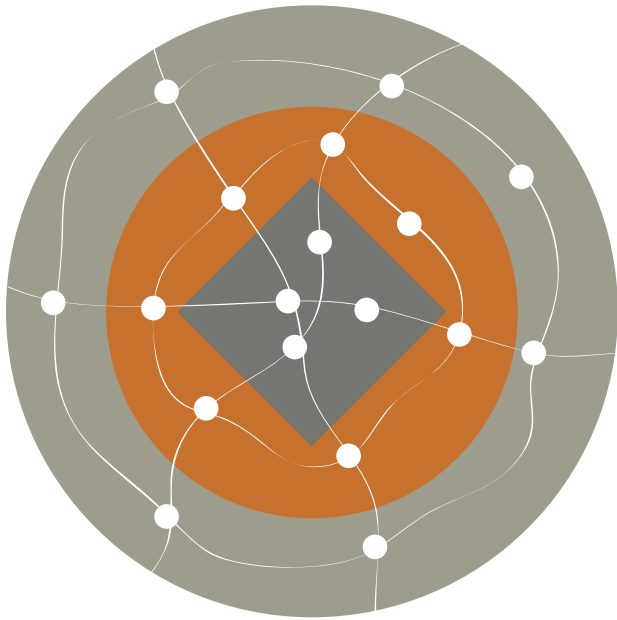


# TPB Scenario Study

## CLRP Aspirations Scenario



## Final Report

September 8, 2010

National Capital Region Transportation  
Planning Board

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<p><b>AGENCY:</b> The Metropolitan Washington Council of Governments (COG) is the regional organization of the Washington area’s major local governments and their governing officials. COG works toward solutions to such regional problems as growth, transportation, the environment, economic development, and public safety. The National Capital Region Transportation Planning Board (TPB) conducts the continuing, comprehensive transportation planning process for the National Capital Region under the authority of the Federal-Aid Highway Act of 1962, as amended, in cooperation with the states and local governments.</p>	
<p><b>ABSTRACT:</b> This document provides a summary of the development, analysis and results of the “CLRP Aspirations” scenario, which is one of two scenarios in the TPB Scenario Study. This scenario examines the effects of a long-range land use and transportation vision for the National Capital Region out to horizon year 2030. This report includes a summary of past scenario studies and how this scenario fills a gap, an overview of the scenario development and methodology, and an analysis of how the integrated land use and transportation scenario meets TPB Vision goals. The scenario consists of a smart growth land use strategy, a network of variably priced lanes, and an extensive BRT network running on priced lanes.</p>	
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# Introduction

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The National Capital Region has been blessed for decades with continued growth and prosperity, manifested by consistent population growth, growing commercial investment, and steady growth in jobs, despite the recent economic downturn. As more people come to the region to live and work, the region has also provided vibrant, livable centers and neighborhoods. In the past few decades, the region has become home to many national models for sustainable development, including a wide range of transit-oriented developments (TODs), mixed-use walkable communities, and infill developments that have revitalized neighborhoods in the region's core. These types of developments can be seen throughout the region, from the Rosslyn-Ballston corridor in Arlington County and the Columbia Heights neighborhood in the District of Columbia, to the City of Rockville in Suburban Maryland and the Town of Reston in Fairfax County, Virginia.

These national models also serve as models for other communities within the region, because although the National Capital Region has seen significant growth and prosperity, development has not been geographically balanced, equitable, or sustainable in all cases. For instance, while this region has some of the best examples of TOD, affordable housing for all income levels around transit and major employment centers remains a major challenge. As a result, the geographic separation between where people work and where they live continues to grow larger and the mobility needs of commuters strains the region's highway and transit systems. The region thus finds itself dealing with what ranks among the worst congestion in the country (on both roads and transit) and continuing challenges in meeting federal air and water quality standards.

Of course, these problems have complexities that are unique to the region and difficult to address. Local jurisdictions were able to come together to regionally build the Metrorail system and develop a mature road network that anticipated some future growth. But the growth that came was uneven, with much higher concentrations of commercial investment on the west side of the region than the east. In addition to creating some level of socio-geographic stratification, this uneven growth has had implications for transportation efficiency. It has created problems of directional congestion where some portions of the system are cripplingly overburdened and some are underutilized.

At the same time there is a growing discrepancy between the overall demand for travel within and through the Washington Region and the capacity of the region's transportation networks to meet that demand; the resultant congestion is a major threat to the economic vitality of the region and the quality of life its residents enjoy. Regional strategies to address these challenges must recognize a context of severely constrained resources for transportation operations, maintenance, and investment. But regional approaches to these challenges offer the potential to realize the efficiencies and benefits

of multi-jurisdictional coordination and multi-sectoral integration.

The TPB has tackled these issues of land use growth and transportation for years, testing potential solutions to the many problems discussed above, and collecting and disseminating information on successful local strategies. The CLRP Aspirations Scenario work described in this report is built on a foundation of previous TPB study of alternative regional scenarios and strategies, which are noted in brief in this report.

It became clear after studying previous, distinct land use and transportation growth scenarios, that it was time to develop a more comprehensive approach to meeting long-standing regional transportation goals that not only tackled transportation investment, but land use development as well. The CLRP Aspirations scenario is the next step in the TPB's history of building awareness of regional problems, like congestion, air pollution, unbalanced investment and development, and dwindling funding resources.



# Why Do a New Scenario?

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Although previous TPB scenario work resulted in meaningful conclusions about effective regional strategies for improving future travel conditions, there had not yet been an effort to pull together the best alternatives into a comprehensive scenario that could provide a clear path forward for the region. Such an undertaking could also help clarify the linkage between the TPB’s scenario work and implementation of scenario findings via prioritization of projects in the region’s Constrained Long-Range Transportation Plan (CLRP) or through ongoing initiatives such as the TPB’s Transportation/Land-Use Connections (TLC) Program.

This section briefly describes previous scenario work and demonstrates how it provided the underpinnings for the CLRP Aspirations Scenario, as well as questions for which a new scenario was needed to answer.

## 1. The Regional Mobility and Accessibility Study (RMAS), 2000-2007

The TPB in 2000 launched the Regional Mobility and Accessibility Study (RMAS) to look at land use and transportation scenarios that were not part of current regional plans. A key purpose of the study was to see if there were actions the region’s leaders might take to better meet the objectives of the TPB Vision, the regional transportation policy framework adopted in 1998.

Among its many goals and objectives, the TPB Vision calls for an increase in transit use and a reduction in VMT per capita. The Vision also stresses the need for better coordination between land use and transportation, with an emphasis on regional activity centers - places that are intended to be focal points for jobs and housing, and nodes for transportation linkages. The RMAS focused on those elements of the Vision.

The land use scenarios for the study were initiated by a number of “what if” questions, such as: What if more people who work within the Washington Region also lived here, rather than commuting from far-flung exurban areas like West Virginia and Pennsylvania? What if there was more development on the eastern side of the region? What if more people lived and worked close to transit?

Based on such “what if” questions, five land use scenarios were developed, based on the concept of changing where growth projected for 2030 would be located:

- **More Households** would increase, relative to projections, the total number of households in the region to more closely balance projected jobs to be located in the inner jurisdictions of the region.
- **Households In** would move some of projected household growth from outer jurisdictions into inner jurisdictions.
- **Jobs Out** would shift some of projected job growth from inner jurisdictions into

outer jurisdictions.

- **Region Undivided** would move some of projected job and household growth from the west to the region's eastern side.
- **Transit-Oriented Development** would put more of projected job and household growth close to transit.

These land use alternatives all promote concentrated land use patterns by shifting a significant portion of future growth into or close to regional activity centers. All five scenarios used different means to achieve the same objectives of bringing people and jobs closer together, and improving the transportation connections between them. The scenarios were not mutually exclusive, and in many ways were similar and complementary.

TPB staff analyzed the five land use scenarios, combined with additional transit projects not already included in regional plans, using the TPB's travel forecasting model. The analysis focused on the transportation effects of the various alternatives, including changes in congestion, transit use, and vehicle miles of travel. And on these measures, the scenarios produced positive results. When compared to the 2030 baseline, all five alternatives would slow the anticipated growth in congestion and driving, and in most cases would increase transit use.

The analysis has already inspired new regional programs. The TPB's Transportation/Land-Use Connections (TLC) Program, begun in 2006, promotes models for implementing regional policies by funding community planning activities. These projects help facilitate concentrated growth in the region's activity centers and near transit, and address some of the micro-level issues raised during the RMAS outreach effort.

The next question was how the study could feed back into planning decisions and influence development policy. The 2006 TPB Chairman Michael Knapp is quoted in the 2007 edition of *The Region* saying, "[RMAS] has confirmed that we can make a positive impact on future transportation conditions by locating housing and jobs closer together, approving development closer to transit stations, and expanding our network of public transit lines to support regional activity center." Although the RMAS provides general policy direction, more work is needed to translate those lessons into implementation and policy.

To determine specific next steps, TPB staff worked in conjunction with the TPB's Citizens Advisory Committee to conduct dozens of public forums on the scenario results, called "What if the Washington Region Grew Differently?" The outreach forums highlighted a common desire for comprehensive land use and transportation strategies that take into account multiple factors and regional causes of congestion, and incorporate elements from more than one of the scenarios studied in RMAS. Overall the reactions to RMAS highlighted a significant amount of further work to be done in this area.

