VMT, which may increase the

number of crashes, but this initiative assumes improvements in incident management will reduce their disruptions to the system.

- **Negative Rating.** All the initiatives should have some positive influence on at least one of the components of the challenge.

Pedestrian and Bicyclist Safety

Table 37 shows how each initiative performs compared to the 2040 CLRP on "pedestrian and bicyclist safety" as described in TPB's definition of the challenge (above) and on related quantitative MOEs.

"The number of bicycle and pedestrian fatalities each year is holding steady even as the number of vehicle fatalities has declined steadily."

Table 37: Summary of Performance on Pedestrian and Bicyclist Safety and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Pedestrian and Bicyclist Safety		Neutral	Negative	Neutral	Neutral	Low	Low	Low	Low	Neutral	Low
Mode Share: Non-Motorized	5.60%	0%	0%	0%	<1%	<1%	<1%	<1%	29%	0%	16%*
VMT Daily	141.91 million	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-3%	-1%	-6%

KEY: High; Medium; Low; Neutral; Negative

* Mode share reflect trips taken. Share increases due to telework, but actual bicycle/pedestrian activity stays flat.
Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

Much of the safety risk to pedestrian and bicyclists relates to the design of roadways, which this study did not examine, but the research team can provide some general statements:

- **High/Medium Rating.** No initiative scored high on this challenge because actual safety of these vulnerable roadways users will depend on various factors including engineering/design, education, and enforcement of laws.
- **Low Rating.**
  - Initiatives 5, 6, and 7 improve pedestrian and bicycle access to transit stations and slightly reduce VMT and the related risk of vehicular crashes.
  - Although Initiatives 8 and 10 reduced VMT and, thus, the risk of vehicular crashes, they also increased significantly the nonmotorized mode share, which may increase exposure. While existing studies on pedestrian and bicyclist safety show safety improvements if nonmotorized use reaches high levels, crash risk increases until mode share reaches much higher levels than predicted under these initiatives.
- **Neutral Rating.** Initiative 1 and 3 are not expected to improve pedestrian and bicyclist safety; the study did not assume that they would increase bike/ped infrastructure. Initiative 4 (Transitways) improves bicycle and pedestrian access to stations, but potential benefits from those access improvements may be negated by the ongoing challenges of designing roadways that are safe for shared use of nonmotorized users and transitway vehicles.
- **Negative Rating.** Initiative 2 yields an increase in VMT and may include components that create additional risks to pedestrians and bicyclists, such as reversible lanes if roadway medians are removed.

Environmental Quality

Table 38 shows how each initiative performs compared to the 2040 CLRP on "environmental quality" as described in TPB's definition of the challenge (to the right) and on the related quantitative MOEs.

"Increasing amounts of vehicle travel resulting from population and job growth could threaten the quality of our region's air and water."

Table 38: Summary of Performance on Environmental Quality and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Environmental Quality		○	◒	●	○	○	◒	◒	◓	◒	◉
Daily Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
VMT daily	141.91 million	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-3%	-1%	-6%
VMT daily per capita	21.17	<1%	2%	1%	- <1%	- <1%	-1%	-1%	-6%	-1%	-6%
VOC Emissions	17.2	0%	-3%	1%	-1%	0%	-2%	-1%	-4%	-1%	-8%
NOx Emissions	17.0	0%	0%	1%	0%	0%	-2%	-1%	-4%	-1%	-7%
CO2 Emissions	47,082.3	0%	-1%	1%	-1%	0%	-2%	-1%	-4%	-1%	-7%

KEY: ◉ High ◓ Medium ◒ Low ○ Neutral ● Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

- **High Rating.** Employer-based TDM provides significant reductions in VHD, VMT, and emissions. As a policy-based initiative, it also has no new infrastructure adding impervious surface in the watershed.
- **Medium Rating.** Initiative 8 (Optimize Regional Land-Use Balance) also produces significant reductions in VHD, VMT, and emissions. Initiative 8 even produces these savings with an approximately 130,000 increase in households; it reduces VMT per capita by about 6 percent. As with Initiative 10, Initiative 8 would not require new impervious surface and encourage denser development, which benefit the region's water quality.
- **Low Rating.** Initiative 2 (Operational Improvements and Hotspot Relief) increases VMT but still is anticipated to reduce emissions due to reductions in non-recurring delay and smoother traffic flow, based on research studies on the benefits of the operational and technological strategies applied in that initiative. Initiatives 6, 7, and 9 all reduce VHD, VMT, and emissions but to a lower degree than Initiatives 8 and 10.
- **Neutral Rating**. Initiatives 4 and 5 produced minor improvements in the quantitative MOEs, but these benefits may be offset by minor increases in impervious surface. Initiative 1 improved VHD but increased VMT somewhat; research on the benefits of adding an express lane network does not point to a reduction in emissions, in contrast to Initiative 2.

- **Negative Rating.** Initiative 3 increases VMT and potentially emissions as well. It also would require significant amounts of new impervious surface (bridge and roadway expansions) and disruption of the riverine environment to construct the bridge and new highway corridor, even if controls are in place to prevent development in Montgomery County's Agricultural Reserve.

Open Space Development

Table 39 shows how each initiative performs compared to the 2040 CLRP on the challenge of "open space development" as described in TPB's definition of the challenge (to the right). None of the quantitative MOEs relate to this challenge.

"Wildlife habitat, farmland, and other open spaces are threatened by construction of new transportation facilities and residential and commercial development."

Table 39: Summary of Performance on Open Space Development

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Open Space Development		○	○	●	○	○	○	○	◒	○	○

KEY: ◉ High ◒ Medium ◒ Low ○ Neutral ● Negative

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

This qualitative assessment examined (a) whether or not additional right-of-way was needed and (b) whether the new right-of-way needed was for high-capacity transit or new roadway building; if the new right-of-way was for high-capacity transit, the right-of-way's impact on open space may be offset by the transit initiatives' concentration of development around transit stations (rather than in open space).

- **Medium Rating.** Initiative 8 focuses development in Activity Centers and in areas with premium transit; this reduces the demand for open space development and does not require additional right-of-way.
- **Neutral Rating.** Initiatives 9 and 10 are not likely to affect open space development. Initiatives 4-7 have indeterminate effects. They may require some right-of-way and encourage some households to reside farther out due to reductions in commute travel times, but they also concentrate development at the transit services rather than in open space. Initiatives 1 and 2 may have negligible effect on open space development.
- **Negative Rating.** Initiative 3 (Additional Northern Bridge Crossing/Corridor) would require significant new right-of-way, and it would likely also induce some development to occur in areas outside of Activity Centers, even if controls are in place to prevent development in Montgomery County's Agricultural Reserve. The analysis did not assess a particular alignment.

Bottlenecks

Table 40 shows how each initiative performs compared to the 2040 CLRP on "bottlenecks" overall as described in TPB's definition of the challenge (to the right) and on related quantitative MOEs.

"Bottlenecks on the highway and rail systems cause delays in interregional travel for both freight and passengers, hurting the region's economic competitiveness."

Table 40: Summary of Performance on Bottlenecks and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Bottlenecks											
Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
Travel on Reliable Modes*	11.50%	42%	-5%	-2%	6%	2%	9%	6%	0%	3%	-3%

KEY: High; Medium; Low; Neutral; Negative

*Travel on reliable modes reflects the percentage of passenger miles on express lanes, Metrorail, bus rapid transit, commuter rail, walking, and biking; it does not reflect improvements in reliability due to reduced traffic congestion or programs that affect non-recurring delay, such as improved incident management.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

These assessments rely on the assumption that existing road and transit infrastructure is in a state of good repair. Inadequate maintenance of these assets will worsen bottlenecks and may create new ones as the system declines. The challenge seeks to address bottlenecks on both roadways and rail; an initiative had to alleviate bottlenecks on both to achieve a high score; those with lesser overall reductions or that only alleviate bottlenecks to one system scored as medium or low.

- **High Rating.** Initiative 10 (Employer-based Travel Demand Management) is the only initiative that significantly relieves bottlenecks on both the highway and rail systems, which is why it is rated high. Initiative 10 achieves this relief due to a significant reduction in commute trips for auto and transit users. The roadway traffic reduction is exemplified by the estimated 24% reduction in VHD.
- **Medium Rating.**
  - Initiative 6 (Metrorail Core Capacity Improvement) would significantly relieve bottlenecks on the rail system's core while also reducing VHD on the highway system, but neither improvement is as significant as those seen by Initiative 10.
  - Initiatives 1, 2, and 8 would significantly relieve bottlenecks on the highway system but less so on the rail system. Initiative 1 (Express Travel Network) reduces VHD while also significantly increasing the share of passenger miles using reliable modes, as the dynamic tolling on the express lane network reduces the risk of highway

bottlenecks and adds capacity to some of the most significant roadway bottlenecks in the system, including the American Legion Bridge (#1 existing roadway bottleneck), I-95/I-495 in Maryland, other points along I-495, I-270 spur, and DC-295.[28]. Initiative 2 (Operational Improvements and Hot Spot Relief) also reduces VHD, and several of its components specifically focus on congestion hotspots on the highway system. Initiative 8 (Optimize Regional Land-Use Balance) produces significant VHD reductions, and helps reduce the peak flows from households to jobs, which also should relieve highway bottlenecks.

- **Low Rating**. Initiative 3 (Additional Northern Bridge Crossing/Corridor) provides some VHD reduction, but some roadways at the ends of the new highway corridor (VA-28 and MD-200 and vicinity) may see an increase in traffic congestion as users access the new corridor. Initiative 9 (Transit Fare Policy Changes) provides a minor reduction in VHD while also slightly increasing the share of passenger miles on reliable modes; any benefits to rail bottlenecks would also be low because the benefits of reducing fares in the off-peak direction may be somewhat offset by the free fares for low-income riders.
- **Neutral Rating.** Three initiatives scored as neutral because they may have effects that push in both directions on the challenge, and it is not determinable whether they would lead to a slight positive or negative impact. Initiative 4 and 5, like Initiative 9, provide minor reductions in VHD while increasing travel on reliable modes, but, unlike Initiative 9, they also would aggravate rail bottlenecks by adding new riders to the core without expanding core capacity. Initiative 7 (Transit Rail Extensions) has some positive effect on highway bottlenecks from VHD reductions, but it would likely worsen rail bottlenecks by adding additional riders to the core without accompanying increases in capacity.
- **Negative Rating.** None of the initiatives are expected to result in increased bottlenecks.

[28] For a list of the region's most significant highway bottlenecks, see the TPB's 2016 Congestion Management Process (CMP) Technical Report, available at: http://www1.mwcog.org/clrp/elements/cmp/.

Reliable Access to Intercity Hubs (Travel Time Reliability)

Table 41 shows how each initiative performs compared to the 2040 CLRP on "bottlenecks" as described in TPB's definition of the challenge and on related quantitative MOEs.

"Travel times to and from the region's airports and Union Station are becoming less reliable for people and goods movement."

Table 41: Summary of Performance on Reliable Access to Intercity Hubs and Related MOEs

Challenge and Related MOEs	BASE 2040 CLRP	I1 Express Travel Network	I2 Operational Improvements & Hotspot Relief	I3 Add'l Northern Bridge	I4 BRT and Transitways	I5 Commuter Rail	I6 Metrorail Core Capacity	I7 Transit Rail Extensions	I8 Optimize Regional Land-Use Balance	I9 Transit Fare Policy Changes	I10 Travel Demand Management
Travel Time Reliability		High	Low	Low	Low	Low	Medium	Medium	Low	Neutral	Low
Average Best Travel Time to Intercity Hubs	81 minutes	-2%	-3%	-2%	0%	-1%	-2%	-2%	-3%	0%	-3%
Vehicle Hours of Delay	1.85 million	-11%	-8%	-3%	-2%	-2%	-9%	-3%	-18%	-2%	-24%
Travel on Reliable Modes*	11.50%	42%	-5%	-2%	6%	2%	9%	6%	0%	3%	-3%
Share of Households in Zones with High-Capacity Transit	39.90%	0%	0%	- <1%	25%	<1%	<1%	17%	9%	0%	0%
Share of Jobs in Zones with High-Capacity Transit	57.70%	0%	0%	- <1%	15%	<1%	0%	13%	2%	0%	0%

KEY: High; Medium; Low; Neutral; Negative

*Travel on reliable modes reflects the percentage of passenger miles on express lanes, Metrorail, bus rapid transit, commuter rail, walking, and biking; it does not reflect improvements in reliability due to reduced traffic congestion or programs that affect non-recurring delay, such as improved incident management.

Source: Analyses performed by COG, ICF, Sabra Wang (SWA), Fehr & Peers (F&P), and Shapiro Transportation Consulting (STC).

In addition to the MOEs used for other challenges, the study team created a formula to calculate the average best travel times to four intercity hubs: Union Station, Ronald Reagan National Airport, Dulles International Airport, and Baltimore-Washington International Thurgood Marshall Airport. The table above shows how each initiative improves upon that travel time from the CLRP's performance. See Appendix B for more information on this measure. Feedback received from the task force indicated that this measure may not be very meaningful given that it averages travel times across four different locations from throughout the region and generally shows relatively small changes, which is why it is not used in most of the report. Future studies could develop more detailed measures of performance addressing each individual hub on this challenge.

The research team considered how each initiative affects travel times and reliability to the four major hubs for interregional travel: Union Station and the three major airports: DCA, IAD, and BWI.