## 2. Study of a Regional Network of Variably Priced Lanes - 2006-2008

The TPB has had an active interest in variably priced highway lanes as a possible method of managing congestion and raising revenue to provide much needed transit service. In 2003, in conjunction with the Federal Highway Administration (FHWA) and the region's three state departments of transportation, TPB sponsored a conference on value pricing that catalyzed regional discussion on the opportunities for developing variably priced lanes and implementing other pricing strategies. Following the conference, the TPB created its Task Force on Value Pricing to examine how value pricing could benefit the region.

Beginning in 2006, this Task Force oversaw the development of a study funded by the FHWA to analyze the potential effects of pricing highway use in the Washington Region and outline several different scenarios for adding new priced lanes, pricing existing highways, and enhancing bus services.

Three different scenarios of variably priced lane networks were developed and analyzed:

- A. The “**Maximum Capacity**” scenario added two variably priced lanes (VPLs) to each direction of most of the region's freeways. One VPL was added to each direction of major arterials outside the Capital Beltway. Existing high-occupancy vehicle (HOV) lanes were converted to VPLs, and direct access/ egress ramps were added at key interchanges in the VPL network.
- B. The “**DC Restrained**” scenario applied variable pricing to existing freeways and selected arterial lanes in the District of Columbia instead of adding new VPL capacity as in the “Maximum Capacity” scenario. Outside DC, this scenario would add the same new capacity as in the “Maximum Capacity” scenario.
- C. The “**DC and Parkways Restrained**” scenario further enhances the “DC Restrained” scenario by applying variable pricing to the existing capacity on the region's parkways (Baltimore-Washington, George Washington Memorial, Rock Creek, Clara Barton, and Suitland).

The results of the analysis demonstrated that toll rates would need to vary significantly by segment, direction, and time-of-day in order to maintain free-flowing conditions on the networks of toll lanes. Toll rates would range from a low of 20 cents per mile to more than \$2.00 per mile on the “Maximum Capacity” scenario, where all of the VPLs were either newly added lanes or conversions of existing HOV lanes. In the “DC Restrained” and “DC and Parkways Restrained” scenarios, toll rates were significantly higher on some segments, which was due in part to the fact that a significant percentage of lane miles in those scenarios were existing lanes as opposed to newly added lanes (43 percent and 56 percent, respectively).

The analysis was designed to elicit discussion, not to provide conclusive answers. “This

is not a proposal, it's a 'what if' study that provides very interesting insight into the implications of tolling for our region," said Arlington County Board Member Chris Zimmerman, 2008 Chairman of the TPB Value Pricing Task Force.

High-quality public transit was integral to the scenario analysis, as was emphasized by many Task Force and TPB members. The ability to run buses on value-priced lanes that are designed to be free-flowing allows for greater schedule predictability and more cost-efficient service, and is a key way to ensuring that value-priced lanes benefit not just those who can afford to pay the tolls.

While individual variably-priced facility projects such as the I-495 HOT Lanes in Virginia and the Intercounty Connector in Maryland have progressed and are currently under construction, with other projects in planning stages, the TPB study provided the first look at a region-wide network. The Value Pricing Task Force acknowledged early on that while VPL projects were likely to become more prevalent in the region, they would come online gradually on a project-by-project basis, not as part of a comprehensive regional initiative to implement an entire network. But it is possible and perhaps likely that individual toll projects and studies would eventually connect to form a network very similar to the one studied and the study allowed for quantification of the congestion benefits and cost estimates for such a network. The study also showed that there would be significant regional benefits, but that feasibility and equity concerns would be major hurdles to implementing an integrated regional network of VPLs.

## The TPB Scenario Study

The RMAS and the VPL Study yielded several important insights that can, and have, informed decision-making in the region. Moving forward, the TPB sought to fill in the gaps of the studies through new research and outreach opportunities that would eventually lead to a meaningful integration of study results into TPB planning processes and initiatives.

At its September 19, 2007 meeting, the TPB established the Scenario Study Task Force, chaired by TPB member Michael Knapp. The mission of the Task Force was to provide policy-level stewardship for the continuation of the Scenario Study and related TPB activities (such as the RMAS and VPL Study) and to move from "what if" to "how to."

The Scenario Study Task Force, the TPB Citizens Advisory Committee (CAC), and others identified several factors that limited the relevance and impact of the Scenario Study results. First, the RMAS and VPL scenarios had been essentially one-dimensional in approach; each scenario employs a distinct strategy for addressing regional challenges, but no scenarios had been studied that combined multiple strategies. While cost analysis was performed for the original RMAS scenarios, and costs were analyzed as part of the VPL scenarios, the Scenario Study had focused only limited attention on consideration of financial constraints. In addition, the study assessed the impacts of certain land-use and transportation strategies on regional transportation indicators, but

only touched upon non-transportation related indicators such as environmental and other quality-of-life measures.

In February 2007, the CAC issued recommendations to the TPB calling for “development of refined, new, or composite scenarios that will identify packages of transportation projects and land-use strategies that produce positive, synergistic results,” and for the process to “draw upon information developed from existing scenarios and from public feedback.

With those issues in mind, the Scenario Study Task Force proposed development of two new scenarios: a “What Would It Take?” Scenario that would start with a 2030 goal such as a level of mobile-source greenhouse gas emissions reduction and see what would be necessary to meet that goal; and the “CLRP Aspirations” Scenario described in this report.

The CLRP Aspirations Scenario represents a combination of land-use strategies from the RMAS scenarios along with a slate of transportation improvements that builds off of the 2008 CLRP and incorporates elements from the transportation networks analyzed in the RMAS and VPL scenarios; however, the land-use shifts and added transportation facilities included in the scenario were not limited to those already included in the previous studies. The scenario was intended to remain generally within the realm of affordability for the region given expected availability of funds, including the incorporation of VPL facilities as a revenue source. Analysis of the scenario relies entirely on the regional travel demand model and thus adheres to the representations of travel behavior reflected in the model.

# Goals of the Scenario Exercise

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The CLRP Aspirations Scenario represents the first time that the TPB has developed an alternative land use and transportation scenario whose purpose is not just to explore a single regional challenge or experiment with a single strategy, but instead to take a holistic, comprehensive approach to achieving a long-range regional outcome that is as preferable as possible to the business-as-usual baseline.

More specifically, the scenario seeks to better align land use and transportation planning with the goals of the TPB Vision and of the previous RMAS initiative. These goals include creating “economically strong regional activity centers with a mix of jobs, housing, services, and recreation in a walkable environment”, “a web of multi-modal transportation connections which provide convenient access”, “a user-friendly, seamless system”, and a combination of land use and transportation options that result in the “reduction of per capita VMT.” In addition, the scenario seeks to maintain the principles of RMAS, such as capitalizing on existing transit infrastructure through transit-oriented development, addressing geographic imbalances in development, and reducing congestion and commute times by getting jobs and housing closer together. The scenario in its completed form is intended to achieve these goals to the extent possible by creating highly accessible and developed activity centers served by an extensive transit network.

The determination was made that in constructing the scenario, goal-oriented rules would serve as the basis for land-use shifts and corresponding transportation investments and interventions. The process for developing the scenario is described in further detail in subsequent sections, but it is important to note that rather than simply being a composite of previous scenarios, the CLRP Aspirations Scenario arose from a fresh process that was strongly informed by, but not constrained by, previous scenario work.

## Land Use

One way in which previous scenario work informed the CLRP Aspirations Scenario was by providing evidence, courtesy of the regional Travel Demand Model, that bringing jobs and housing closer together and closer to transit enhances mobility, access, and transportation choice for residents of the region. Analysis of the RMAS scenarios - all of which were variations on that common theme, showed that even pursuing a concentrated, transit-oriented land use pattern incrementally could result in VMT decreases.

While the presence of transit infrastructure facilitates the concentrated land-use that is desired, the concentrated land-use also facilitates transit by providing transit-supportive density—a sufficient demand for transit service within a small enough space that transit investment is cost-effective. A certain level of density and a mix of land uses are also



helpful in ensuring that activity centers are walkable. In order for people to want to walk, they must feel safe - a quality that is enhanced by both activity and design. Dense, mixed-use development provides destinations that attract both day and evening activity. And permitting a certain level of density can also help local jurisdictions give developers the incentive to provide well-designed and well-constructed sidewalks, plazas, and other enhancements to the pedestrian experience.

Achieving more concentrated development also helps attain other regional benefits not related to transportation. It can slow down the rate of greenfield and agricultural land consumption, and can make it more affordable for localities to provide public utilities and other services.

## Transportation

The provision and maximization of complementary transportation infrastructure is just as crucial as achieving desired land-use patterns in this chicken and egg relationship. “Which comes first?” is an oft-debated question, but is largely irrelevant to the CLRP Aspirations Scenario, which is grounded in the knowledge that both are necessary to achieve regional goals.

The outreach effort that followed the development of the RMAS scenarios captured the extent to which members of the public appeal for more and better transit service when presented with the prospect of more concentrated development and communities with greater density. The region’s residents want transit that facilitates circulation with the region’s activity centers and that connects activity centers to each other—for both work and non-work trips.