- **High Rating.** Initiative 1 (Express Travel Network) increases the availability and use of reliable modes of travel, driving up the percentage of passenger miles on reliable modes by 42%. Under this initiative, travelers would have the option to pay a toll to use the express lanes to have a fast, reliable trip, and this express travel network would provide direct access to all three airports. It also significantly reduces VHD, another indicator of the level of reliability on the network, and it provides some reduction in the average best travel times to the regional hubs.
- **Medium Rating.** Initiatives 6 and 7 scored as "medium." Initiative 6 scored medium because it is the second best initiative at increasing travel on reliable modes, and it reduces VHD and the average travel times to the hubs. By relieving the major transit bottlenecks on access routes to Union Station, Reagan National Airport, and Dulles International Airport, it should also improve reliability on transit access. Initiative 7 (Transit Rail Extensions) increases travel on reliable modes while reducing VHD and travel times to the hubs. It also significantly increases the share of households and jobs having access to high-capacity transit, which offer more reliable options for reaching the hubs.
- **Low Rating.** Initiatives 2, 3, 4, 5, 8, and 10 all provide some improvements to reliable access but of an order of magnitude less than those rated as medium. Initiative 2 (Operational Improvements and Hotspot Relief) reduces VHD, reduces travel times to the hubs, and adds demand-responsive services for persons with disabilities and others with limited mobility, but these improvements were somewhat offset by its reduction in the share of travel occurring on reliable modes. Initiative 3 (Additional Northern Bridge Crossing) provide small VHD reductions and improves travel time to hubs while providing a more direct road option for parts of the region in reaching Dulles International Airport and BWI. Initiative 4 (Transitways) slightly reduces VHD, improves travel on reliable modes, and provides a large increase in the number of households and jobs with having good transit options for reaching the hubs. Initiative 5 (Regional Commuter Rail Enhancements) provides modest improvements on travel times to hubs, VHD, and travel on reliable modes, and it provides new, reliable service throughout the day for reaching BWI Airport and Union Station via commuter rail. Initiative 8 (Optimize Regional Land-Use Balance) significantly reduces VHD, reduces travel times to the hubs, and provides some improvement on the numbers of households and jobs with high-capacity transit options for reaching the hubs. Initiative 10 (Amplified Employer-based TDM) provides significant reductions in VHD and reduced travel times to the hubs.
- **Neutral Rating.** Initiative 9 (Transit Fare Policy Changes) is not anticipated to affect travel times or reliability to the hubs or numbers of households or jobs with access to high-capacity transit options for reaching the hubs.
- **Negative Rating.** No initiatives performed worse on this challenge than the CLRP.

These results are dependent upon the assumption that WMATA, other transit, and all other existing transportation infrastructure are in a state of good repair. Inadequate maintenance of these assets will significantly worsen travel time reliability.

OTHER FACTORS TO CONSIDER

Other factors beyond those captured in the challenges and measures of effectiveness (MOEs) are important to consider when comparing the initiatives. Based on input from the task force, the following factors were identified as being potentially important considerations:

- Affordability and User Costs
- Costs of Implementation
- Equitable Distribution of Benefits
- Placemaking
- Right-of-Way and Community and Other Environmental Impacts
- Public Support and Implementation Feasibility

This section discusses each of the these factors, and a summary of assessments across each of these factors is shown below in Table 42.

Table 42: Summary of Ratings for Other Factors

OTHER FACTORS	BASE	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10
	2040 CLRP	Express Travel Network	Operational Improvements & Hot Spot Relief	Additional Northern Bridge	BRT and Transitways	Commuter Rail	Metrorail Core Capacity	Transit Rail Extensions	Regional Land-Use Balance	Transit Fare Policy Changes	Travel Demand Management
Affordability and User Costs	BASELINE	↑ / ↓	↓	↑ / ↓	↓	↓	–	↑ / ↓	↓	↓↓↓	↑ / ↓
Capital Costs of Implementation		$	$$	$$	$$	$$	$$$	$$$	$	$$	$
Equitable Distribution of Benefits		Mixed	Positive	Negative	None	None	None	None	Positive	Positive	Mixed
Placemaking		Neutral	Neutral	Neutral	Very Positive	Positive	Positive	Very Positive	Very Positive	Neutral	Positive
Right of Way, Community, & Environmental Impacts		Yes	Yes	Yes	Yes	Limited	Limited	Yes	No	No	No
Public Support & Implementation Feasibility		Not Assessed									

In addition, some other factors were identified for consideration by task force members, one of which is system resiliency (or network redundancy). This factor was not directly assessed but it is worth noting that several of the infrastructure initiatives create additional redundancy.

Affordability and User Costs

Some of the initiatives will reduce users' transportation costs (e.g., transit fare reductions) while others will increase some costs or create options (e.g., toll roads) that might be unaffordable for low- and moderate-income households. In addition, congestion relief and shifts to transit can reduce vehicle operating costs. While these costs are difficult to compare, Table 43 provides high-level indicators of user cost change relative to the baseline CLRP, and a brief explanation of those cost ratings.

Table 43: Affordability and User Costs

Initiative		Relative User Costs	Explanation of User Cost Ratings
I1	Express Travel Network	↑ / ↓	New express facilities require a toll to utilize for those with less than HOV3, with tolls that can be expensive. However, facilities are assumed to be free to HOV3+ and new express transit services could reduce out-of-pocket costs for travelers.
I2	Operational Improvements & Hotspot Relief	↓	Improvements in roadway operating conditions should yield some reduction in vehicle operating costs. .
I3	Additional Northern Bridge	↑ / ↓	New facility is assumed to be tolled, which will add direct out-of-pocket costs for those who use the facility. However, new express bus services can help commuters save money and improvements in operating conditions on the Beltway should reduce vehicle operating costs.
I4	BRT and Transitways	↓	No changes to existing transit fare structures are assumed. Improved transit/bike/ped options provide some opportunities to shift from driving to transit or nonmotorized travel at lower cost.
I5	Commuter Rail	↓	No changes to existing fare structures are assumed. Potential savings from new transit and bike/ped options.
I6	Metrorail Core Capacity	-	No expected changes to user costs and affordability.
I7	Transit Rail Extensions	↑ / ↓	Metrorail fares tend to be higher than existing bus services and may increase travel costs for some transit users. However, improved transit/bike/ped options provide opportunities to shift from driving to transit or nonmotorized travel at lower cost.
I8	Optimize Regional Land-Use Balance	↓	Moving trip destinations closer should yield reduction in vehicle operating costs and more opportunities for low-cost bike/ped options.
I9	Transit Fare Policy Changes	↓↓↓	Free rail for low-income residents. Reduced fares for Metrorail commuters using underutilized, reverse commute segments.
I10	Amplified Employer-Based Travel Demand Management	↑ / ↓	Increased parking costs will increase out-of-pocket costs for some commuters. However, these will generally be offset by savings from transit subsidies, significant trip reductions, and trip sharing.

Costs of Implementation

Given limited funding for maintenance/renewal of existing transportation infrastructure (both for transit and highways) and to pay for on-going system operations, the costs of implementing new initiatives is an important consideration for potentially advancing individual initiatives. While detailed cost estimates will depend on project details that are not available at this time, a high-level assessment of public sector costs for implementing the initiatives is below, accounting for both capital and operating costs to state and local governments. Table 44 presents a summary of the estimated relative public sector costs of these initiatives, as well as a brief explanation.

Table 44: Costs of Implementation

Initiative		Relative Costs to Implement	Explanation of Cost Ratings
I1	Express Travel Network	$	While total infrastructure costs would be high for new lane capacity, the private sector would largely cover the cost in exchange for toll revenue, with minimal public sector contribution (For instance, the I-66 express lane project outside the Beltway has the private developer responsible for all costs to develop, design, construct, maintain, and operate the project, as well as provide transit funding payments).
I2	Operational Improvements & Hotspot Relief	$$	Development of reversible lanes on major arterials, addition of integrated corridor management/active traffic management treatments, and targeted hot spot projects would likely be well over $1 billion across the region.
I3	Additional Northern Bridge	$$	New corridor is somewhat similar in length to the $2.57 billion Intercounty Connector (MD-200). Tolls/toll revenue bonds would cover a portion of the cost.
I4	BRT and Transitways	$$	BRT lines on dedicated lanes generally cost $4-$50 million per mile. This initiative envisions dozens of new BRT and transitway services across the region, plus additional operating costs.
I5	Commuter Rail	$$	New rail cars and station improvements will be required, plus additional operating costs.
I6	Metrorail Core Capacity	$$$	100% 8-car trains may cost $2.28 billion. A new core line, including new tunnel under the Potomac River would be several billion dollars. Costs per mile would be high in the urban core (for comparison, Second Avenue Subway in New York cost was $2.1 billion per mile).
I7	Transit Rail Extensions	$$$	Metrorail extensions may be comparable to the Silver line cost of about $250 million per mile, resulting in a total cost of several billion to build all extensions, plus additional operating costs. Light rail costs are extensive as well (For instance, existing purple line cost is about $2.65 billion for the 16-mile route; state will pay about $150 million/year for 30 years to cover debt service).
I8	Optimize Regional Land-Use Balance	$	This initiative focuses primarily on policies and potential incentives to encourage more development in optimal locations. New revenue potential occurs from taxes to discourage development in certain locations.
I9	Transit Fare Policy Changes	$$	Low cost to implement but significant loss of fare revenue, likely above $150 million/year
I10	Amplified Employer-Based Travel Demand Management	$	This initiative primarily involves policies, with limited direct public sector expenditures. Costs may include increased public sector incentives to businesses, while new revenue potential occurs from parking taxes or fees.

Key: **$ =** Limited to less than $1 billion; **$$ =** $1 billion to $5 billion; **$$$** = In excess of $5 billion

Equitable Distribution of Benefits

Only one initiative explicitly addresses the East-West divide, but some may appear to benefit one portion of the region over the other. Further, other initiatives may have their benefits felt especially in disadvantaged communities, or conversely, have benefits disproportionately to wealthier communities. Although the project team did not address this quantitatively, this may be a factor for some members to consider. Table 45 summarizes which initiatives will have positive effects on addressing the East-West divide and mitigating equity issues.

Table 45: Equitable Distribution of Benefits

Initiative		Impact to E/W Divide and Equity	Explanation of Rating
I1	Express Travel Network	Mixed	Transportation improvements appear equitably distributed. While express travel lanes with tolls may favor higher income and business travelers, combination with new express bus services supports equity. Needs additional analysis of distribution of benefits.
I2	Operational Improvements & Hotspot Relief	Positive	Demand responsive service for persons with disabilities improves access for disadvantaged populations. Need additional analysis of distribution of benefits.
I3	Additional Northern Bridge	Negative	Investment and benefits primarily accrue to western areas, particularly around the Beltway
I4	BRT and Transitways	None	Transportation improvements appear equitably distributed. Need additional analysis of distribution of benefits.
I5	Commuter Rail	None	Transportation improvements appear equitably distributed. Need additional analysis of distribution of benefits.
I6	Metrorail Core Capacity	None	Transportation improvements appear equitably distributed. Need additional analysis of distribution of benefits.
I7	Transit Rail Extensions	None	Transportation improvements appear equitably distributed. Need additional analysis of distribution of benefits.
I8	Optimize Regional Land-Use Balance	Positive	Designed to reduce East-West Divide by shifting jobs to areas with poor jobs-housing balance.
I9	Transit Fare Policy Changes	Positive	Favors low-income residents and reverse commuters.
I10	Amplified Employer-Based Travel Demand Management	Mixed	May favor higher-income residents due to higher ability to telework, carpool, and absorb higher parking costs. However, transit benefits and reduced subsidies for parking may favor lower-income residents. Need additional analysis of distribution of benefits.

Placemaking

In addition to effects on transportation system performance, the initiatives differ in terms of likely effectiveness in supporting transit-oriented development, mixed use development, and general placemaking. To assist with this consideration, the team identified whether each initiative is likely to have positive, neutral, or negative impacts.

Table 46: Placemaking

Initiative		Placemaking Impacts	Explanation of Rating
I1	Express Travel Network	Neutral	Potential for minor effect – Depending on design, express bus may support or detract from TOD in Activity Centers served.
I2	Operational Improvements & Hotspot Relief	Neutral	No clear relationship.
I3	Additional Northern Bridge	Neutral	Potential for minor effect – Depending on design, express bus may support or detract from TOD in Activity Centers served.
I4	BRT and Transitways	Very Positive	Potential for significant positive effect if designed to support TOD and private investment in corridor; also assumed increased land-use and bike/ped access at Activity Centers and stations.
I5	Commuter Rail	Positive	Minor positive effect from improvements to bike/ped access at stations. No new stations.
I6	Metrorail Core Capacity	Positive	Potential positive effect on TOD from improvements to bike/ped access, stations, and rail service.
I7	Transit Rail Extensions	Very Positive	Potential for significant positive effect if designed to support TOD; also assumed increased land-use in areas served.
I8	Optimize Regional Land-Use Balance	Very Positive	Potential for significant positive effect from increasing development around underdeveloped station areas and the east side.
I9	Transit Fare Policy Changes	Neutral	No clear relationship.
I10	Amplified Employer-Based Travel Demand Management	Positive	Potential for positive effect if parking fees are used to improve placemaking.

Right-of-Way and Community and Other Environmental Impacts

Due to the high-level nature of these initiatives – which do not define alignments – the project team was unable to estimate the right-of-way costs and potential threats to environmentally sensitive areas. However, some initiatives will require new right-of-way, which may cause displacements of homes or businesses, create community impacts (e.g., noise, barrier effects), or affect environmentally sensitive areas. These and other considerations would require further exploration in later stages for any selected Initiatives, since they can be important. To assist with their consideration, the project team identified whether each initiative will require new right of way (Table 47).

Table 47: Right-of-Way and Community and Other Environmental Impacts

Initiative		Right of Way Needed	Explanation of Rating
I1	Express Travel Network	Yes	Roadway widening will occur along major highways, with potentially significant property impacts, particularly along the Beltway and I-270.
I2	Operational Improvements & Hotspot Relief	Yes	Limited roadway widening at congestion hot spots and development of reversible lanes may require right of way.
I3	Additional Northern Bridge	Yes	New highway corridor will require significant new right-of-way and likely impacts to many properties along the estimated 14-mile route.
I4	BRT and Transitways	Yes	BRT lines and transitways will likely cause impacts to properties due to roadway widening needed for dedicated lanes.
I5	Commuter Rail	Limited	No new rail lines or stations would be built. However, new run-through service may require expansions/adjustments to stations that may have some limited effects.
I6	Metrorail Core Capacity	Limited	New rail line would be underground. Disruption would occur during construction but with limited new land required for transportation infrastructure.
I7	Transit Rail Extensions	Yes	Significant rail extensions will create impacts on properties and other community impacts, but are generally assumed to be within existing highway rights of way.
I8	Optimize Regional Land-Use Balance	No	No new land-use requirements for roadways or rail systems.
I9	Transit Fare Policy Changes	No	No new land-use requirements for roadways or rail systems.
I10	Amplified Employer-Based Travel Demand Management	No	No new land-use requirements for roadways or rail systems.

Public Support and Implementation Feasibility

Each of the TPB members represents different constituents with different priorities. The members may want to consider whether the projects will receive support or staunch opposition from any of the jurisdictions whose support would be necessary for implementation. They may also want to consider the likelihood of passing any required supporting legislation or policies.

CONCLUSION

The sketch analysis results provide significant information on the benefits of the ten different initiatives, along with associated costs. The results overall suggest that the National Capital Region would benefit from concerted efforts to advance strategies beyond what is currently planned in the CLRP. All of the initiatives provide some improvements in performance and in addressing regional challenges compared to the CLRP. Yet the magnitude and range of benefits varies across the initiatives and many initiatives also have a negative impact on at least one challenge. The costs of initiatives and other factors also vary by initiative.

The analysis reveals that non-infrastructure solutions, such as efforts focused on land-use and amplified transportation demand management (such as parking policies, telework, etc.) could make important contributions to addressing the region's challenges at relatively low cost. Within a growing region, transportation infrastructure initiatives, with supporting land-use and bicycle/pedestrian improvements, also demonstrated the ability to make a positive difference in addressing regional challenges across an array of important issues, including increasing travel options, improving mobility, and enhancing system reliability. Consequently, deciding which initiatives are most promising for the region is complicated and will require value judgements based on decision-makers' priorities.

Study Limitations

While this study should help to inform regional decision making, it is important to recognize that the analysis has limitations and leaves some important questions unanswered. The study timeframe required the research team to define and analyze ten regional initiatives across a range of challenges and performance measures in a short three-month period. Due to the compressed time-frame, the study could only perform high-level "sketch" analyses of the initiatives. This report notes several instances where additional studies could be conducted to improve understanding of the potential benefits to the region of the proposed initiatives and their components. Several task force members requested subregional results to understand how corridor-specific projects would benefit particular areas, but future studies would need to study these impacts at a finer level of detail than permitted in the current study. In addition, it is important to recognize several constraints:

- **Importance of Assumptions.** The results of this analysis are dependent upon assumptions used within the analysis, and alternative assumptions could yield different results. For instance, different assumptions about level of tolls, the locations of new transit services, and shifts in land-use development would have impacts on the results of several initiatives. In particular, the land-use and travel demand management outcomes envisioned in Initiatives 8 and 10 are influenced by an array of factors, including market forces.

- **Limited Ability to Assess Nonrecurring Delay.** Travel time reliability (the variability in travel times and ability to get to destinations at a set time) is a critical issue for travelers. It is estimated that nearly half of overall delay experienced by travelers nationally is associated with non-recurring events, such as adverse weather conditions, incidents, and work zones. However, the tools available to forecast improvements in reliability are very weak and this study was not able to truly assess changes in system reliability and impacts associated with nonrecurring delay. The region's travel demand model is designed to reflect average weekday conditions, and it is important to note that the quantitative measure used in this

study of "travel on reliable modes" does not assess changes in reliability associated with improvements in transportation system operations, congestion relief, or the development of alternative routes.

- **Lack of Assessment of Emerging Technologies.** This analysis is based on current models and tools that reflect understanding of travel behavior today. At the same time, we are heralding an era of potentially transformational technologies in relation to transportation, including autonomous and connected vehicles, shared mobility options, and new transportation modes (Hyperloop, Mag-lev, drones) – as well as demographic changes and technology changes -- that are likely to have substantial impacts on travel choices and demand in the future, which are not accounted for in this analysis. Some of these impacts are likely already occurring but not accounted for in the 2040 forecasts; for instance, the share of telework has increased dramatically over the past decade from about 6 to 10 percent of all workers teleworking on an average day. But tools used for the 2040 CLRP are calibrated based on existing travel behavior and do not account for future anticipated growth in telework or even the current levels of telework, let alone the effects of e-commerce, telemedicine, and other social and economic changes due to technology.

- **Limited Ability to Assess Sub-Regional and Distributional Effects.** While each of the initiatives was designed to be bold, many initiatives generally show a limited regional impact when viewed from the perspective of all travel in the region, which may look disappointing. However, the corridor-specific or more localized impacts may be quite important to people in parts of the region and have meaningful effects on people's lives. However, this study generally does not address these sub-regional and distributional effects. It is important to note that the initiatives differ somewhat in scope and scale. In particular, the impacts of the northern bridge crossing (I3) and commuter rail improvements (I5) are more generally "targeted" on a few key corridors, while several of the other initiatives are more "diffuse" in their impacts based on how they were defined. Even for the initiatives with relatively broad geographic coverage, such as rail extensions (I7), there will be geographically-focused effects, which are not captured in this analysis. Similarly, the impacts of initiatives on particular population groups, such as low-income populations, those in Equity Emphasis Areas, and people with disabilities, do not clearly show up in the regional figures and would require more detailed assessments, but may be particularly important in affecting the quality of life and opportunities for people.

Recommendations for Further Regional Cooperation

While the Long-Range Plan Task Force is charged with recommending a limited set of initiatives for endorsement by the Transportation Planning Board for further concerted regional action, and the results of this study provide important and valuable insights into the potential benefits of these initiatives, it will be important to keep in mind several issues.

RECOGNIZE THE CRITICAL ROLE OF STATE OF GOOD REPAIR

The task force recognized that maintaining the existing and planned transportation system in the region is of critical importance, given current funding shortfalls, particularly in relation to the Metrorail system. It is important to recognize that the results of this analysis assume that WMATA, other transit, and all other existing highway, bridge, and related infrastructure are operating in a

state of good repair. The levels of congestion, reliability, and other factors explored in the 2040 CLRP assume that all system assets are operating effectively, and state of good repair will affect the many indicators within this study.

CONSIDER THE POTENTIAL OF EMERGING TECHNOLOGIES

As noted above, the analysis did not explicitly account for changes in motor vehicle and transit technologies, such as connected and autonomous vehicles, new shared mobility options, and changes in travel patterns and roadways capacities associated with these technologies. Emerging technologies may have impacts on vehicle ownership and travel patterns that help to either support regional goals or might work against regional performance. In addition, technologies may affect the values placed on some issues. For instance, the advent of autonomous vehicles may alter the value placed on travel time, if time in vehicles may be more productive and may not be viewed as onerous, which in turn may increase the value of travel time reliability in comparison to total travel time. If future vehicle advancements include significant shifts to electric/clean vehicles, VMT may not be as negative from an environmental perspective. And there are many other potential implications that are not well understood.

Several regions around the country have begun to conduct scenario analysis to address the potential impacts of emerging transportation technologies, and the TPB may wish to explore similar analyses. Some regions, such as Atlanta and St. Louis, have also developed Emerging Transportation Technology Strategic Plans or policy documents to help the region focus on opportunities for advancing technologies that improve system performance, quality of life, and other regional goals. Moreover, investments in emerging technology could help to support economic development, job growth, and other regional benefits.

CONSIDER NEW PERFORMANCE MEASURES

The measures of effectiveness used in this study were limited based on the time-frame for the analysis and ability of sketch tools and models to calculate outputs. However, it would be useful to build on best practices from around the country in performance measurement, particularly in relation to developing and communicating performance of the transportation system in relation to the traffic congestion experience of travelers. Ideally traffic congestion would be measured from the perspective of the traveler rather than of the vehicle, and this study used a traditional measure of vehicle hours of delay (VHD). A person-based measure would be more effective at capturing the benefits of strategies that move more people in fewer vehicles such as bus rapid transit, transit signal priority, and HOV strategies. This study could not develop a measure of person hours of delay due to limitations with the sketch planning framework.

In addition, it would be useful to explore measures to better put the future levels of congestion in context. For instance, population in the region is forecast to grow by 24% from 2015 to 2040 (from about 5.4 million to 6.7 million residents). Consequently, a corresponding 24% increase in VHD in 2040 would equate to essentially the same amount of delay experienced *per person* in the region as in 2015. Using a per capita measure therefore may provide a useful benchmark for what it means to hold congestion steady rather than a total hours of delay measure in a growing region. The TPB could explore opportunities to continue to enhance how performance of the system is communicated.

EXPLORE THE COMBINED VALUE OF STRATEGIES

Given time constraints, this study was not able to explore the combined benefits of initiatives. However, further study of the interactions among initiatives and strategies would be very valuable. Some initiatives are very complementary to each other, while some if combined will have overlapping effects such that the results will not equal the sum of the individual initiatives.

CONDUCT MORE DETAILED ASSESSMENTS

Finally, given the conceptual nature of many of the initiatives, it would be valuable to conduct more in-depth study for many of these. Most of the initiatives encompass a number of individual projects (whether Express Travel facilities, hot spot relief projects, BRT and transitways, or transit rail extensions) as well as individual policies (such as transit fare policy changes, which analyzed a combination of both free transit fares for low-income riders and reduced price Metrorail in off-peak directions during peak periods). Different assumptions about toll rates and location for an additional northern bridge crossing also could have important impacts on results. Consequently, it would be valuable to explore specific alternatives as well to assess individual components of several initiatives in order to determine the most promising and cost-effective options or elements of each.

Moreover, it is valuable to recognize the wide and varied context and challenges within the region, from a low-income person challenged to access faraway jobs to a household facing an hour long commute in what otherwise might be short trip, each facing different transportation challenges related to access to jobs and impacts on quality of life. Identifying the mix of projects, programs, and policies to best meet the varied needs of this diverse and growing population, and identifying the most promising implementation mechanisms, will require further study.

Draft

APPENDIX A: TPB RESOLUTION R16-2017

[PREPARER'S NOTE: The adopted TPB Resolution R16-2017 will be included in the Final Technical Report.]

APPENDIX B: QUANTITATIVE MEASURES OF EFFECTIVENESS SELECTED

The study team, with input from the Long-Range Plan Task Force, selected measures of effectiveness (MOEs) to address the regional goals and challenges identified by the task force. While the selected MOEs reflect best practices from metropolitan areas around the country, they are limited based on the sketch planning framework of this analysis but represent the study team's best effort within the study constraints to provide quantitative assessments of the performance of each initiative across the challenges. The quantitative MOEs in some cases include multiple sub-measures, as follows:

- Average Travel Time per Trip
  - Single Occupant Vehicle (SOV)
  - High Occupancy Vehicle (HOV)
  - Transit
- Vehicle Hours of Delay
- Number of Jobs Accessible within 45 Commute
  - By Transit
  - By Auto
- Mode Share for Commuting
  - Single Occupant Vehicle (SOV)
  - High Occupancy Vehicle (HOV)
  - Transit
  - Non-Motorized
- Travel on Reliable Modes
- Vehicle Miles of Travel (VMT)
  - Daily VMT
  - Daily VMT per Capita
- Transit Options
  - Share of Households in High-Capacity Transit Zones
  - Share of Jobs in High-Capacity Transit Zones
- Motor Vehicle Emissions
  - Volatile Organic Compounds (VOCs)
  - Oxides of Nitrogen (NOx)
  - Carbon Dioxide (CO_2)

Table 48 below shows the relationship of each quantitative MOE to the 14 identified regional challenges.

Table 48: Relationship Matrix for Quantitative MOEs and Regional Challenges

Quantitative Measures of Effectiveness (MOEs)	Regional Challenges													
	Roadway Congestion	Transit Crowding	Inadequate Bus Service	Access to Bike/Ped Options	Development at Metrorail	Housing and Job Location	Metrorail Repair Needs	Roadway Repair Needs	Incidents and Safety	Ped and Bike Safety	Environmental Quality	Open Space Development	Bottlenecks	Travel Reliability to Airports
Travel Time: average travel time per trip for each mode	✓		✓			✓							✓	✓
Vehicle Hours of Delay	✓										✓		✓	
Jobs Accessible by Transit: # of jobs accessible within 45 min transit commute	✓		✓		✓	✓							✓	
Jobs Accessible by Auto # of jobs accessible within 45 min car commute	✓					✓							✓	
Mode Share	✓		✓	✓					✓	✓	✓			
Travel on Reliable Modes: share of trips on reliable modes (e.g., express lanes, BRT, etc.)	✓		✓										✓	✓
VMT and VMT per capita	✓					✓			✓		✓			
Transit Options for Households: share of households in high-capacity transit zones			✓		✓	✓								
Transit Options for Employment: share of jobs in high-capacity transit zones			✓		✓	✓								
Emissions: Report separately on VOC, NOx, and CO_2											✓			

Note: A checkmark represents a relationship between each MOE and challenge. Some relationships are more direct, while others are indirect or secondary relationships. No quantitative MOEs were developed that relate to four challenges: Transit Crowding, Metrorail Repair Needs, Roadway Repair Needs, and Open Space Development. For these, the research team instead applied various assessments to evaluate initiatives' performance. See the discussion of those challenges in the results section.

As can be seen from this table, some quantitative MOEs relate to multiple challenges. For instance, the measure, "vehicle hours of delay" relates to the challenges of roadway congestion, environmental quality, and bottlenecks, since hours of delay is an indicator of roadway congestion and roadway bottlenecks, as well as increased levels of emissions per mile. Some challenges have several quantitative MOEs that are related. For example, the challenge of inadequate bus service is related to six MOEs, none of which is a perfect measure of inadequate bus services but each of which provides a potential indicator.

There are a few challenges with no quantitative MOEs that the study team could produce within the study timeframe. As a result, the study team developed a qualitative assessment for each challenge. For challenges with multiple quantitative MOEs, the study team considered how the various MOEs

relate to the challenge and used a combination of the quantitative and qualitative information to assess and rate the contribution of each initiative to each challenge. (See the section on the challenges to learn more about how the team developed those assessments.)

Below is a brief description of how each of the quantitative MOEs was defined and measured.

Travel Times (SOV, HOV, and Transit)

Travel time is a valuable measure that reflects the traveler's experience in reaching destinations. Changes in travel times can reflect a variety of factors, including changes in trip distances (for instance, if trip destinations are closer) and changes in travel speeds (for instance, due to reduced congestion or faster travel options, such as express transit services). This measure focuses on work trips on typical weekdays, and reports average travel times for three modes: single-occupant vehicles (SOV), high-occupant vehicles (e.g., carpools and vanpools), and transit (across all types of transit services). Reduced travel times generally reflect improvements for travelers, but changes in this measure can reflect changes in travel choices that may have counter-intuitive results. For instance, if transit services are extended to outlying areas, average transit travel times might increase due to more long-distance transit trips.