But while there is certainly under-utilized transit capacity in the region, which is addressed by the Aspirations scenario, the demand created by growth and more concentrated development cannot likely be accommodated without some level of additional investment. That requires revenue, which is currently scarce and not expected to become abundant any time before the scenario horizon. The earlier TPB analysis on options for implementing variable pricing in the Washington region was seen as a possible scenario input to deal with revenue issues, as well as other transportation challenges.

Across the country and the globe, metropolitan areas facing revenue constraints for transportation are turning to variable pricing of both new and existing travel lanes as a way of funding both highway and transit improvements, while simultaneously decreasing congestion and improving bus service by providing free-flowing lanes. Including a network of VPL facilities throughout the region, along with a network of enhanced bus service utilizing those facilities, was viewed as the most promising way to make the CLRP Aspirations scenario financially feasible.

The scenario was designed to represent a realistic alternative future for the region

that could be implemented via TPB planning processes and a collaborative regional effort led by the TPB and COG. As such, it was developed within the limits of two key constraints. The first is that land use shifts should be able to realistically accommodate proposed densities while maintaining the existing or planned neighborhood character so that it can be considered for possible inclusion in the Cooperative Forecasts. The second is that transportation projects proposed for development under this scenario should be financially within reach, by assuming realistic funding sources. Possible funding sources include local and/or regional tax revenues, financial contributions from developers and increased land values around transit stations, revenue streams from pricing selected facilities, and new federal funding available for transit or possibly metropolitan areas through climate change legislation and federal transportation legislation reauthorization.

The CLRP Aspirations Scenario was intentionally designed to reflect the current procedures of the CLRP, such as the same representations of travel behavior used in the current TPB travel demand model and the same procedural guidelines required for federal air quality conformity analysis. This method preserves the possibility that the CLRP Aspirations Scenario could eventually serve as a de facto ‘unconstrained’ regional long-range transportation plan, following regional dialogue and outreach about the study findings. As updates are made to the TPB travel demand model through the inclusion, for example, of more recent household travel survey data both the CLRP and the scenario analyses will be updated to reflect the latest technical data and methods available.



# Scenario Baseline

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It is impossible to gauge the value and effectiveness of an alternative scenario without an accurate and well-understood baseline. The TPB and COG are tasked with regularly producing a long-range transportation and land-use baseline, in the form of the Constrained Long-Range Transportation Plan (CLRP) and the Cooperative Land-Use Forecasts, respectively. The combination of the most recent cooperative forecast and the current CLRP serves as the input for the regional Travel Demand Model, which in turn produces long-term forecasts for travel conditions and air quality. The CLRP Aspirations Scenario was analyzed in relation to a baseline comprised of the Round 7.2 Cooperative Land-Use Forecasts for 2030, approved by the COG Board on October 14, 2009, and the 2030 CLRP as of the updates approved by the TPB at its July 16, 2008 meeting. Each aspect of the baseline is discussed below:

## The Cooperative Land-Use Forecasts

The Cooperative Forecasting Program, established in 1975 and administered by COG, enables local, regional, and federal agencies to coordinate planning using common assumptions about future growth and development in the region. Each series of forecasts, or a “Round,” provides land use activity forecasts of employment, population, and households by five-year increments. Each round covers a period of 20 to 30 years.

The Cooperative Forecast is a multi-stage, “top-down/bottom-up” process undertaken by COG’s Planning Directors Technical Advisory Committee and the Cooperative Forecasting and Data Subcommittee. It employs a regional econometric model and local jurisdictional forecasts. The model projects employment, population, and households for the metropolitan Washington area based on national economic trends and local demographic factors. Concurrently, local jurisdictions develop independent projections of population, households, and employment based on in-the-pipeline development, market conditions, planned transportation improvements, and adopted land use plans and zoning. The Cooperative Forecasting and Data Subcommittee, which is comprised of local government planners, economists, and demographers, reviews and reconciles the two sets of projections.

Recognizing that market conditions and policies may change, the subcommittee reviews the forecasts annually, and allows local governments to make minor adjustments. The forecasts are also adjusted to reflect local governments’ assessments of the likely housing and employment impacts due to major new transportation facilities.

The Cooperative Forecasts are approved by the COG Board concurrently with the National Capital Region Transportation Planning Board’s (TPB) approval of the results of the annual air quality conformity analysis of the Transportation Improvement Program (TIP) and the Financially-Constrained Long Range Plan (CLRP).

The Round 7.2 Forecasts reveal dramatic increases in employment, households, and population by 2040, the end of the forecast period. According to the forecast, regional employment would total more than 4.6 million jobs by 2040, a 49 percent increase over the 2005 employment base of 3.1 million jobs. Households would reach more than 2.7 million, a 44 percent increase. The Round 7.2 Forecasts reflect the recommendations of the 2005 Base Realignment Closure (BRAC) Commission, as of June 2009.

## The Regional Activity Centers

The concept of “Regional Activity Centers” has been a part of the cooperative forecasting process since 2002, but how exactly is a “regional activity center” defined, and what power does this framework have as a tool for developing, analyzing, and implementing transportation and land-use scenarios?

As part of its 1998 Vision, the TPB adopted a series of goals, objectives and strategies, including the following objective seeking better interjurisdictional coordination of transportation and land use planning: “...A composite general land use and transportation map of the region that identifies the key elements needed for regional transportation planning—regional activity centers, principal transportation corridors and facilities, and designated green space.”

In 2002, the COG Board of Directors and the TPB approved the final Regional Activity Centers and Clusters maps based on the Round 6.1 Cooperative Forecasts as a tool to help guide land use and transportation planning decisions. The 58 Regional Activity Centers, which are based upon current local comprehensive plans and zoning, contained slightly more than half of the region’s current and future employment, but only about 10 percent of the region’s households. They are classified into one of five typologies according to their concentration of employment and housing. The Regional Activity Clusters were developed to portray a more stylized, conceptual depiction of development in the transportation corridors, much like the maps prepared for the Northern Virginia 2020 Plan. They depict groupings of Regional Activity Centers as well as the concentrations of housing and jobs immediately surrounding the Centers and along major transportation facilities. These Regional Activity Clusters contained nearly 70 percent of the region’s current and future jobs and approximately 31 percent of the region’s current and projected households.

In approving the maps of Regional Activity Centers and Clusters, the COG Board and the TPB also approved Resolution R13-02 which recommended that COG review and amend the regional activity centers maps following the adoption by the COG Board of each major round of its cooperative forecasts, i.e., Round 7.0, Round 8.0, etc. In addition, local and regional planning and policy goals may recommend working to increase either the amount of employment or housing in the Centers and Clusters.

The Regional Activity Centers and Clusters have been used extensively as a technical and policy tool to analyze the likely effects of growth and change in the region. For instance,

the Regional Activity Clusters served as the basis for reallocating future household and job growth for each of the five alternative land use scenarios in RMAS. TPB staff has also used the Regional Activity Clusters to identify how transportation projects/proposals support the regional core and regional activity centers, as stated in Goal 2, Strategy 4 of the TPB Vision: "...Give high priority to regional planning and funding for transportation facilities that serve the regional core and regional activity centers, including expanded rail service and transit centers where passengers can switch easily from one transportation mode to another."

In the most recent TPB Regional Household Travel Survey (2007/2008), the results indicated that placing priority on activity centers would not be without significant benefits. Among the survey findings are important differences in travel behavior between activity centers and non-activity centers. First, it was found that residents of the larger Regional Activity Centers/Clusters made two to three times more daily transit and walking trips than persons living elsewhere in the region. Correlated to this finding is that residents of inner area Regional Activity Centers/Clusters make fewer daily auto trips and travel fewer vehicle miles per household than persons living elsewhere in the region. It is likely that the density, walkability, and often-transit oriented nature of the activity centers provides enough alternative options to driving to enable a more balanced mode choice distribution across auto, transit, and walk/bike, which in turn has environmental, equity, and travel efficiency benefits.

The benefits of concentrating growth in activity centers make them an important potential policy tool; however, they are not fully utilized to date. By 2030, the Regional Activity Centers are forecast to capture approximately 2.05 million jobs, or 50 percent of all jobs in the region. Excluding the Mixed-Use Centers, the Regional Activity Centers are defined in terms of concentrations of employment. As a result, by 2030, the Regional Activity Centers are forecast to capture approximately 427,000 households, which is only 18 percent of all households.

The Round 7.2 Forecasts show that only about 45% of new jobs between 2015 and 2030 and about 30% of new households will be added to activity centers. Therefore, there is significant growth that can be better managed and concentrated to achieve the region's development goals. The forecasts also show a continued mismatch between the areas of concentrated development and the region's transit infrastructure. The Regional Activity Centers and Clusters contain 62 Metrorail Stations, eight Maryland Commuter Rail (MARC) stations, and seven Virginia Railway Express (VRE) stations. However, within the COG/TPB member jurisdictions, there are 24 Metrorail stations, 12 MARC, and eight VRE stations that are not located within Activity Center or Cluster boundaries.

While the Regional Activity Centers and Clusters are clearly descriptive of future growth anticipated in the region, a more important question has been whether or not the Centers and Clusters would or could be used as a prescriptive tool to guide future residential and commercial growth. The TPB Regional Mobility and Accessibility Study (RMAS) land use and transportation scenarios demonstrated the positive benefits

which would result from alternative future land use growth patterns. Discussion of other possible steps toward implementation has included the idea of identifying specific regional and local numeric targets for land-use density and mix in each center and overall.

The five typologies for Regional Activity Centers were established in 2002, with land-use criteria and descriptions of the differing character of the urban environment in the different types of centers:

- **DC Core**—Primary focal point of Metropolitan Washington. Comprises major centers within the District of Columbia. Contains the major governmental, cultural and tourism activities of the region, as well as significant business and commercial activity. Center of the region’s transit system. Pedestrian-oriented sidewalk network with an organized street grid/block configuration.
- **Mixed Use Centers**—Generally urban in character, areas up to two square miles (1,280 acres) that contain either a dense mix of retail, employment, and residential activity or significant levels of employment and housing. Accessible by transit or commuter rail and by major highways. Employment Criteria: Greater than 15,000 jobs and greater than 25 jobs/acre in 2030. Residential Criteria: Greater than 10 units per acre.
- **Employment Centers**—Higher density areas up to 3.5 square miles (2,240 acres) that contain significant concentrations of employment. Generally urban or becoming more urban in character. Employment Criteria: Greater than 20,000 jobs and greater than 30 jobs/acre in 2030.
- **Suburban Employment Centers**—More dispersed, lower-density areas, less than six square miles (3,840 acres). Employment Criteria: Greater than 15,000 jobs and greater than 10 jobs/acre in 2030.
- **Emerging Employment Centers**—Rapidly developing “campus-style” suburban employment areas less than six square miles (3,840 acres) in total area. Employment Criteria: Greater than 15,000 jobs in 2030, and greater than 50 percent job growth between 2005 and 2030 OR less than 50 percent commercial buildout in 2030.

The Regional Activity Centers provide a useful framework to guide a land use and transportation vision for the region and is used as a primary basis for the CLRP Aspirations Scenario.

## The CLRP and its Performance

The transportation component of the baseline for the CLRP Aspirations Scenario analysis is provided by the CLRP as adopted in November 2008. The performance analysis of the 2008 CLRP showed trends that run counter to the goals for the CLRP Aspirations Scenario. On the land-use side, metropolitan growth was projected to be most rapid in outer jurisdictions and outside regional activity centers. Additionally, there would continue to be areas of concentrated development with no transit service, as

well as areas with high quality transit capacity but no concentrated development.

As a result of the land-use trends and a slate of transportation improvements highly constrained by available revenues, it is no surprise that the performance analysis indicated large increases in congestion by 2030 on both the road and transit networks. With population and employment increases throughout the region, both VMT and transit ridership are expected to rise considerably. Lane miles of congestion in the region are projected to increase 43% between 2007 and 2030, though there is some improvement around planned HOT lane facilities. Similarly, the entire Metrorail system is expected to approach full capacity by 2030 absent additional, currently unforeseen funding.

# Developing the Scenario

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The CLRP Aspirations scenario is intended to provide guidance for the Washington region to better meet the goals of the TPB Vision and RMAS. Meeting these goals requires changes to both the transportation system and also where residential and commercial development is forecast to be located. As such, two components of the scenario were developed in concert: a transportation component and a land use component. Both components were developed separately using different inputs and tools, as discussed below; however, the development of each component was informed by the other in order to create a transportation system that fully supports the land use, which in turn was modified to best take advantage of the region’s existing transportation assets.

## Land Use

The primary purpose of the scenario’s land use component is to make the transportation system more efficient by concentrating growth in mixed use activity centers around existing and planned transit, which is expected to enable shorter trips made by transit, walk, or bicycle. However, this general approach is expected to more than just achieve transportation efficiencies. The land use component seeks to recreate the region’s 58 activity centers and additional transit station areas into economically vibrant, walkable, and transit supportive places.

As described in the previous “Baseline” section, regional forecasts of residential and commercial growth indicate a more sprawling, less efficient future than what is described in the goals of the Aspirations Scenario. Therefore, the land use component strategically redirects projected jobs and household growth, which factors in both new development and also projected redevelopment, into activity centers and around existing or planned transit infrastructure.

The concept of shifting projected land use growth for the purposes of this study has practical limitations that can inform how long-range integrated transportation and land use planning should be undertaken. As evidenced by RMAS, the amount of growth available to shift into existing activity centers is limited. In this study, it is assumed that all residential and commercial development planned before 2015 is in the pipeline and therefore unchangeable, leaving only 15% of 2030 jobs and households to be physically redirected to create more concentrated, smart growth oriented land use development. This becomes further constrained because 28% of the 2015-2030 growth is already forecast to occur in targeted growth areas, ultimately leaving only 11% as movable growth. While this may be true, adopting a strategic framework for shifting projected land use growth makes it possible to improve the urban form and achieve densities high enough to increase transportation options for much more of the population than is represented by the 2015-2030 growth.



The development of the land use component is comprised of a series of goal-oriented “rules” for shifting growth. All activity centers and transportation analysis zones (TAZs) with current/planned transit infrastructure received the necessary amount of residential and employment growth to be (1) transit supportive, (2) walkable, and (3) mixed use. These areas are the scenario’s “targeted growth areas.”

**(1) Transit Supportive**

In order for transit to be successful and financially feasible, it must be easily accessible to critical threshold of potential users. Currently, many of the region’s activity centers do not possess high enough densities to fully support even low frequency, lower cost transit services. Therefore, all targeted growth areas have varying residential and employment density goals that reflect what is realistic given their current urban form, but that are high enough to support varying levels of transit service, from local bus service with 30 minute or more headways to rapid transit with 5 minute or less headways. These assessments were based on research linking density and urban form to transit service:

Table 1: ITE Relationships between Transit Frequency and Land-Use Density

Transit Mode	Frequency of Service	Density Threshold
Bus	60 Minute Headway	4-5 du/acre
	30 Minute Headway	7 du/acre
	10 Minute Headway	15 du/acre
Light Rail	5 Minute Peak Headway	9 du/acre
Rapid Transit	5 Minute (or Less) Peak Headway	12 du/acre
Commuter Rail	20 trains/day	1-2 du/acre

**(2) Walkable**

The targeted growth area density goals were also determined based on regional criteria for walkability. This region has several models of walkable urban centers, each with varying levels of density and scale of development. Two representative models were used to frame density goals, one for higher density activity centers and another for lower density activity centers. The Rosslyn-Ballston Corridor has high densities of 20 du/acre or more and was thus used to inform walkable density goals for existing high density activity centers. Old Town Alexandria has lower, but walkable densities of 7-10 du/acre and was thus used as a model for lower density centers. Of course, achieving walkable centers requires more than just high densities; it also requires pedestrian infrastructure, such as sidewalks, sufficient crosswalks, adequate lighting, and inviting and engaging streetscapes. The scenario analysis depends entirely on the regional travel demand model, which makes “area type” assumptions based on density. As such, specific assumptions regarding pedestrian infrastructure are not included in the scenario and instead are assumed to be implicit in areas of higher density.

### **(3) Mixed Use**

Lastly, creating options for short trips requires some level of concentration of a variety of uses to ensure that origins (a home, for example) are relatively close to destinations (office, retail, entertainment, etc). Therefore, all targeted growth areas have varying goals for jobs/housing balance that, like with the density goals, reflect what is realistic given their current urban form.

Of the five different types of activity centers (DC Core, Mixed Use, Employment Center, Suburban Employment Center, and Emerging Employment Center) only Mixed Use centers have a residential density requirement in addition to an employment density requirement. The three types of employment centers have varying levels of density, but in some instances the residential density can be very low, such as less than one unit per acre, indicating an inability for residents to live near their work in these job centers. Therefore, the goal for these types of activity centers is to approach a balance of housing, employment and services. For other centers where the current densities are higher, the goal is to create a truly balanced mix of uses, enabling a resident to walk to a myriad of destinations.

The jobs/housing balance for the region is also improved by using the strategy of the More Households RMAS scenario, where additional households, and in this case some jobs, were added to the region's 2030 forecast. Specifically, a 3.5% increase in households and a 1% increase in jobs was assumed to be attracted into the region from outer jurisdictions beyond the TPB member area, which translates into a reduction in external trips coming into and leaving the region within the regional travel demand model. Jobs/housing balances were also maintained at the jurisdictional level to guide the inter-jurisdictional shifts of housing and jobs.

It is worth repeating that the density and jobs/housing goals for each targeted growth area will vary according to existing or planned conditions. Some activity centers that currently have lower densities cannot support the density of the DC Core or the Rosslyn-Ballston Corridor, nor is there enough projected growth between 2015 and 2030 to bring the densities of the 58 regional activity centers to those levels. Therefore, the concept of the targeted growth area was disaggregated further into seven "typologies," each with a residential density goal, an employment density goal, and a jobs/housing balance goal that reflects what is realistic. These typologies include the five types of activity centers, as well as transit station areas not in an activity center (either metrorail/transitway or commuter rail), each with different, realistic density and jobs/housing balance goals.