Vehicle Hours of Delay

Vehicle hours of delay is a traditional measure of traffic congestion. While this is an important measure to reflect congestion on the roadway network, it is important to recognize its limitations. Most notably, this measure focuses on vehicles rather than on people, and it would be preferable to use a measure of passenger hours of delay. However, within the context of the sketch level analysis and timeframe of this study, it was not possible to develop a more refined measure of delay. The analysis results for this measure generally are derived from analysis using components of the regional travel demand model, and it is important to note that the model primarily focuses on average travel conditions and does not address nonrecurring delay, or strategies that reduce nonrecurring delay; consequently, the sketch-level analysis incorporated some procedures to address initiatives that would address nonrecurring delay. This measure is reported in terms of average daily vehicle hours of delay on a typical weekday.

Number of Jobs Accessible (by transit, by auto)

Access to jobs within 45 minutes by transit and auto provides an important measure of accessibility to economic opportunity and means of livelihood for households. While a variety of different thresholds could be used, TPB staff have found that 45-minutes provides the most meaningful measure of what is generally considered a reasonably good commute time by the public. According to the latest MWCOG State of the Commute survey, the average one-way commute travel time was 35 minutes for driving alone, 42 minutes by carpool, 47 minutes by bus, and 48 minutes by Metro.[29] These times are forecast to increase considerably in the 2040 CLRP, with the average commute travel time for each of these modes to exceed 45 minutes.

This measure does not capture changes in access improvements for long-distance commuters, who may benefit from investments (e.g., such as investments in commuter rail) but do not fall within a 45-minute commute time-frame. The number of jobs accessible within 45 minutes provides an indication of how performance relates to challenges of traffic congestion, inadequate bus services, and housing and job location.

Mode Share (SOV, HOV, Transit, and Non-motorized)

Mode share provides information on the share of commuters who drive alone (single-occupant vehicles), use carpools or vanpools (high-occupancy vehicles), use transit, and walk or bike to work.

[29] MWCOG, National Capital Region State of the Commute Survey, 2016 Survey.

As such, mode share provides useful information on the mix of travel options used by commuters, and helps to provide an indication of how the initiative addresses challenges related to inadequate bus services, and access to bike/ped options.

This measure provides the share of work trips for people on a typical weekday using single occupant vehicles (SOVs), high-occupancy vehicles (HOVs), transit (bus and all forms of rail, including light-rail, Metrorail, and commuter rail), and walking and biking. It is important to note that the mode shares reported are based on trips taken outside of the home, and do not include the share of employees who telecommute.

Travel on Reliable Modes

This measure is a surrogate for a more direct measurement of travel reliability that is not possible with sketch planning tools. "Travel on Reliable Modes" measures the percentage of system wide person miles of travel (PMT) made on what was defined for this study as "reliable modes", specifically: express lanes (which are designed to operate at a reliable travel time), Metrorail, light-rail, commuter rail, buses on transitways/bus rapid transit (which often utilize dedicated lanes), as well as walking and bicycling. It is important to recognize, however that this measure does not reflect enhanced travel time reliability that would be expected from congestion relief or operational improvements that are designed to improve travel time reliability by addressing nonrecurring delay associated with incidents, weather conditions, work zones, and other factors.

VMT and VMT per Capita

Vehicle Miles Traveled (VMT) and VMT per capita are often used as regional indicators associated with sustainability, and COG's *Region Forward* includes VMT per capita as an indicator to evaluate progress at the regional scale toward accessibility goals. Higher VMT is generally associated with increased vehicular emissions and roadway fatalities and injuries, and as an indicator of development that is not accessible by transit, walking, and biking. Consequently, this report shows increased VMT and VMT per capita as a negative indicator of regional performance. It is worth noting that advanced clean vehicle technologies (e.g., electric vehicles) mean that the linkage between VMT and emissions will be weaker in the future. Also, VMT can be an indicator of economic activity, with increased connectivity yielding more vehicle trip-making for shopping, entertainment, recreation, or other functions (e.g., reduced congestion may result in increased VMT as people are able to travel to more regional destinations within the same amount of time). The two indicators of daily VMT and daily VMT per capita have the same percentage changes for all initiatives, with the exception of Initiative 8, which includes more households in the region.

Transit Options for Households and Jobs

Two measures are used that reflect the number of households, and the number of jobs, that are located in transportation analysis zones with high-capacity transit. For purposes of this analysis, high-capacity transit is defined to include Metrorail, light-rail, commuter rail, and transitways/bus rapid transit, consistent with COG's other studies.

Emissions: VOC, NO_X, CO_2

Emissions of volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) from motor vehicles contribute to regional ozone formation. Carbon dioxide (CO_2) is a greenhouse gas that contributes to climate change, and motor vehicles are a significant contributor to emissions of CO_2. Motor vehicle emissions are affected by the amount of vehicle travel, with more VMT generally yielding more emissions. However, vehicle operating conditions affect emissions rates, with stop-and-go traffic generally resulting in higher emissions per mile than smoother traffic flow. Emissions were estimated relying on simplified methods building on emissions factors for the region in 2040, along with adjustments to account for the impacts of delay reduction, rather than conducting full emissions

modeling. The emissions for VOCs and NOx reflect a typical summer day (seasonal measure) using seasonal emissions factors that represent temperatures and other factors that affect emissions levels during the summer months when ozone is of most concern. Given the complexity of factors that affect emissions levels and the simplified analysis conducted for this study, the emissions estimates have a relatively high level of uncertainty. Also, it is important to note that the analysis did not account for any increases in emissions associated with implementation of new transit or commuter rail services, essentially assuming these would utilize zero-emissions vehicles/electricity.

Average Best Travel Times to Intercity Hubs

This was an experimental measure developed for this study to assess changes in travel times to intercity transportation hubs. The four regional transportation hubs used within this metric are: Union Station, Ronald Reagan Washington National Airport (DCA), Dulles International Airport (IAD), and Baltimore- Washington International Thurgood Marshall Airport (BWI). This measure was calculated using the average travel time (peak and off-peak) for all TPB planning area residents to the four transportation hubs using the fastest travel mode considering both auto (SOV) and transit. Specifically, the average travel time to each of the hubs was calculated for all residents in the planning area, and then the results of the four hubs was averaged.

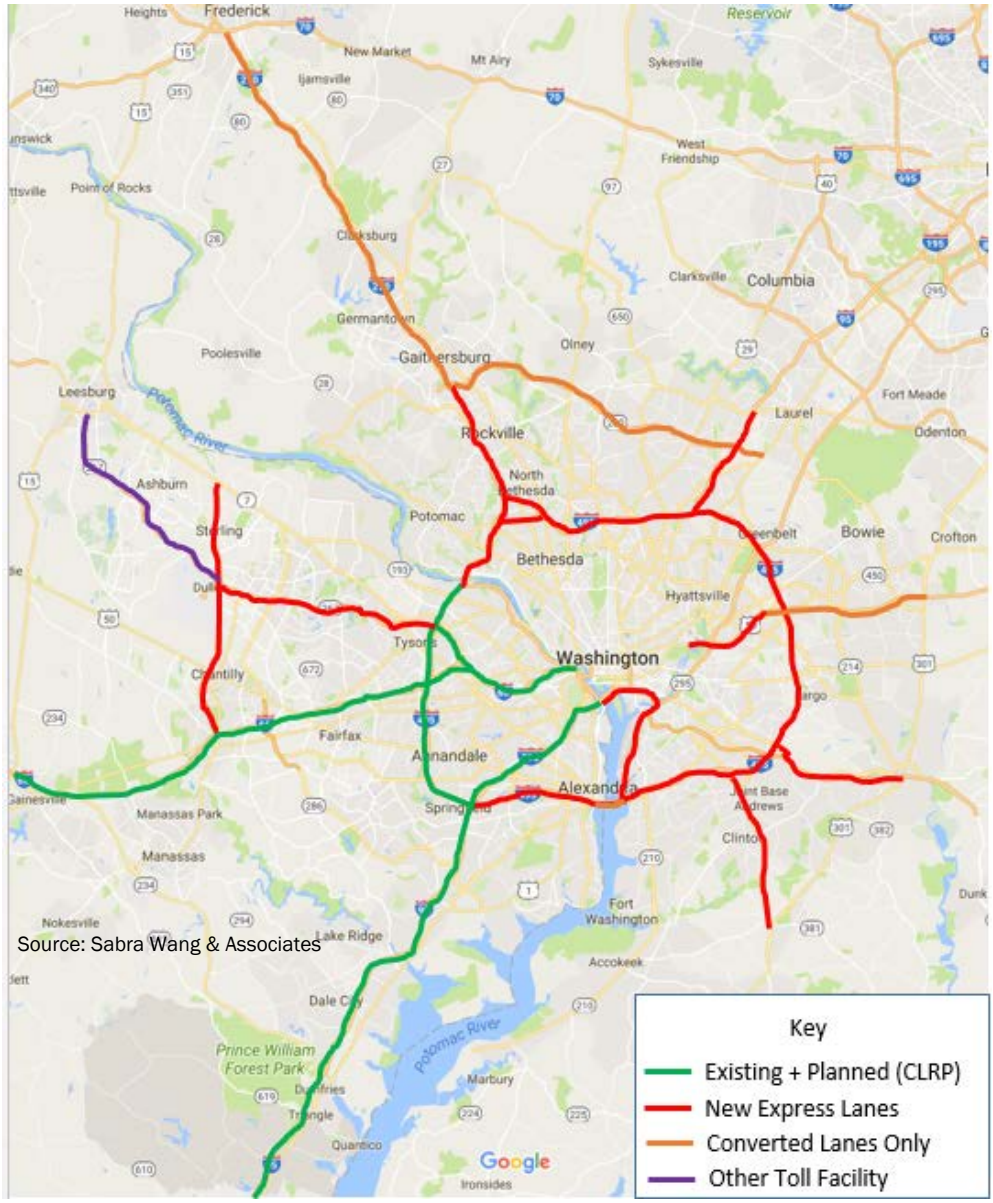
APPENDIX C: SUMMARY OF ASSUMPTIONS AND METHODS USED

Initiative 1: Regional Express Travel Network

Express Toll Lanes

Regional network of express toll lanes on limited access highways; dynamic tolling is assumed on the express toll lanes with no toll for HOV-3.

Figure 12. Express Travel Lane Network



Source: Sabra Wang & Associates

Table 49: Express Lane Facilities in Network

Facility	#HOT lanes*	Notes
I-95 (VA)	2-3^	*Existing/in 2040 CLRP*
I-395 (VA) to DC line	3^	*Existing/in 2040 CLRP*
I-66 outside Beltway (VA)	2	*In 2040 CLRP*
I-66 inside Beltway (VA)	2-3	*In CLRP; converts existing HOV to HOT*
MD-200 ICC	3	Toll road functions as HOT (free HOV-3)
I-495 Beltway (VA)	2	Largely existing/in CLRP; adds capacity from I-95 to Woodrow Wilson Bridge
American Legion Bridge	2	New capacity
I-495 Beltway, American Legion Bridge to I-270 (MD)	2	New capacity
I-495 Beltway, I-270 to Woodrow Wilson Bridge	1	New capacity
I-270, north of ICC (MD)	1	HOV converted to HOT lane
I-270, south of ICC (MD)	2	New capacity with 1 HOV lane converted to 2 HOT Lanes
I-95 (MD)	2	New capacity
US-50 (MD)	1	New lane from South Dakota Ave. to MD-410, conversion of HOV to HOT lane beyond
MD-4	1	New capacity
MD-5	1	New capacity
I-395 (DC)	1	New capacity
I-295 (DC)	1	New capacity
I-695 (DC)	1	New capacity
VA-267 Dulles Toll Road	1	New capacity east of VA-28
VA-28	2	New capacity with 1 HOV lane converted to 2 HOT Lanes

Each direction, unless otherwise noted.
^Reversible lanes

Express Bus Network

New express bus services on network (paid in part through tolls) connect major Activity Centers. The express bus services rely primarily on the express lanes. Analysis assumes headways of 10 minutes peak periods and 20 minutes off-peak periods.

Figure 13: Express Bus Network

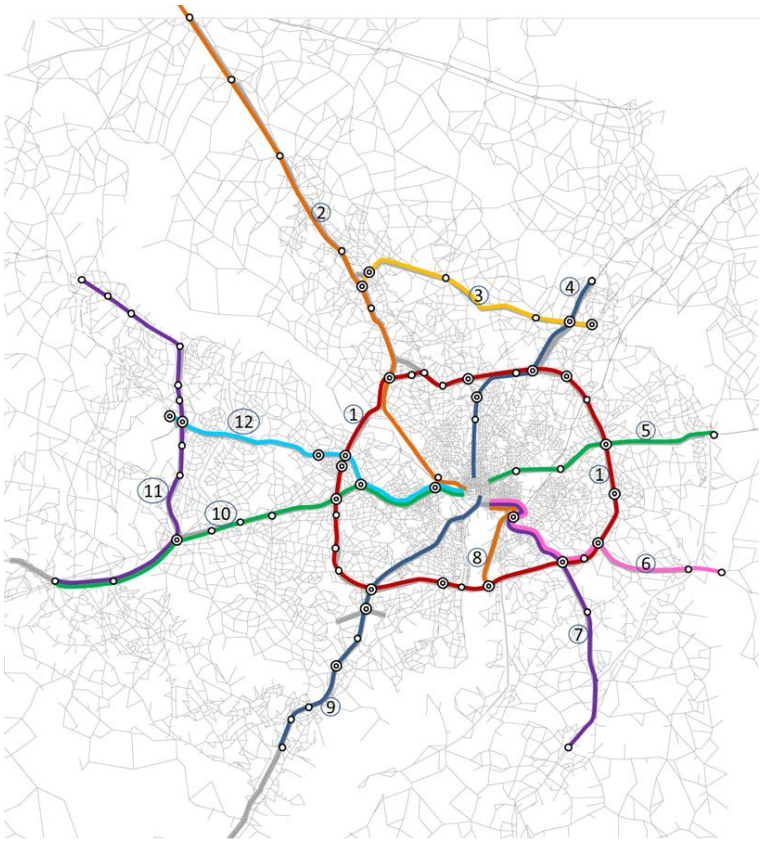


Table 50: Express Bus Network

No.	HOV/HOT Facilities	Origin, Destination, and Transfer Points
1	I-495 Beltway	I-270 (N. Bethesda), Georgia Ave., I-95, Greenbelt, US-50, Largo, MD-4, MD-5, National Harbor, Eisenhower Ave, I-395, I-66, Tysons, VA-267*
2	I-270	N. Frederick, Shady Grove/King Farm, I-495, DC core via Canal Rd.
3	ICC	King Farm, Shady Grove, Calverton/I-95, Muirkirk
4	I-95, I-495	West Laurel, Calverton/ICC, I-495/College Park, Silver Spring, DC Core via Georgia Ave.
5	US-50, New York Ave.	US301 (Bowie), I-495, DC Core via US-50/New York Ave.
6	MD-4, I-495	Wayson's Corner, I-495, MD 5, Anacostia (via Suitland Pkwy.), DC Core
7	MD-5	Waldorf, I-495, Anacostia (via Suitland Pkwy.), DC core.
8	I-295	National Harbor, Anacostia, DC Core.
9	I-95 S, I-395	Dale Blvd, Lorton, Springfield, I-495, DC Core.
10	I-66	Gainesville, VA-28, I-495, West Falls Church, Rosslyn, DC Core.
11	I-66, VA-28	Gainesville, VA-28, VA-267, Sterling, Leesburg.
12	Dulles Tollway	Dulles Airport, VA-28, Spring Hill, I-495,West Falls Church, Rosslyn, DC Core via I-66.