By concentrating growth strategically in these different types of areas, it is expected that the goals of the TPB Vision as well as the principles of RMAS can be better achieved. Directing future growth into activity centers can allow them to be more walkable and amenable to high quality transit infrastructure. Additionally, because growth is directed to areas with current transit infrastructure, progress is made toward geographically balancing development across the region, such as in the eastern portion of the region where development opportunities around transit stations are not fully utilized.



## Transportation Component

It is understood that just as transportation cannot single-handedly solve the region's development problem, neither can land use planning. The scenario's transportation component focuses on supporting the land use component by providing increased accessibility to the targeted growth areas, specifically for transit riders, carpools and those willing to pay tolls to drive low-occupant vehicles on variably priced lanes and facilities.

Although it is expected that concentrating land use around particularly underutilized transit stations can improve the efficiency of the current system, it is likely that new, more extensive services will be necessary to support increased population and commercial growth. The transportation component includes highway and transit improvements with major improvements to the baseline forecast coming from 3 major sources: TPB's 2008 study of variably priced highway lanes, a new regional network of bus rapid transit (BRT) operating on the network of variably priced highway lanes, and the RMAS transit network.

Pairing the priced lanes with BRT service provides the potential for great synergy: variably priced toll lanes provide free-flowing running-way for bus rapid transit vehicles and toll revenue offsets the cost of BRT facilities and service. BRT services reduce the demand for the priced lanes, allowing them to operate more smoothly and preventing congestion. Both the BRT and priced lanes should provide mode-shift incentives, providing congestion relief to the existing general purpose lanes.

### **1. Regional Network of Variably Priced Highway Lanes**

In February, 2008, the TPB completed an 18-month study of networks of variably priced lanes for the Washington region. The study evaluated the demand and revenue forecasts for different combinations of pricing of newly constructed and existing lanes. One such network included new lanes on all freeways outside the District and selected urban arterials outside the Capital Beltway in addition to the tolling of selected existing facilities: US National Park Service Parkways and all freeways and river crossings in the District. The revenue forecasts for this network approached the estimated cost of constructing and operating the toll facilities.

This regional network of variably priced lanes is the basis for the CLRP Aspirations scenario.

### **2. Regional Bus Rapid Transit Network Operating on Toll Lanes**

A high-quality network of bus rapid transit (BRT) service was then layered onto the regional network of priced lanes. The BRT is intended to be high quality, rail-like service that would integrate with the existing Metrorail system. It uses the relatively free-flowing priced lanes as running-way, allowing for rail-like travel speeds and levels of service. The BRT network provides service to BRT stations in the regional activity centers as well as connections to Metrorail stations and existing park-and-ride

lots via dedicated access ramps, which correspond with the targeted growth areas of the land use component. The extensive reach of the BRT network provides critical, new circumferential transit service and also provides important redundancies to the Metrorail system, which should relieve projected transit congestion.

The BRT service consists of varying bus transit service levels that depend on the goal densities specified in the Land Use Component. Lines connecting to the core have peak headways between 10 and 12 minutes (5 or 6 trips per hour) and off-peak headways of 30 minutes. Lines connecting less-dense activity centers operate less frequently.

Although the BRT would be running on the freeway, service would be provided to bus stations in activity centers via dedicated access ramps. In most cases existing infrastructure, such as transit stations and park-and-ride lots were used as BRT stations. In cases where there were no existing transit stations or lots, new stations were created in the regional travel demand model. In order to provide a high quality service, all stations are assumed to include BRT design standards and technologies (off-board fare payment), level-boarding, multi-door access) to reduce the dwell time. This reduced dwell time, dedicated access ramps and pseudo-dedicated right-of-way should result in an average BRT operating speed of approximately 45 mph where the transit service operates on freeway lanes.

Within the urban core, where few priced lanes will be evaluated, the bus transit service will operate in mixed traffic lanes along selected priority corridors as identified by WMATA in its Priority Corridor Network plan. Technologies and techniques such as transit signal priority, queue jump lanes and selective dedicated bus lanes are being considered for these Metrobus corridors. Along these corridors, an approximate average speed of 15 mph was assumed.

The BRT system is largely designed to facilitate longer trips utilizing the region's freeway network. Accessing transit in certain activity center neighborhoods would likely require neighborhood circulator services, which were provided in the scenario. For transportation analysis zones that were within targeted growth areas but did not have high frequency bus service (10 minute or less headways), circulator services were provided to connect one or more BRT stations with targeted growth areas. Fifteen activity center circulator systems with 10-minute headways were added to the scenario.

### **3. Selected RMAS Projects**

The BRT and priced lane network provides access to nearly all of the targeted growth areas and would also overlap with and connect many transit projects considered under the RMAS effort. A few RMAS projects that would provide additional transit service particularly to and within activity centers not connected to the BRT and priced lane network were included in the scenario transit network. These projects include:

- A. Purple Line Extension from Silver Spring to New Carrollton
- B. Georgia Avenue Transitway, from Glenmont to the Intercounty Connector

- C. US 1 Transitway, from King Street Metrorail station to Potomac Mills via Fort Belvoir and Woodbridge.
- D. VRE Extension from Manassas to Haymarket, via “Innovation” and Gainesville.

### **Local Outreach**

A major factor in the development of the CLRP Aspirations scenario was to somewhat limit the land use and transportation components using the concept of being “within reach.” This does not mean that the components have been rigorously tested for technical or political feasibility; however, extensive outreach to local planners was conducted to reflect local-level realities at a high level. After developing the basic framework for both the land use and transportation elements of the CLRP Aspirations Scenario and applying a rules-based approach, TPB staff met with planning and transportation staff from the local jurisdictions in the TPB planning area. These jurisdictional meetings were held with:

- A. District of Columbia
- B. Prince William County
- C. Prince George’s County
- D. City of Alexandria
- E. Montgomery County
- F. Arlington County
- G. Frederick County and City of Frederick (joint meeting)
- H. Loudoun County
- I. Fairfax County
- J. Virginia Department of Transportation

At each meeting technical details regarding both the land use and transportation components were discussed and comments were collected for incorporation into the final scenario. These comments included broad changes, such as a request to use the COG Cooperative Forecast Round 7.2 rather than Round 7.1, which included outdated assumptions and that targeted growth areas should only have growth shifted into them and not out even if they were already beyond the density goal. Other major comments included: modifications to the targeted growth areas to deemphasize some regional activity centers and/or to concentrate growth in up-and-coming local centers, such as Westphalia, Fort Belvoir, and others; changes to specific BRT routing, particularly when circulating through targeted growth areas; and changes to BRT station number and placement.

Additionally, the scenario received review throughout the development process from the TPB Regional Bus Subcommittee and the COG Planning Directors Technical Advisory Committee, as well as broader review from the TPB Technical Committee and Scenario Study Task Force.

In addition to some degree of technical feasibility, the “within reach” concept also

attempted to consider financial feasibility of the transportation component. The reality that funding for new transportation infrastructure is severely limited and is becoming more limited every year was a primary driver of the inclusion of the pricing component. The regional priced lane network is roughly estimated to generate \$2.5 billion in revenue annually and the cost for the tolled network is estimated at roughly \$51.5 billion. The figures are intended to provide an idea for the cost-revenue balance of the system and to show that while the costs of the tolled network are high, with costs and revenues not equally distributed across the region, it is expected that the toll revenue could be used to partially finance transit, which is a necessary component of a pricing strategy in order to insure some level of social equity. It should be noted that detailed cost and revenue calculations were not completed for this study, but will be a part of future scenario work.

Although detailed calculations of toll revenue, construction costs, and transit costs/revenues were not completed, revenue estimations for the “CP Scenario” from the 2008 TPB Study “Evaluating Alternative Scenarios for a Network of Variably Priced Highway Lanes in the Metropolitan Washington Region”, which provides the foundation for the CLRP Aspirations Transportation Component, can be used to get an idea of the expected cost recovery from the tolled lane and transit network. The CP Scenario shows that 20-year revenues from tolls are expected to achieve a 110% cost recovery for the construction of the new priced lanes and associated interchanges providing access to the tolled network. The CP scenario did not include enhanced transit, but an additional scenario with enhanced bus transit (“CPT”) was run. The enhanced transit consisted of more frequent existing bus service and some new bus routes. The CPT scenario achieved a 96% cost recovery, indicating that the surplus revenue from the CP scenario could be used to partially fund the enhanced transit. The Aspirations scenario transit system is significantly more robust than the 2008 study enhanced transit assumptions and would thus likely be more costly than the CPT scenario and show a lower cost recovery. For more information on the priced network and the cost assumptions, please see the aforementioned 2008 study here: [http://www.mwcog.org/TPB/VPTF/docs/RVPS\\_Final\\_Report.pdf](http://www.mwcog.org/TPB/VPTF/docs/RVPS_Final_Report.pdf). It should be noted that these estimates assume a high number of costly interchanges that provide access to the tolled network. This is discussed further in the “future work” section.

The scenario also includes other transit services that do not operate on tolled lanes, such as BRT and circulator service assumed to operate on local streets, as well as rail projects. These services are assumed to be funded by various sources, such as special tax districts, tax-increment financing or developer proffers, as it is well understood that public funding for such projects is in short supply.