*For sketch analysis purposes, showing service around the entire Beltway, but individual bus routes might cover portions (e.g., Greenbelt-N. Bethesda; Largo-Eisenhower Ave.) Also, some "Beltway" routes might include connections to spurs (e.g., Dale Blvd. /I-95 toward Tysons via I-495).

Land-Use

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change

Analysis Approach

The express lanes and express buses were coded in the 2040 CLRP network to assess mode choice and traffic assignment effects (using the 2040 CLRP person trip tables as inputs). Tolls were assumed on the newly coded facilities with no toll for HOV-3. A post -distribution mode choice was performed and then the auto assignment was performed within the MWCOG model framework to prepare the MOEs.

Initiative 2: Regional Roadway Congestion Hotspot Relief

Hotspot Relief

Maximize available capacity using technological and operations management strategies at locations with top congestion hotpots in the region, and supplemental lane capacity in limited locations where potentially warranted. The hotspots selected were based upon the Congestion Management Process list of top bottlenecks plus selected spots from the 2040 CLRP where the forecast volume to capacity ratio was greater than 1.

The general guideline used to select locations to add capacity were as follows

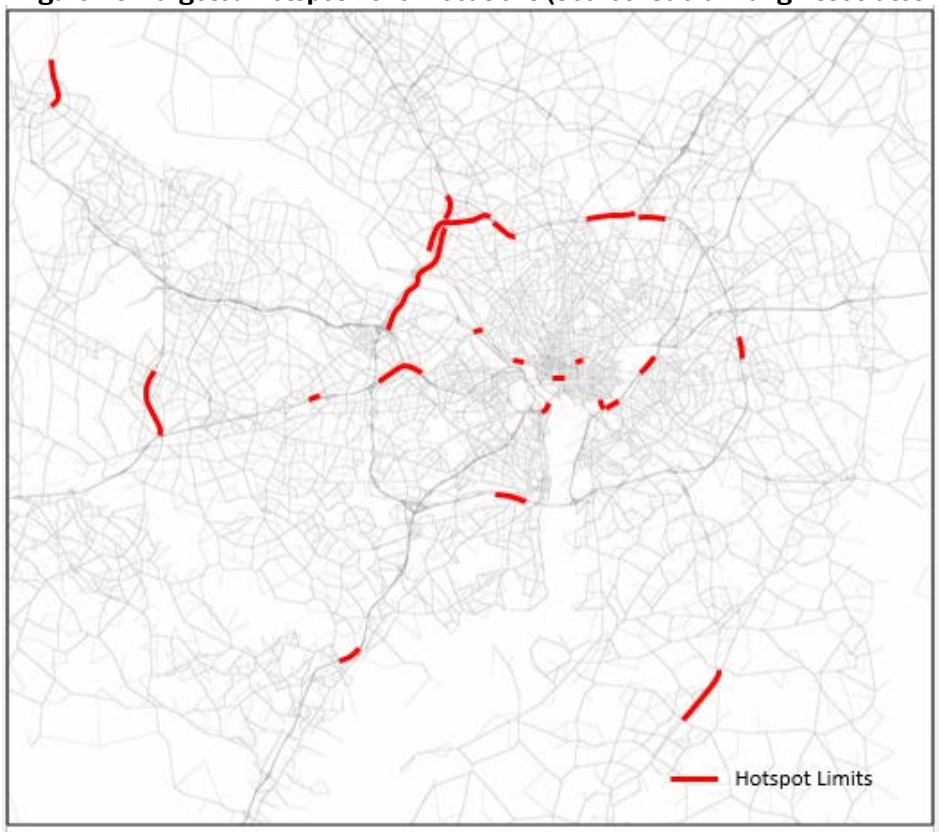
- If mentioned in the 2040 CLRP and 1.0 <V/C <1.5 then assume operational improvements to improve flow
- If mentioned in the 2040 CLRP and V/C > 1.5 add capacity to remove bottlenecks.

Figure 14: Hotspot Relief Locations (Source: Sabra Wang and Associates)

	Location	Addressed In 2040 CLRP?
From Congestion Management Process Report	I-495 IL between VA-267 and I-270 Spur	X
	I-495 OL between I-95 and MD-193	
	I-66 EB at VA-267	X
	I-270 SPUR SB	
	I-95 SB at VA-123	X
	VA-28 SB between US-50 and I-66	X
	US-15 NB between VA-7 and N. King St.	
	I-495 OL between I-270 and MD-190	
	I-495 IL between MD-355 and MD-185	
	I-66 WB at Vaden Dr./Exit 62	X
	I-495 IL between I-95 and US-1	
	I-495 OL at Telegraph Rd.	X
	I-495 OL at MD-202/Landover Rd.	
	Constitution Ave WB between 12th St. and 17th St.	X
	New York Ave. WB between N. Capitol St. and I-395	X
	DC-295 NB at Pennsylvania Ave	X
	DC-295 SB at Benning Rd.	X
	I-395 NB between US-1 and GW Pkwy	X
	VA-123 between GW Pkwy and Canal Rd	
	Canal Rd NW between M St and Foxhall Rd	
	US 301 between Berry Rd and McKendree Rd	
	I 695 between Anacostia Fwy and M St	

Note: Locations addressed in the CLRP were not analyzed as a part of this effort.

Figure 15: Targeted Hotspot Relief Locations (Source: Sabra Wang Associates



Source: Sabra Wang & Associates

Reversible Lanes

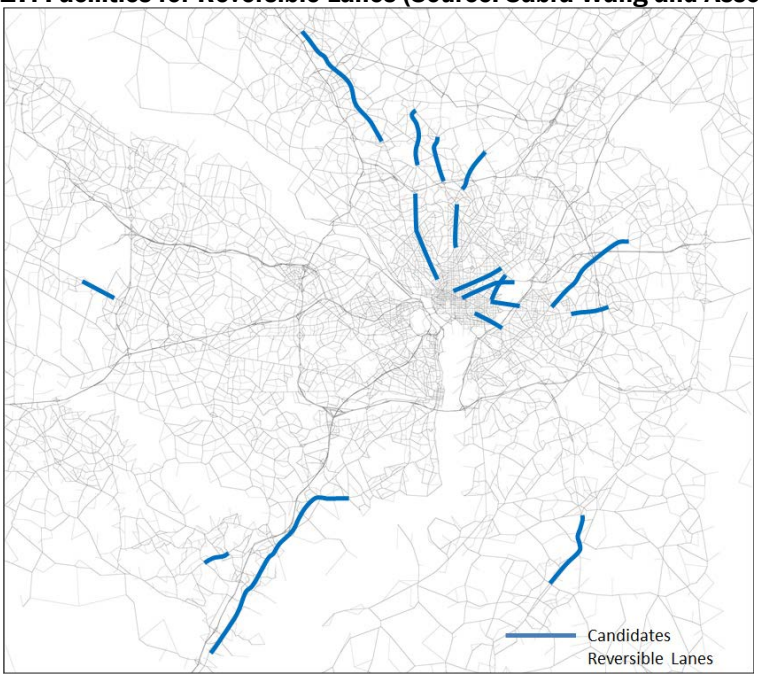
Non-expressway segments with 3+ lanes and with high volume/capacity ratios in the peak direction and relatively low volume/capacity ratios in the off peak direction in the 2040 CLRP forecast were selected.

Figure 16: Reversible Lanes Facilities

Facility	Limits		Divided	Undivided	2040 CLRP Total # Lanes
	A	B			
MD-355	MD-124	Montrose Pkwy			
Connecticut Ave	Georgia Ave	Knowles Ave	X		6
Connecticut Ave	I-495	Calvert St	in MD	in DC	6
Georgia Ave	Randolph Road	I-495	X		6
Georgia Ave	Colesville Road	Arkansas Ave		X	6
New Hampshire Ave	Eastern Ave NE	Metzerott Road	X		6
Rhode Island Ave	Eastern Ave NE	Logan Circle	X		6
New York Ave	South Dakota Ave	H Street	X		6
Bladensburg Road	South Dakota Ave	Benning Road	X		6
Benning Road	Bladensburg Road	Minnesota Ave	X		8
Pennsylvania Ave	Minnesota Ave	Independence Ave	X		8
Martin Luther King Jr Hw	Eastern Ave NE	Glen Dale Road	X		6
Central Ave	Harry Truman Drive	Hill Road	X		6
Crian Hwy	Smallwood Drive	Accokeek Road	X		6
US 1	Curtis Drive	Backlick Road	X		6
Minnieville Rd	Dale Blvd	Caton Hill Road	X		6
US-50	Watson Road	Sully Road	X		6

Source: Sabra Wang & Associates

Figure 17: Facilities for Reversible Lanes (Source: Sabra Wang and Associates)

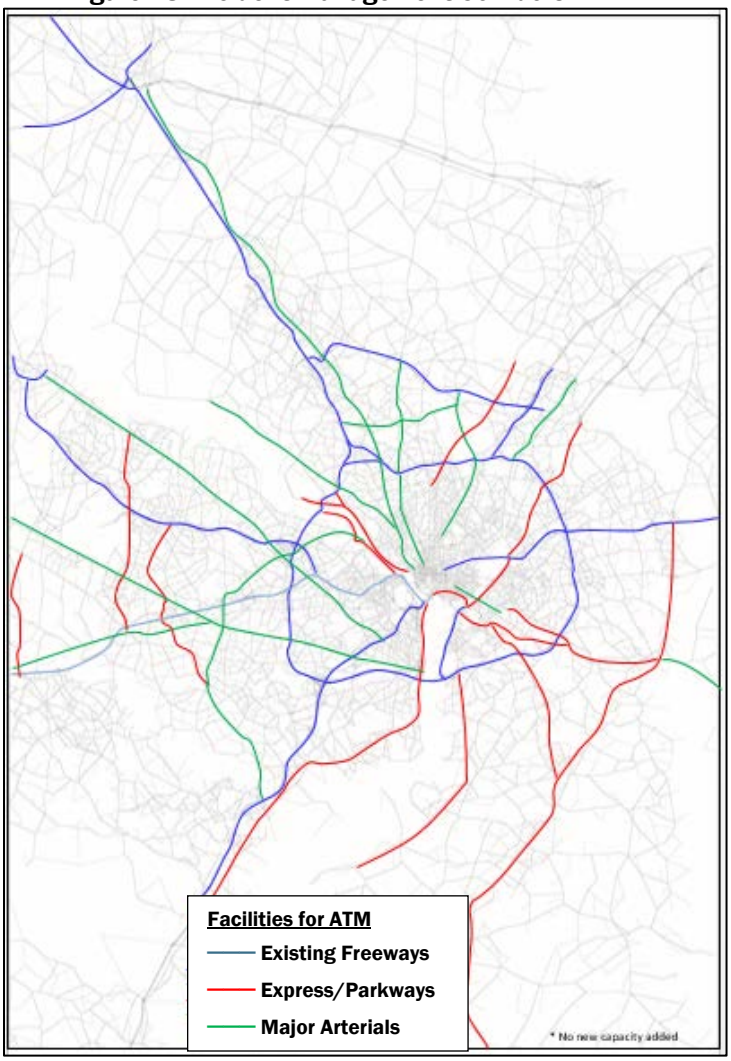


Source: Sabra Wang & Associates

Enhanced Incident Management

It is assumed that all major freeways already have active incident management in place including hero/response teams for motorist assistance. This initiative therefore will provide for additional incident response along expressways, parkways, and high volume major arterials (~ 30,000 AADT or greater). A map of these facilities is shown in Figure 7 below

Figure 18: Incident Management Corridors



Source: Sabra Wang & Associates

Integrated Corridor Management (ICM)

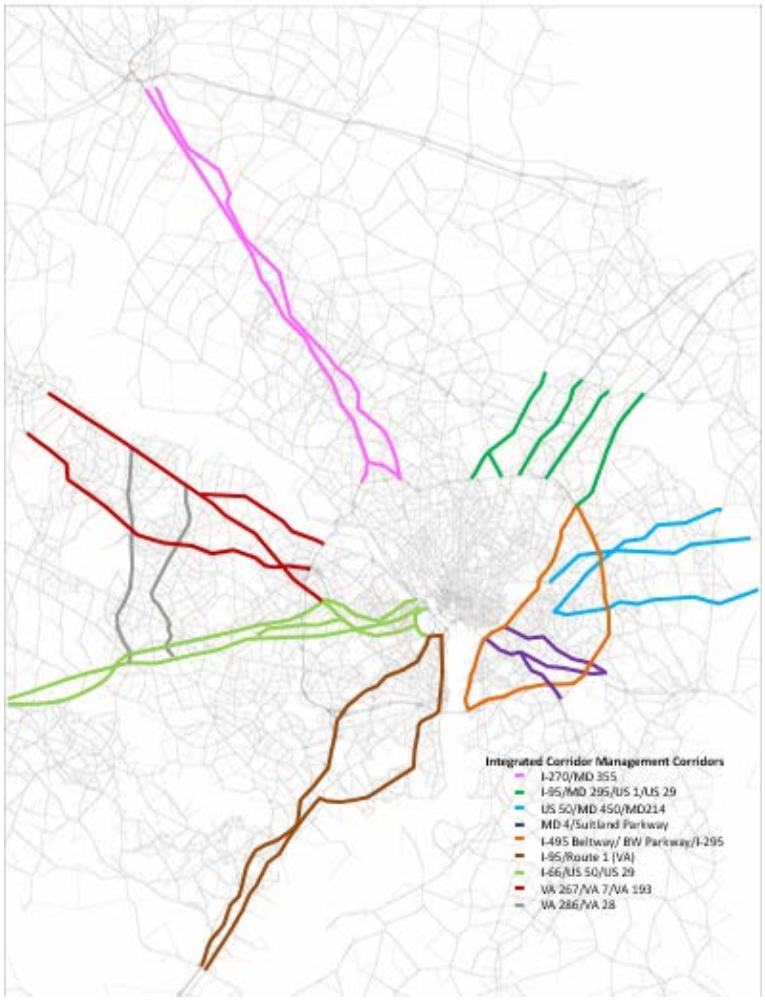
- Assume corridors are integrated and managed for efficient multimodal operations
- Identified candidate facilities among existing freeways, express and parkways, and major arterials
- Based on the literature, a capacity increase of 3% was assumed for corridors with no other treatment and a 1% increase was assumed where other treatments were applied to these corridors and facilities

Figure 19: Integrated Corridor Management Facilities

Integrated Corridor Management Corridors
I-270/MD 355
I-95/MD 295/US 1/US 29
US 50/MD 450/MD214
MD 4/Suitland Parkway
I-495 Beltway/ BW Parkway/I-295
I-95/Route 1 (VA)
I-66/US 50/US 29
VA 267/VA 7/VA 193
VA 286/VA 28

Source: Sabra Wang & Associates

Figure 20: Integrated Corridor Management



Active Traffic Management (ATM)

- Includes ramp metering, transit signal priority, enhanced traveler information and other design and operations strategies not specifically listed in the components
- Identified candidate facilities among existing freeways, express and parkways, and major arterials
- Based on the literature review, applied a capacity increase of 5% on Freeways and 6% on Arterials selected for ATM

Figure 21: Active Traffic Management Facilities

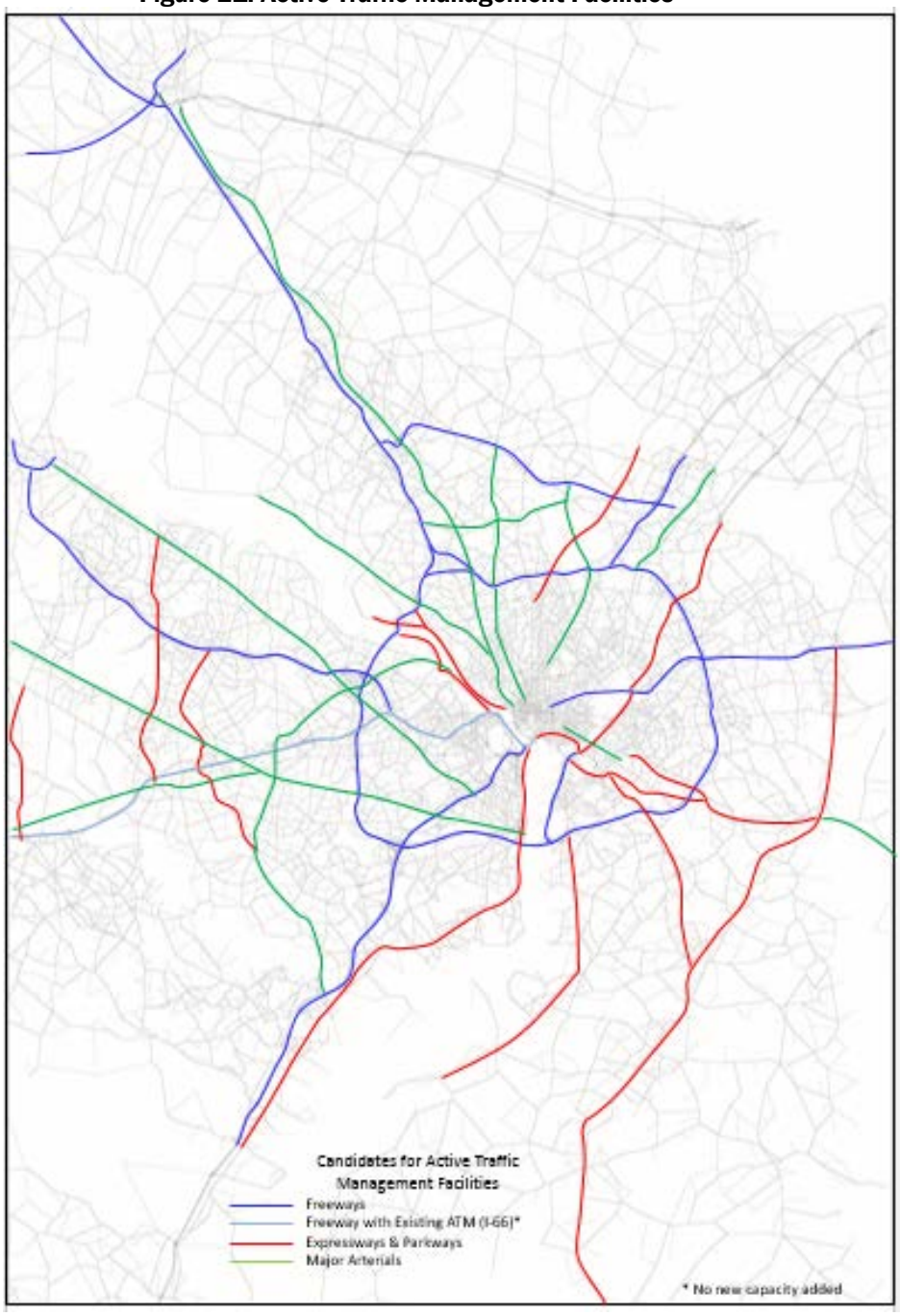


Figure 22: Facilities for Active Traffic Management

Facilities with Active Traffic Management
Freeways
I-495 - Beltway
I-95 (Md): Howard County Line to I-495
I-270: I-70 to I-495
US 50: New York Ave. to the Patuxent River
ICC - MD 200
I-295: I-695 to I-495
I-395: DC Core to I-495
I-95 (Va): I-495 to Va 619
I-66: Gainesville to the DC Core (ATM exists in CLRP 2040, No new Capacity added)
VA 267/Dulles Toll Road/Greeway: I-66 to Leesburg
Arterials & Expressways
US 301 from Governor Nice Bridge to US 50
US 1 to the DC Core
Pennsylvania Avenue to MD 4
MD 4 to US 301
US 50/New York Ave. to the DC Core
BWI Parkway to the Anne Arundel County Line
New Hampshire Ave to the DC Core
US 29 to Silver Spring/Georgia Ave./7th Street
MD 355/Connecticut Avenue to the DC Core
Wisconsin Avenue to the DC Core
River Road to Wisconsin Avenue
Va 123 from DC line to I-95
Route 50 from the George Washington Memorial Parkway to VA 15
Route 29 from Gaineville to Route 50
Route 7 from I-495/I-95 to I-395
Route 236 from I-495/I-95 to Alexandria
MD-210 from Indian Head to I-495
MD-5 from US-301 to I-495
MD-4 and Suiteland Parkway from US-301 to DC Line
VA-267 from US-15 to I-66
VA-28 from I-66 to VA-7
VA-286 from VA-123 to VA-267
GW Parkway from I-495 to I-66

Demand-Responsive Services

for persons with limited mobility and general population.

Land-Use

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

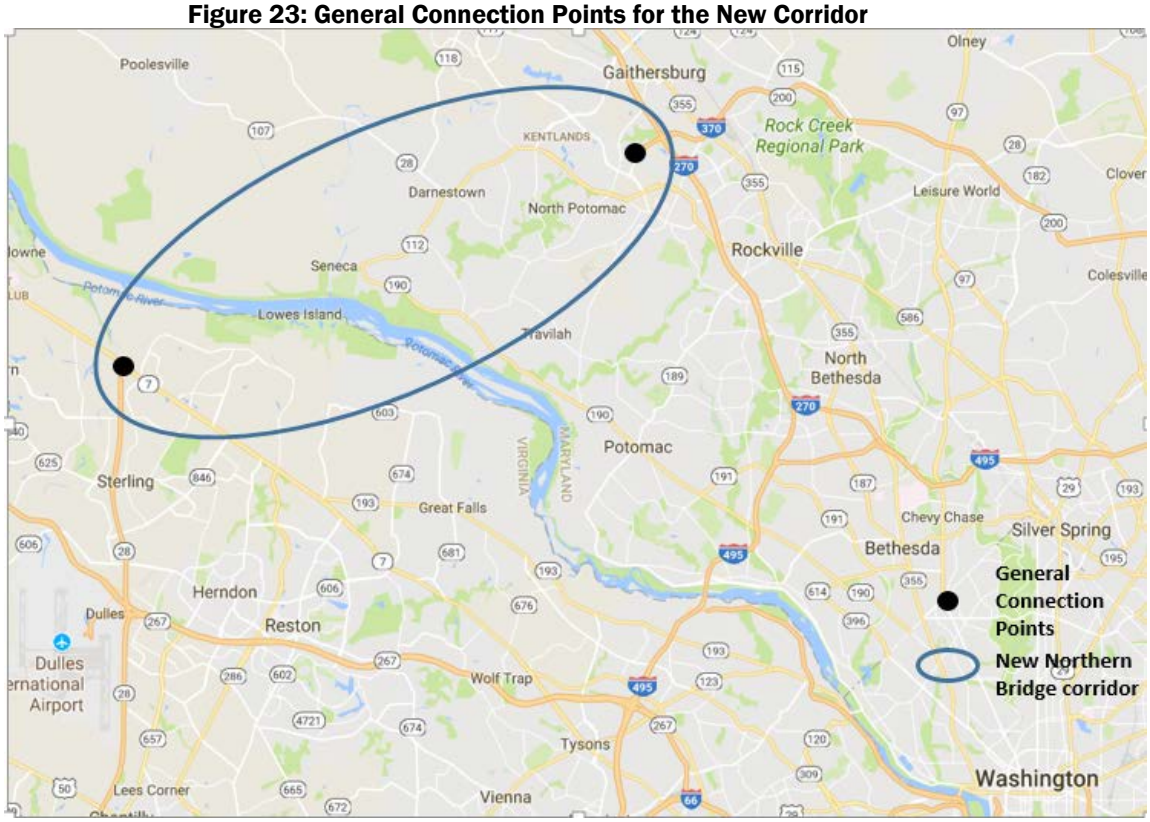
Analysis Approach – Estimated benefits by application of the strategies described above were coded in the regional model by increasing the effective capacities of the segments on the selected corridors. The increased capacity will reflect the cumulative operational improvements expected to accrue from the strategies applied, based on available literature/studies. A post mode choice assignment was carried out using the 2040 CLRP vehicle trip tables as inputs.

Further, the technical team applied professional judgment to refine targeted MOEs for this initiative. The refinements were informed by sensitivity tests that were conducted by staff and designed to simulate some aspects of the initiative.

Initiative 3: Additional Northern Bridge Crossing /Corridor

New Northern Bridge Crossing – New toll road (about 14 miles long) between VA28/VA 7 junction and I 270/I-370 junction (MD-200/Intercounty Connector) across Potomac River, 3-lanes each direction (to connect with existing 3-lane per direction facilities). Parkway-style facility (similar to Intercounty Connector) with no interchanges between the above terminal points. The per-mile toll rates from MD-200 is assumed on the new toll road connection.

Figure 23: General Connection Points for the New Corridor



New Express Bus Service

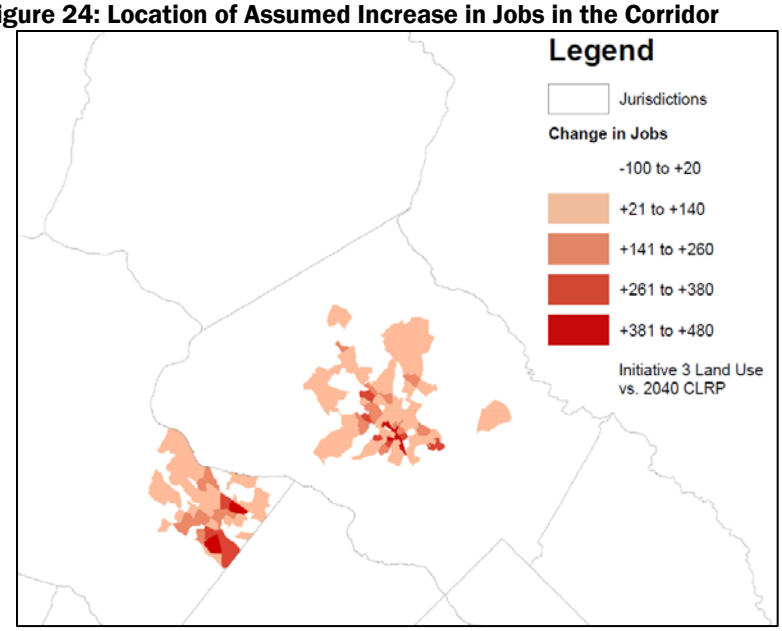
New express bus services connecting activity centers along the corridor (Rockville-King Farm-Research Center-Shady Grove to/from Dulles Town Center, Route 28 Central/South, Innovation Center at 20 minute peak, 30 minute off-peak headways. Existing fare pricing is assumed for the new express bus service.

Land-Use

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were altered by assuming modest increase in households and jobs in areas with existing development areas within Montgomery and Loudoun Counties impacted by the new facility. About 8,900 households and 16,200 jobs (about 0.4% and 0.3% of TPB Planning Region totals, respectively) will be added to these areas with reduction in other parts of the planning area proportionate to anticipated growth in the CLRP Round 9.0 Cooperative Land-Use Forecasts. The new households and jobs in the corridor will be added based on accessibility across the bridge using an initial model run, as below:

- 5% increase in households and employment in Traffic Analysis Zones (TAZs) with a 55-minute or less travel time between Loudoun and Montgomery County
- 3.5% increase in households and employment in TAZs with a 56- to 60-minute travel time between Loudoun and Montgomery County
- Proportional reductions in all other TAZs (approximately 0.3%) to maintain normalized regional totals
- Approximately 60% of the job shift and 30% of the household shift are to activity centers in the corridor.