## The Final CLRP Aspirations Scenario

Following the process outlined above, the developed scenario consists of three distinct, but connected layers: land use, roads and pricing, and transit. The scenario redirected a substantial amount of residential and commercial growth projected to come into the

region between 2015 and 2030 and added substantial new transportation infrastructure to the current road and transit networks.

### **Layer 1: Land Use**

Of the 11% of jobs and households projected for 2030 to be “movable,” 60% was actually shifted. This translates into 7% of 2030 jobs and households being shifted into targeted growth areas. Jobs and households projected to be in targeted growth areas increased significantly under the scenario with an 11% increase in the number of jobs and a 42% increase in the number of households. Under baseline conditions 58% of jobs and only 26% of households are forecast to be in targeted growth areas. Under the scenario, these numbers jump to 64% of jobs and 36% of households.

On the succeeding four pages are two sets of land use maps illustrating the major changes studied in the land use component. Figure 1 shows the land use growth in the scenario in terms of households and employment for 2030. For comparison, Figure 2 shows the same data for the baseline. The scenario growth maps clearly show a much more concentrated growth pattern than the forecast baseline. Figure 3 shows the density of the scenario land use, which, when compared with Figure 4 showing forecast land use density, shows particularly higher household densities in targeted growth areas, as expected. Higher household densities coupled with high employment densities in targeted growth areas implies that a more even jobs/housing balance within activity centers was achieved, as desired.

### **Layer 2: Roads and Pricing**

The scenario creates a 1,650-mile regional priced lane network with 150 priced lane miles that are currently in the baseline CLRP (9% of the total network), 350 lanes miles converted from HOV lanes (21% of the total network), 650 new priced lane miles (40% of the total network), and 500 priced lane miles converted from general purpose lanes in the District of Columbia and on the region’s national parkways (30% of the total network). This priced lane network provides new, priced capacity for auto users and creates relatively free-flowing right of way for bus transit. A map of this network is provided in Figure 5 on page 28.

### **Layer 3: Transit**

The scenario creates a 500-mile regional BRT system with 138 BRT stations located in activity centers and existing parking facilities. To support the BRT system, 140 miles of circulator service is also provided. This is in addition to three RMAS rail projects and one transitway on Georgia Avenue that connect to the regional BRT system. In total, the transit system creates a system that provides critical new service (particularly circumferential connections between activity centers), redundancies to the Metrorail system to relieve current and forecast congestion, and connections to the existing transit system. A map of this network is provided in Figure 6 on page 29.

Figure 1: Scenario Growth by TAZ, 2015-2030

# 2030 Scenario Growth by TAZ

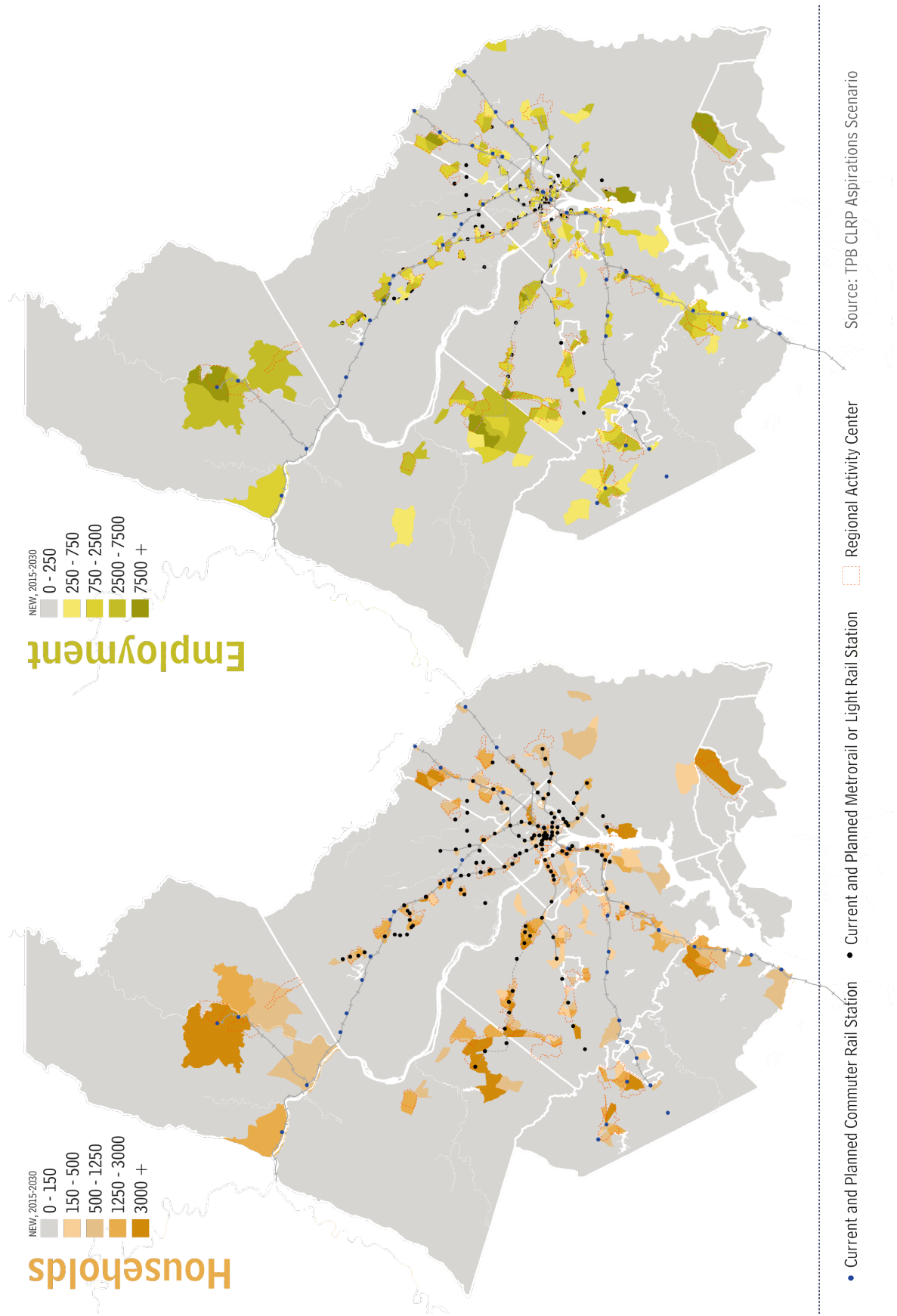




Figure 2: Forecast Growth by TAZ, 2015-2030

# 2030 Forecast Growth by TAZ

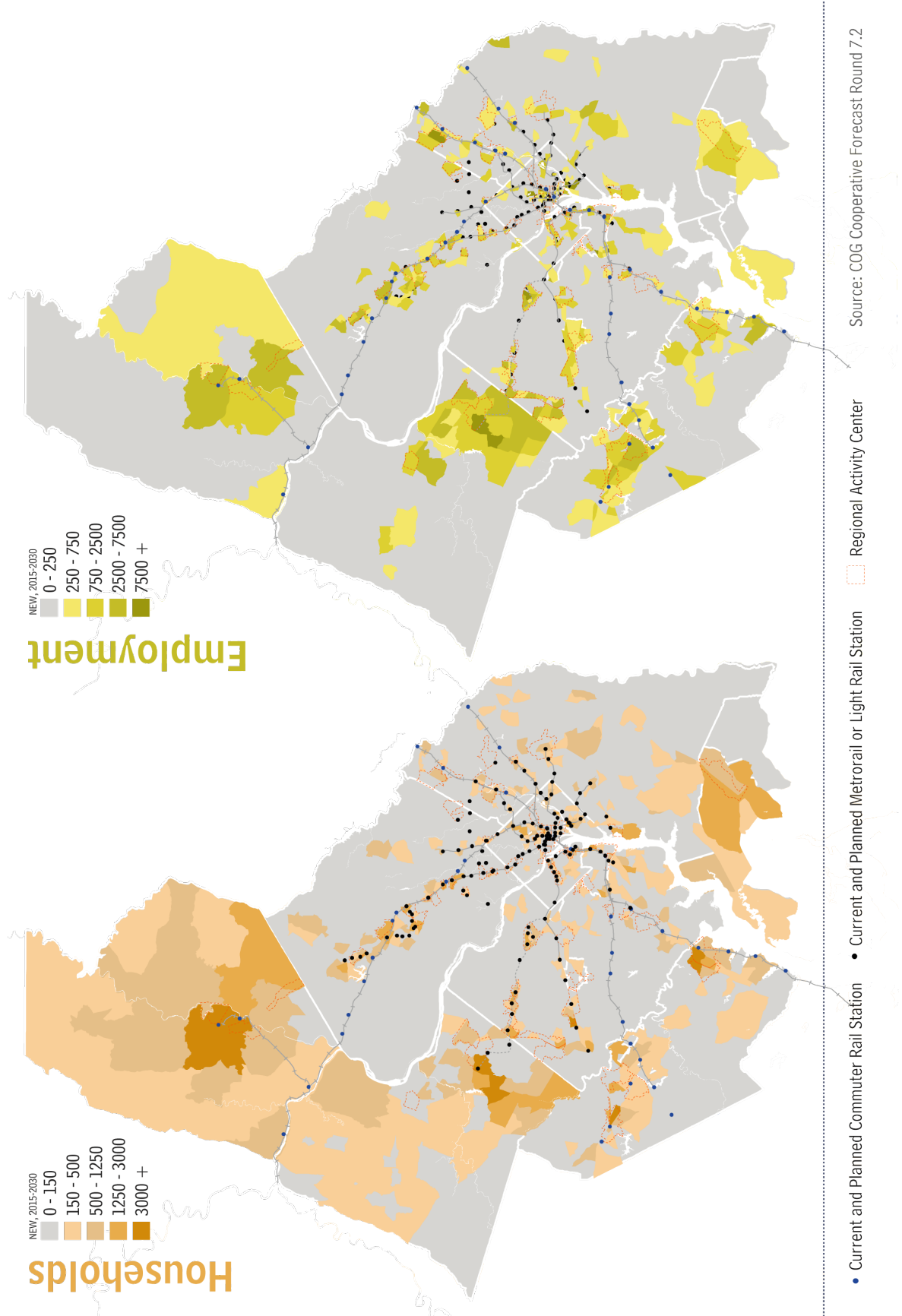
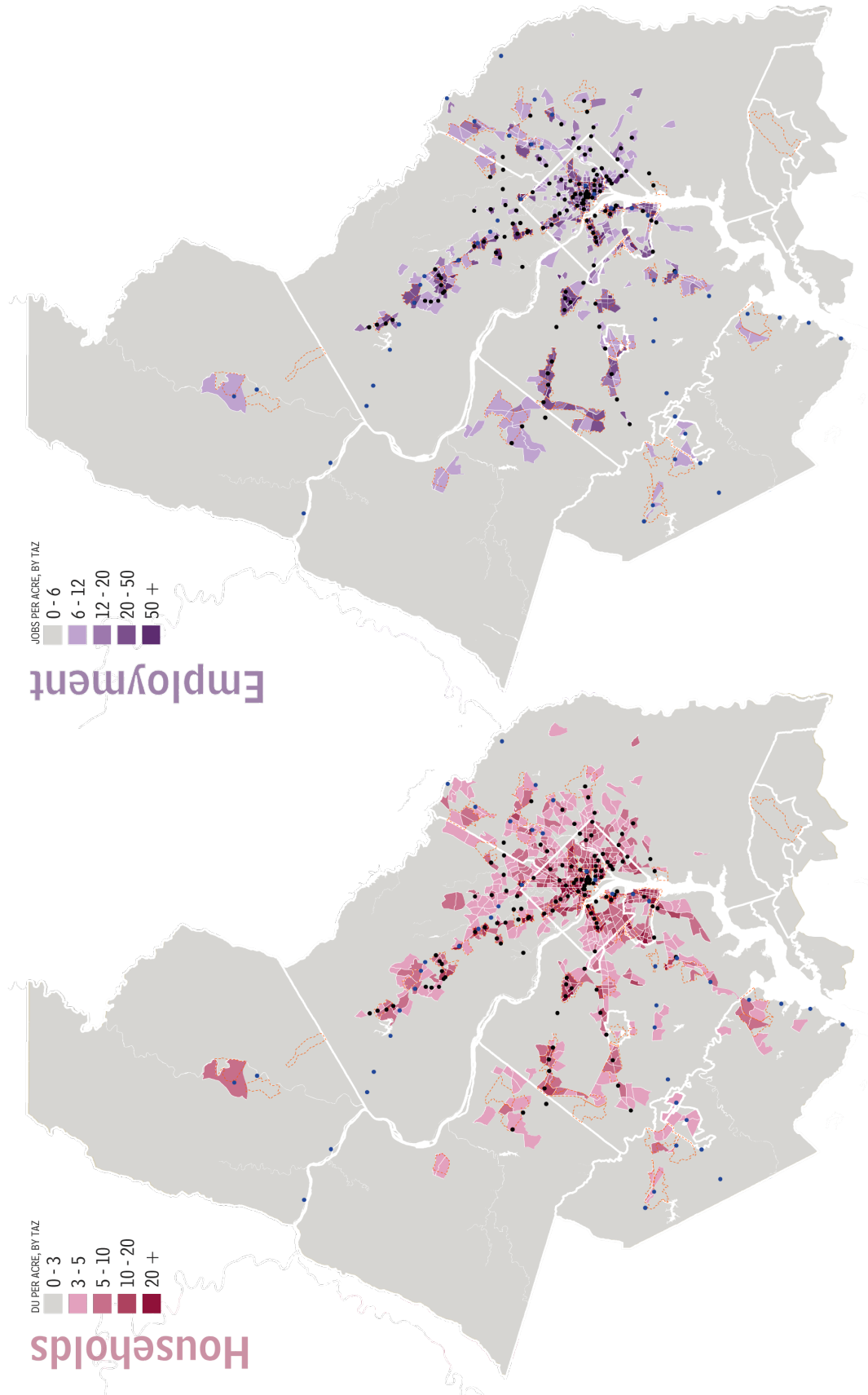


Figure 3: 2030 Scenario Density by TAZ

# 2030 Scenario Density by TAZ

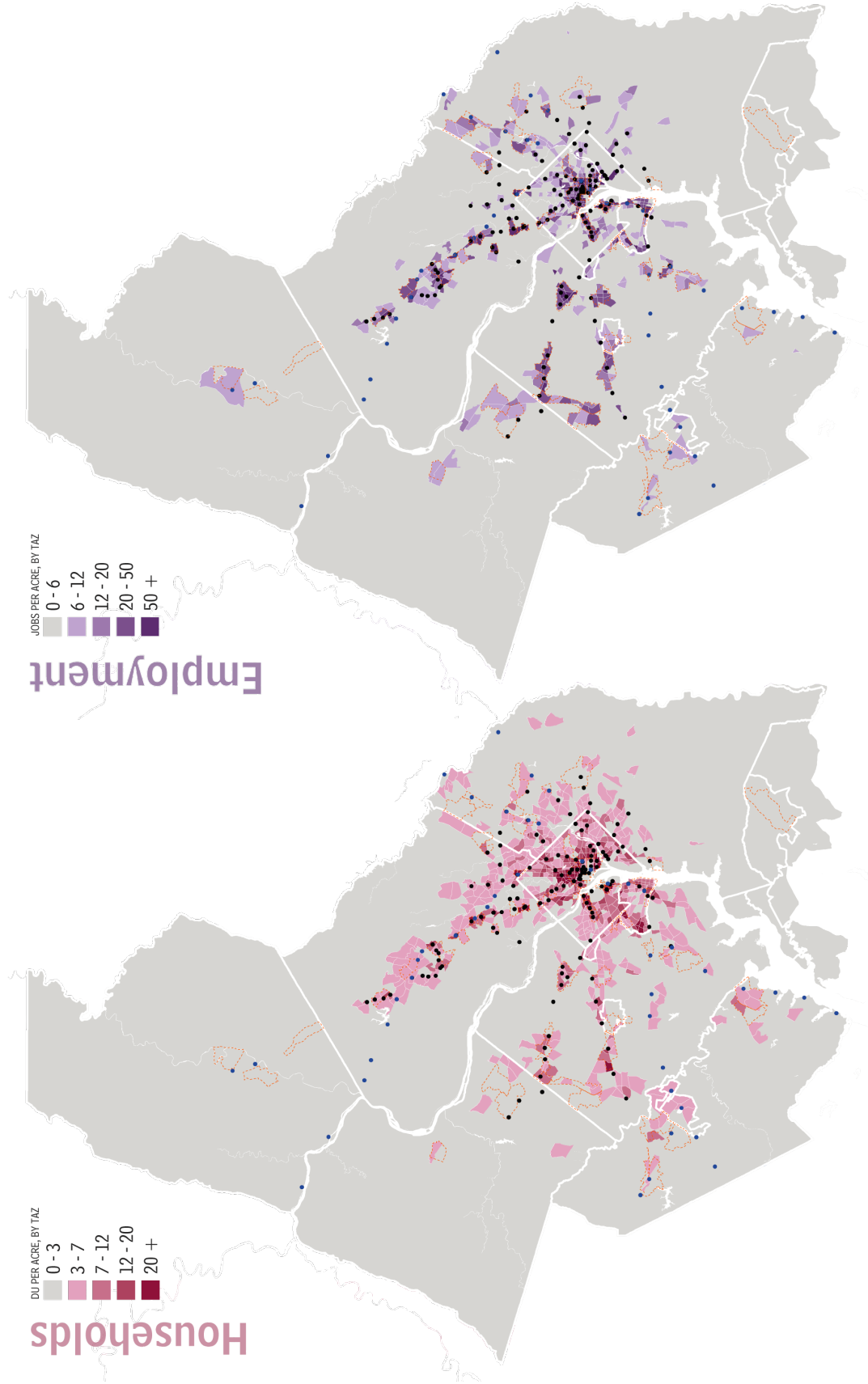


• Current and Planned Commuter Rail Station • Current and Planned Metrorail or Light Rail Station • Regional Activity Center Source: TPB CLRP Aspirations Scenario