Figure 24: Location of Assumed Increase in Jobs in the Corridor



Source: Fehr & Peers

* Note: Compared to the 2040 CLRP, approximately 16,200 jobs are shifted to the indicated TAZs from all other TAZs in the TPB Planning Area.

Analysis Approach

A 6 lane tolled corridor was added to the 2040 CLRP network, Express busses were coded along with modified land-use to the regional model. A complete MWCOG model run was conducted and then the MOEs were calculated.

Initiative 4: Regionwide Bus Rapid Transit and Transitways

Bus Rapid Transit/Transitway Networks – Additional bus rapid transit (BRT)/transitway networks in Montgomery County, Prince George's County, Northern Virginia (TransAction 2040), DC, and a transitway from Branch Ave to Waldorf. *These lines are in addition to those already in the CLRP, which include: DC streetcar (Union Station-Georgetown), Corridor Cities Transitway, Crystal City Transitway Northern Extension, US-1 BRT (Huntington Metro to Woodbridge), West End Transitway (Van Dorn Metro to Pentagon Metro), and Tiger Grant Bus Priority Improvements.*

The following is a list of the BRT/ Transitways Services for Initiative 4. Figure 25 illustrates proposed and planned BRT/ Transitway services in the area.

DC:

- Georgia Ave/9th St (Takoma Park-Buzzard Pt)
- Waterfront- Capitol South Metro
- 16th St (Silver Spring-McPherson Sq)
- Minnesota Ave/11 St (E. Capitol St-Eastern Mkt),
- Nebraska/Military Rd/Missouri Ave/S. Dakota (Tenleytown-Michigan Park)
- U Street/ Florida Ave/ 8th Street (Woodley Park-Navy Yard)
- Wisconsin Ave (Tenleytown-Georgetown)
- N. Capitol (McMillan-Union Station)

Maryland:

- Georgia Avenue North / Georgia Avenue South
- MD-355 North / MD-355 South
- Randolph Road (US-29 to White Flint)
- New Hampshire Avenue
- North Bethesda Transitway (White Flint Metro - Montgomery Mall)
- University Blvd (Wheaton – Takoma/ Langley Transit Center)
- US-29 (Columbia-Silver Spring)
- Veirs Mill Rd (Rockville-Wheaton)
- US-1 (Arundel Mills-College Park)
- US-1 (Greenbelt-Konterra)
- MD-5 / US-301 (White Plains-Branch Ave)
- US-50 (Bowie-New Carrollton)
- University Blvd/Riggs Rd/MD-410/MD-201/MD-450 (Bladensburg-Takoma-Langley

Virginia:

- VA-28 (Manassas to Dulles Town Center)
- US-29 (Fair Oaks Mall to Rosslyn)
- US-50 (Dunn Loring Metro to Rosslyn)
- VA-236/US-50 (King Street Metro to Fair Oaks Mall)
- VA-7 (Spring Hill Metro to West End Transitway)
- Gallows Rd/Annandale Rd (Tysons - Annandale)
- Columbia Pike (Pentagon City - Annandale)

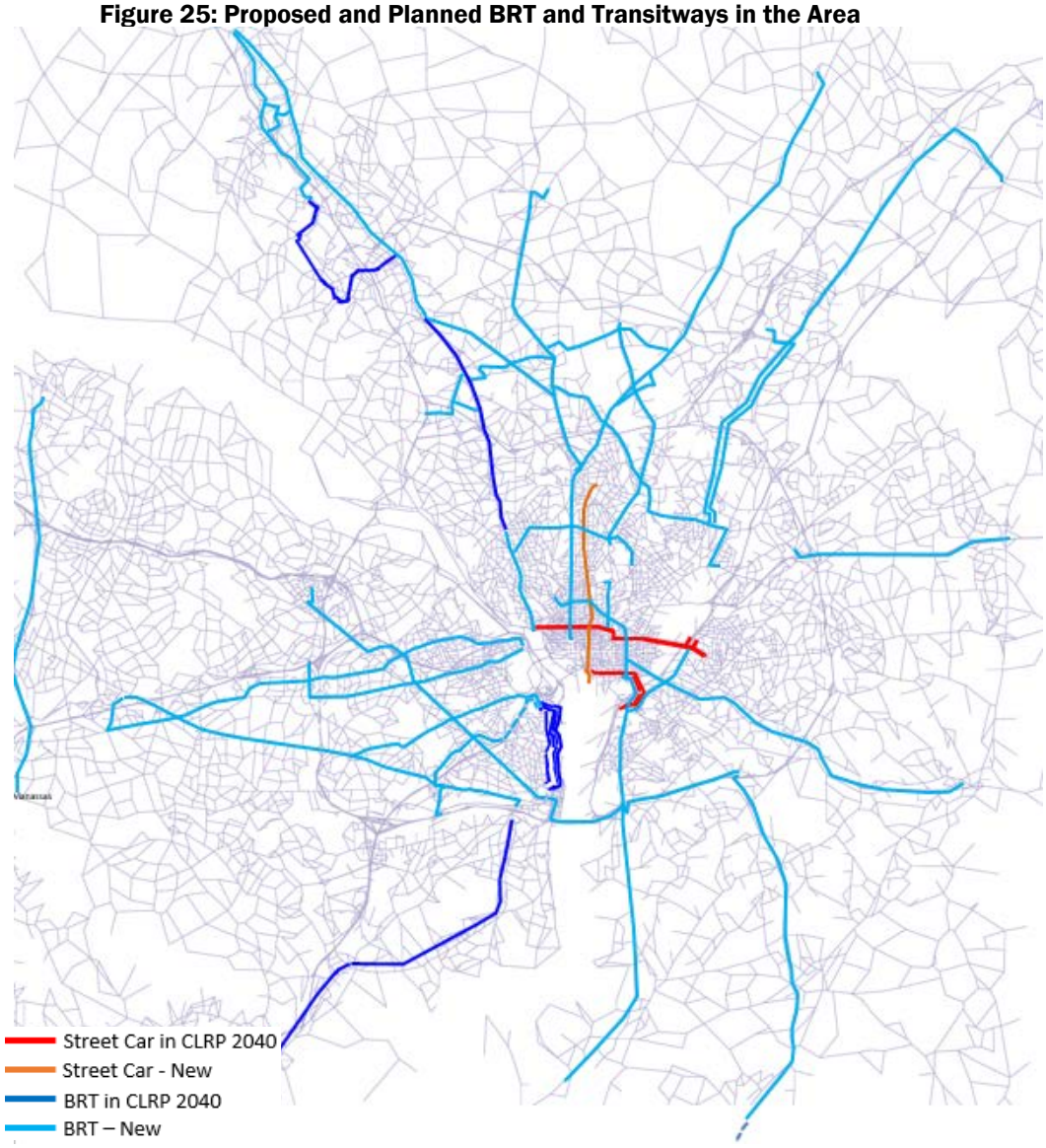
Multi-State:

- MD-4/Penn Ave (Upper Marlboro-Eastern Market),
- MD-210/S. Capitol SW (Byan's Rd-Navy Yard),
- MD-5/Nat'l Harbor/King Street Metro

Existing local bus/streetcar fare pricing is assumed for the new BRT/ Transitways.

Initiative also includes improved bicycle and pedestrian access.

Figure 25: Proposed and Planned BRT and Transitways in the Area



Source: Sabra Wang

Land-Use

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were adjusted to modestly increase employment and household densities in zones with new services, relocating employment and housing from outside activity centers within the same jurisdiction. Densities in the portions of TAZs within a 0.25 mile buffer of new BRT stations were increased to 5 households/acre and 30 jobs/acre while maintaining the jurisdiction-level control totals.

Analysis Approach

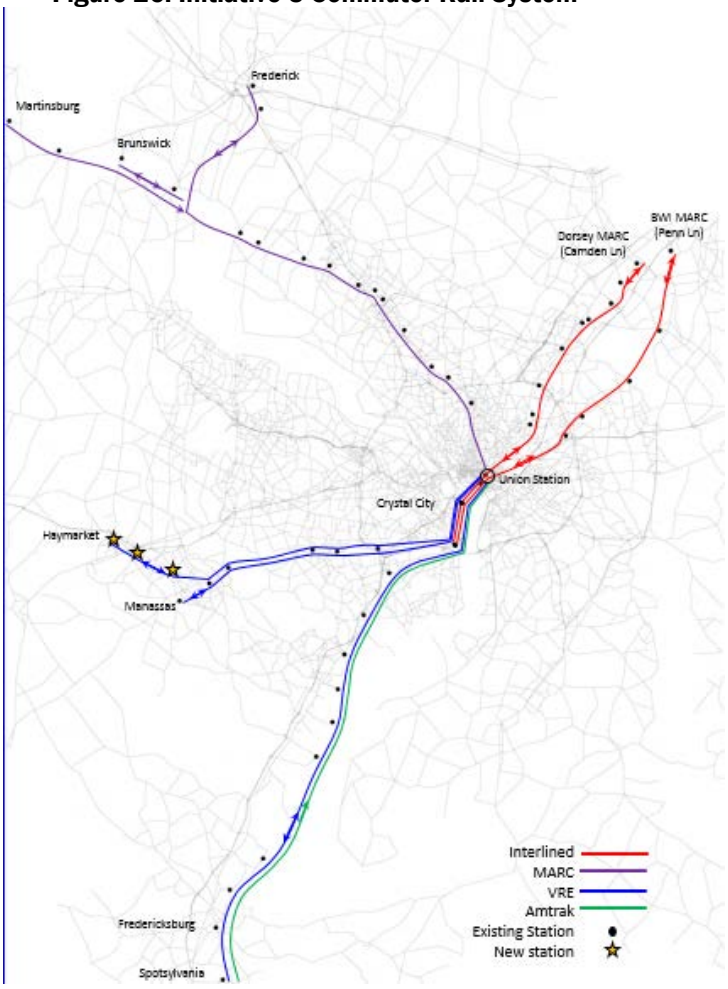
The new BRT/ Transitways with the stops were coded in the MWCOG Model. The bicycle/pedestrian boarding mode shares to the BRT were altered in the MWCOG model to represent increased bike/ped accessibility to the BRT. A post distribution mode choice and assignment were carried out using the person trip tables from the 2040 CLRP model.

Initiative 5: Regional Commuter Rail Enhancements

Improvements to MARC and VRE Commuter Rail Systems –

Expand upon commuter rail enhancements already in 2040 CLRP (which includes an increase in MARC and VRE capacity, frequency, and additional reverse peak service, as well as 3 new stations on an extended Haymarket branch of the Manassas VRE line (Although this extension is not planned to be included in the updated CLRP, it is part of the 2040 CLRP that is forming the base for this analysis).

Figure 26: Initiative 5 Commuter Rail System



Source: Sabra Wang

Table 51: Additional Improvements of Initiative 5 on top of CLRP

Improvement	Notes
Upgrading all 60-min, peak-time headways in the CLRP to 30-min headways.	Applies to both MARC and VRE systems.
Upgrading all 30-min headways in the CLRP to 20-min headways.	Applies to both MARC and VRE systems.
Establishing off-peak service on all MARC and VRE lines, if not already in CLRP.	All off-peak service will run every 60 minutes.
Run-through services of the MARC Camden and Penn lines with VRE to extend to Alexandria.	These two lines have the most potential for run-through service
Improved bicycle and pedestrian connections and access improvements to rail stations	N/A

Note: Existing fare structures and pricing are assumed

Land-Use – 2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

Approach – The increased services and run-through service into network were coded to estimate potential ridership increase and mode shifts. A post distribution mode choice and assignment were carried out using the person trips from the 2040 CLRP model. Utilize estimating ridership increased forecast figures from MARC and VRE to validate/adjust the results. The additional trips due to interlining were incorporated into the VRE and MARC totals. After the rail enhancements were codeda post distribution mode choice and auto and transit assignments were conducted.

Initiative 6: Metrorail Regional Core Capacity Improvements

Core Capacity Improvements – 100% 8-car trains, and additional stations and station improvements to increase core system capacity

Figure 27: Metrorail Core Capacity Improvements

Source: WMATA

Improvements to the Existing System

- 100% 8-car trains
- Metrorail station improvements at high-volume stations in system core
- Improved bicycle and pedestrian connections and access improvements to rail stations.

Additional Stations and Routes- In addition to the general core system improvements listed above, this initiative also expands the Metrorail system:

- Second Rosslyn station to reduce interlining and increase frequency
- New Metrorail core line to add capacity across Potomac River (New Rosslyn tunnel between Virginia and DC through Georgetown to Union Station toward Waterfront as loop, based on WMATA Momentum 2040).

Land-Use

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were used without any change.

Fares

Existing fare structures and pricing were assumed.

Analysis Approach

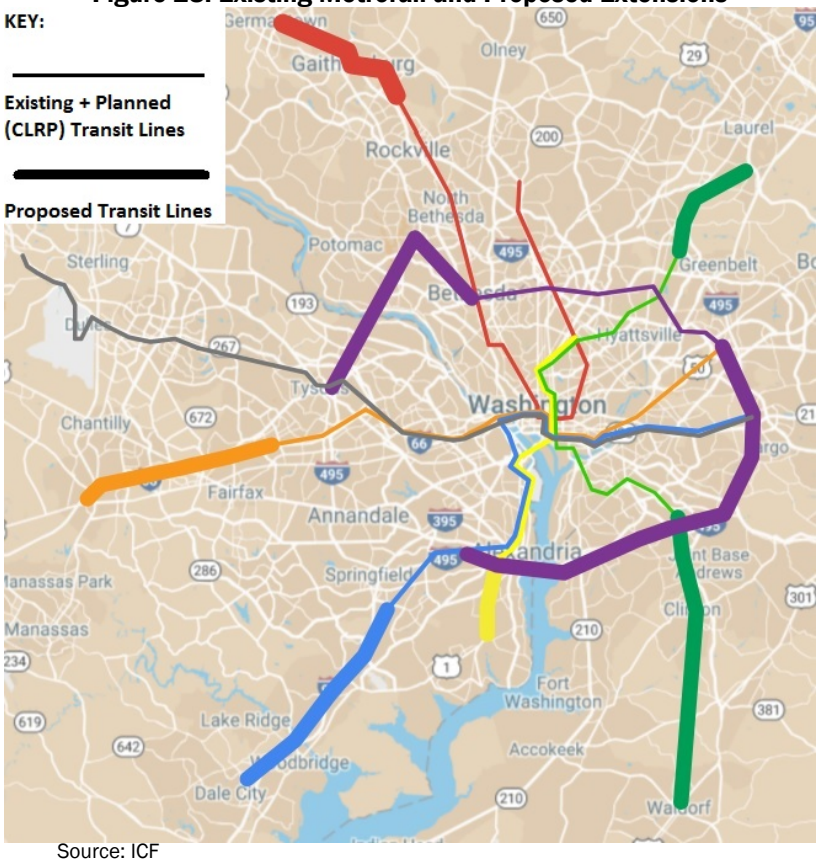
The new stations were added to the MWCOG model network with a simplified approach. Core capacity constraint in the model were removed. The improved bike/ped connections and access improvements to the stations were reflected in the analysis by improving the transit share at the stations. A post distribution mode choice and auto and transit assignment was carried out using the person trips from the 2040 CLRP model. The MOEs were prepared after the assignment.

Initiative 7: Transit Rail Extensions

Rail Extensions

Extensions to all existing Metro lines (except Silver), plus Purple Line Light Rail extensions and light-rail to Waldorf. Improved bicycle and pedestrian connections and access improvements to rail stations.

Figure 28: Existing Metrorail and Proposed Extensions



Source: ICF

Metrorail / Light Rail Line	Proposed Extension
Orange Line	Extend West-bound rails beyond Vienna-Fairfax to Centreville
Blue Line	Extend South-bound rails beyond Franconia-Springfield to Potomac Mills
Yellow Line	Extend South-bound rails beyond Huntington to Hybla Valley
Red Line	Extend Northwest-bound rails beyond Shady Grove to Germantown
Green Line	Extend North-bound rails beyond Greenbelt to South Laurel
	Add new South-bound light rail from Branch Ave to Waldorf

Purple Line Light Rail	Extend West-bound rails beyond Bethesda to Tysons (running north toward Montgomery Mall then along Beltway)
	Extend East-bound rails beyond New Carrollton to Eisenhower Avenue (with stops at Branch Avenue and National Harbor)

Note: Existing fare pricing for transit rail will be used for the extended lines with a cap on the maximum fare

Land-Use Assumptions

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were adjusted to increase employment and housing densities in zones with new services, relocating employment and housing from outside activity centers within jurisdictions:

- Densities in the portions of TAZs within a 0.5 mile buffer of new LRT stations were increased to 7 households/acre and 45 jobs/acre.
- Densities in the portions of TAZs within a 0.75 mile buffer of new Metrorail stations were increased to 15 households/acre and 90 jobs/acre.

Jurisdiction-level control totals were maintained by shifting employment and household growth from TAZs outside of Activity Centers and within the same jurisdiction.

Analysis Approach –

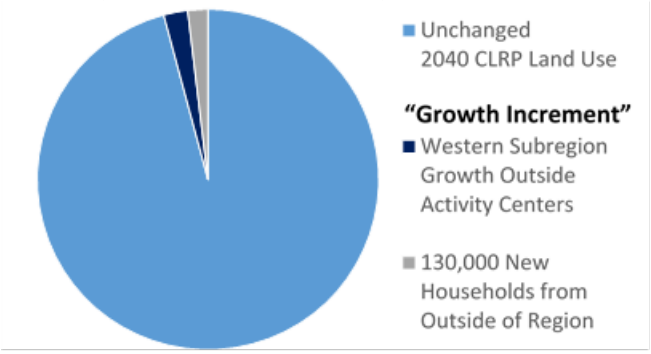
The new extended lines and new stations were added to the transit network of the MWCOG model. Auto access and walk access were added to the new stations. The improved bike/ped connections and access improvements to the stations were reflected in the analysis by improving the transit share at the stations.
A post distribution mode choice and assignment will be carried out using the person trips from the 2040 CLRP model.

Initiative 8: Optimize Regional Land-Use Balance

Land-Use Assumptions –

The focus of this initiative is to achieve better jobs-housing balance in the region. This initiative encourages development near and around underutilized premium transit stations. A better jobs/housing ratio is achieved in the region by increasing the increment of future employment growth in the eastern portion of the region and reducing this increment of future growth in the western portion of region. (Note that the eastern subregion includes the eastern portions of the City of Alexandria, Arlington County, Fairfax County, Prince William County, the District of Columbia, and Montgomery County, in addition to Charles County and most of Prince George's County). Additionally, more housing is added to the region (130,000 households) to reduce the need for daily long-distance "in-commuters" living beyond the region's outer boundaries. Jobs and housing in this optimization process are reallocated to underutilized rail stations and Activity Centers with high capacity transit. Only the increment of growth between 2025 and 2040 outside of Activity Centers ("Growth Increment"; 2.3% of 2040 CLRP total) is reallocated in this Initiative.

Figure 29: Land-Use Changes in Initiative 8



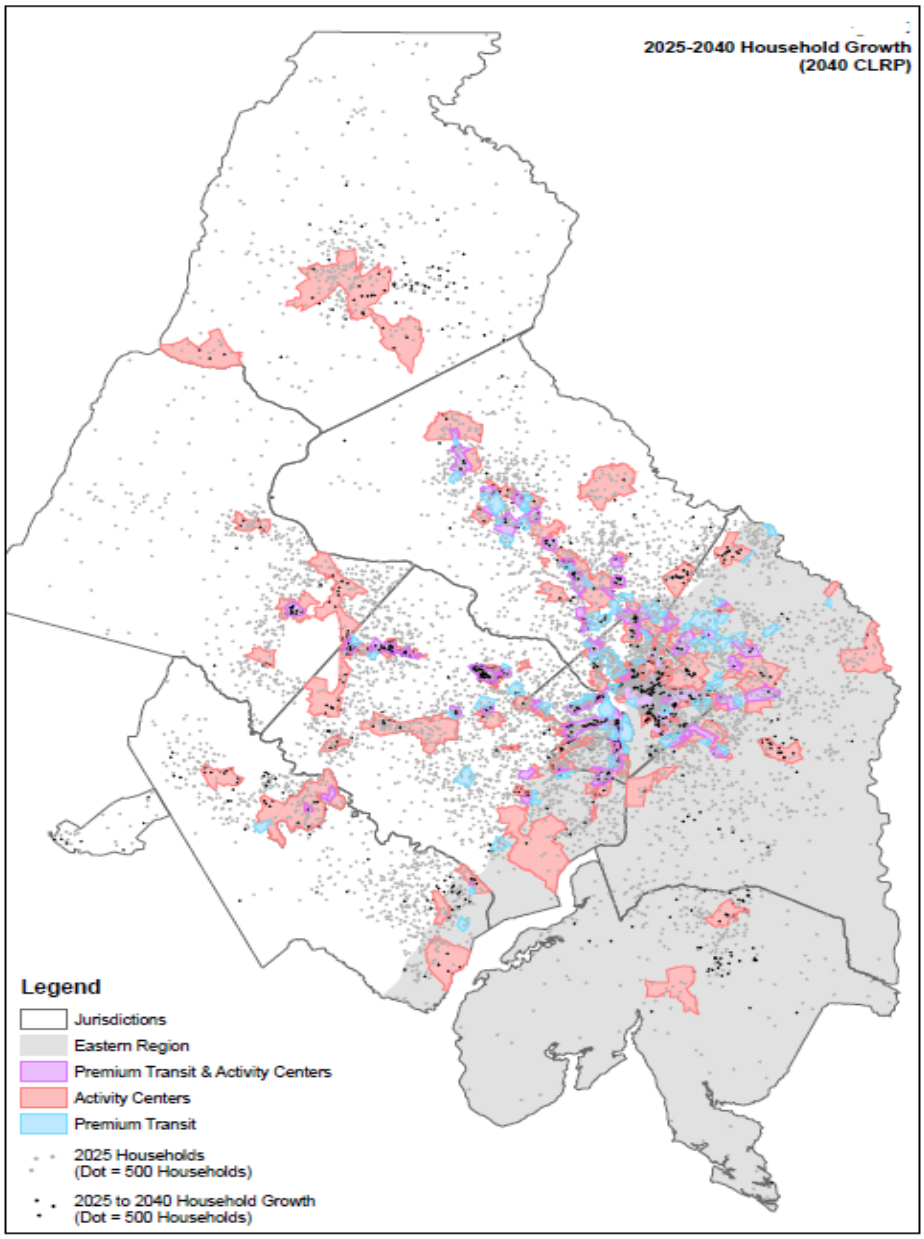
Source: Fehr & Peers

The increment of land-use growth between 2025 and 2040 ("growth increment") in the Round 9.0 Cooperative Forecast is adjusted in the following way:

1.Including the 130,000 additional households from outside the region, the regional job/household ratio in 2040 is 1.54 (including corresponding adjustments in external travel in the region).
2.The job and household growth increment is allocated between the eastern and western subregions such that both subregions reach a job/household ratio of 1.54.
3.Within each subregion, the job and household growth increment is allocated to individual jurisdictions in an iterative process with the goal of each jurisdiction approaching the regional job/household ratio of 1.54. The allocated growth increment for each jurisdiction is assigned to Transportation Analysis Zones (TAZs) to favor Activity Centers with high-capacity transit (underutilized rail stations).

Jurisdiction	2040 CLRP			Initiative 8 Land-Use		
	Households	Jobs	Ratio	Households	Jobs	Ratio
Alexandria	92,898	142,735	1.54	92,898	142,735	1.54
Arlington	131,149	267,641	2.04	165,427	266,422	1.61
Charles	83,426	58,762	0.70	83,426	71,019	0.85
District of Columbia	396,233	1,011,806	2.55	485,486	1,007,702	2.08
Fairfax	530,118	908,430	1.71	578,515	903,797	1.56
Fauquier	10,806	25,296	2.34	13,140	20,961	1.60
Frederick	126,539	133,934	1.06	113,522	127,507	1.12
Loudoun	167,588	273,910	1.63	162,387	249,798	1.54
Montgomery	450,922	653,917	1.45	438,110	644,989	1.47
Prince George's	370,023	393,336	1.06	370,011	453,943	1.23
Prince William	209,020	280,546	1.34	195,800	261,440	1.34
Eastern Subregion	**1,054,764**	**1,604,039**	**1.52**	**1,107,094**	**1,702,578**	**1.54**
Western Subregion	**1,513,958**	**2,546,274**	**1.68**	**1,591,628**	**2,447,735**	**1.54**
TPB Planning Region Total	**2,568,722**	**4,150,313**	**1.62**	**2,698,722**	**4,150,313**	**1.54**

Source: *MWCOG – Round9_2040_zone.dbf; Eastern3722TAZs.shp; TPBTAZ3722_TPBPlan.shp*



Source: Fehr & Peers

Figure 30: 2025 -2040 Household Growth

Analysis Approach

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts were adjusted as described above. Adjust external travel to reflect reduced regional in-flow associated with 130,000 households moved from outside the region. A full regional model with modified land-use and unmodified 2040 CLRP transportation network was done. The model results were used to analyze the MOEs.

Initiative 9: Transit Fare Policy Changes

Reduced Off-Peak Fares – Metrorail fares were reduced for off-peak direction during peak period and on underutilized segments. Fares were set to the non-peak rates for the off-peak direction, even during peak travel times.

Reduced Fares for Low-Income Residents –

Metrorail fares for low-income residents were reduced to zero. The low-income group is assumed to be the lowest income quartile from the MWCOG model.
2040 CLRP network will be assumed for this Initiative.

Land-Use

2040 CLRP Round 9.0 Cooperative Forecasts were used without any change.

Analysis Approach

Low-income trips fares were reduced to zero in the model framework, and non-peak fares will be used for peak trips in the off-peak direction by updating the fare matrices for Metrorail in the model framework.A post distribution mode choice and assignment were carried out using the person trips from the 2040 CLRP model. The model results were analyzed further and MOEs were generated.

Initiative 10: Amplified Employer-based Travel Demand Management

Expansion of Existing and Planned TDM Programs

This initiative assumes significant expansion beyond current TDM programs in the region, and includes new policies to expand them further at a regional scale. Policies that were included in this initiative are listed below:

- Expanded employer-based transit/vanpool benefits
  - Transit/vanpool subsidies averaging $50 per month are provided to 80% of employees
- Increase in priced parking in major activity centers.
  - 90% of parking for work-trips in activity centers is priced, with parking costs assumed to range from $4/day minimum (could reflect employer-provided parking cash out).
- Substantial increase in telework and flexible schedule adoption
  - 20% telework share (from current 10% share; this equates to an average of about 2 days per week [40% telework] for "office" employees, given overall share of office workers). Teleworkers come proportionately from other modes (drive alone, carpool, transit, etc.)

2040 CLRP network is assumed for this Initiative.

Land-Use

2040 CLRP Round 9.0 Cooperative Land-Use Forecasts is used without any change.

Analysis Approach

The effects of these policies were analyzed by applying a series of Transportation Analysis Zone (TAZ)-level adjustments to modal trip tables from the regional travel demand model. First, adjustments were made to trip tables for all modes to reflect an increase to 20 percent telework mode share. Then, adjustments were made to the remaining drive alone trips in the trip tables based on attraction-end TAZs for home-based work (HBW) trips and production-end TAZs for non-home based work (NHW) trips to reflect the expanded transit/vanpool benefits and increased application of parking pricing in activity centers. Drive alone reductions are calculated using TDM+. TDM+ is an Excel-based tool that estimates a percent reduction in vehicle miles traveled (VMT) due to a single Transportation Demand Management (TDM) strategy as well as the combination of multiple TDM strategies. A post mode choice auto assignment was conducted.

Further, the technical team applied professional judgment to refine targeted MOEs for this initiative. The refinements were informed by sensitivity tests that were conducted by staff and designed to simulate some aspects of the initiative.