Figure 4: 2030 Forecast Density by TAZ

# 2030 Forecast Density by TAZ



Source: COG Cooperative Forecast Round 7.2

Regional Activity Center

Current and Planned Metrorail or Light Rail Station

Current and Planned Commuter Rail Station

Figure 5: Value Priced Lanes Network in Scenario

# Network of Variably Priced Lanes

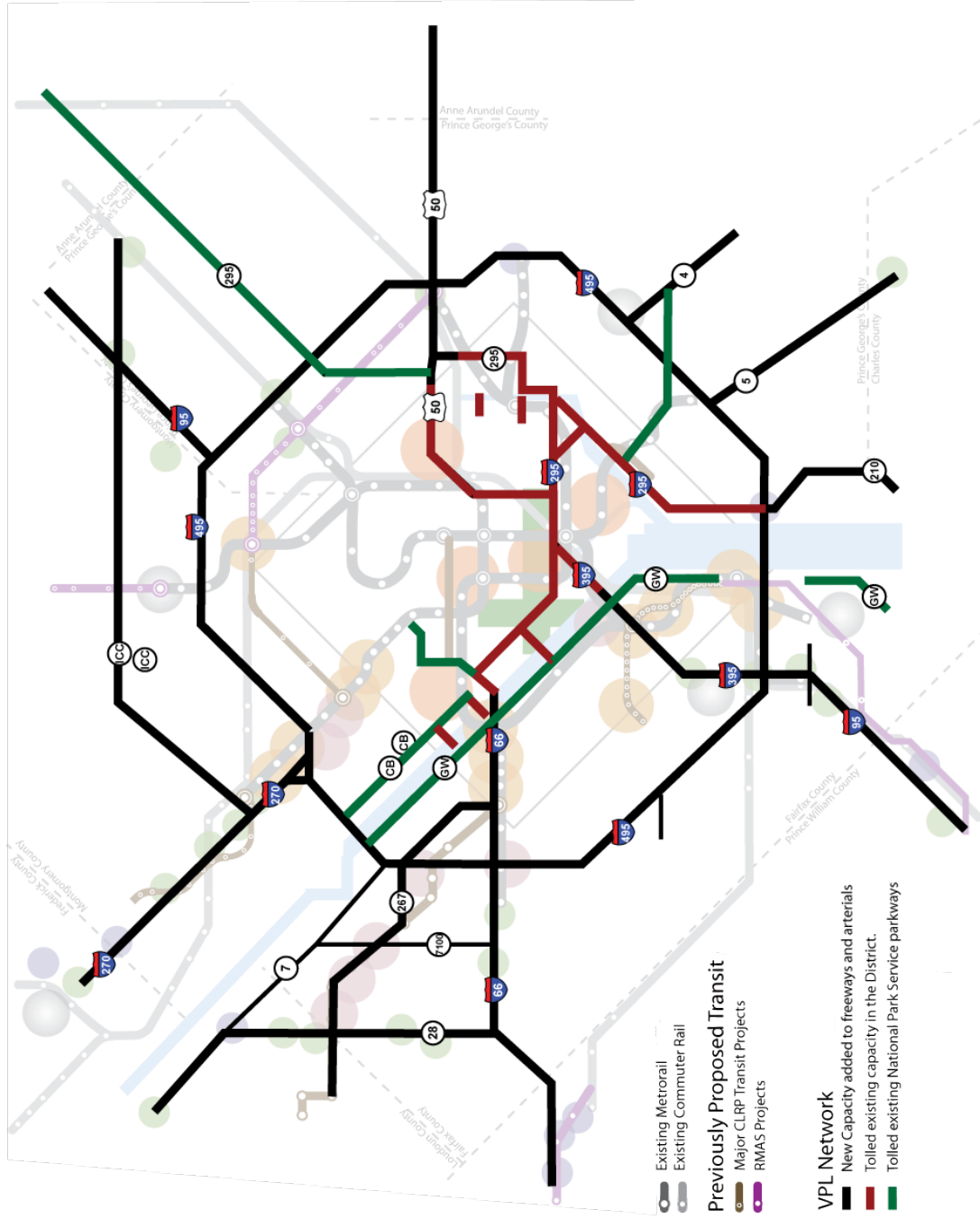
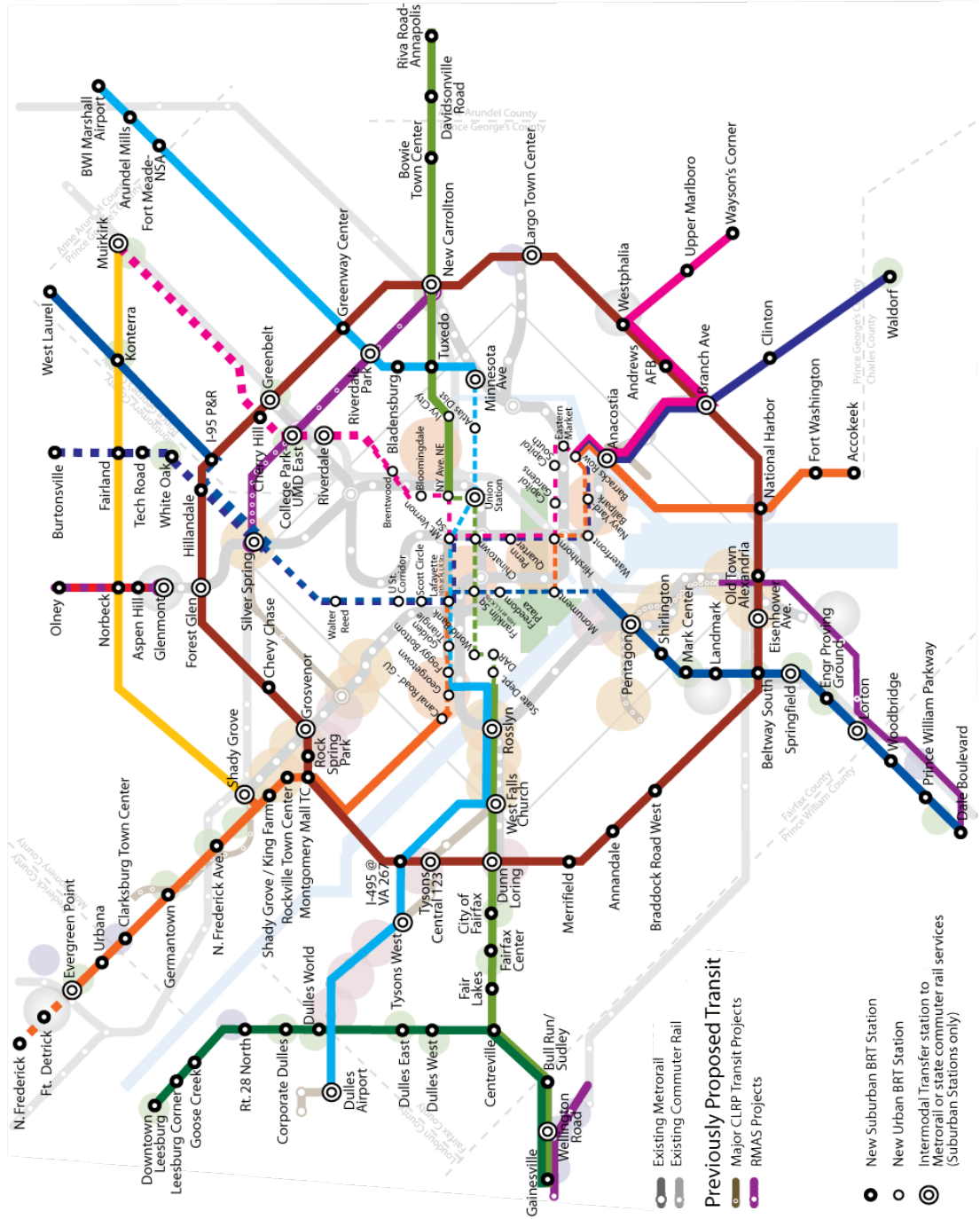


Figure 6: Bus Rapid Transit Network in Scenario

# Bus Rapid Transit Regional Network



# Results

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This section presents the results of the analysis of the CLRP Aspirations scenario as compared to the study baseline, the 2008 CLRP and land use growth assumptions from the COG Cooperative Forecast Round 7.2. Additionally, results are presented of the analysis of a land use sensitivity scenario consisting of only the smart growth assumptions contained in the full CLRP Aspirations Scenario. This sensitivity scenario was run in order to control for land use changes and better understand their potential effects on travel demand.

The following indicators were measured based on the regional travel demand modeling results of the baseline forecast, the full CLRP Aspirations scenario, and the land use sensitivity scenario:

1. **Vehicle miles traveled (VMT):** Provides an overall picture of how much travel by automobile is occurring in the region, which can be a direct or indirect indicator for meeting various regional goals, such as reducing air pollutant emissions and providing a wide range of transportation choices.
2. **VMT per capita:** Indicates how much driving is occurring per person and therefore controls for population growth.
3. **Average auto trip length:** Provides detail into how far travelers live from work and other destinations.
4. **Average daily speed:** Provides an overall picture of the level of roadway congestion.
5. **Vehicle hours of delay (VHD):** A more detailed indicator of congestion, which provides information on the amount of time spent on the road because of roadway delays.
6. **Transit trips:** Trip count that can be used to determine mode shifts across scenarios.
7. **Bicycle and pedestrian trips:** Trip count that can be used to determine mode shifts across scenarios.
8. **External auto trips:** Trips that originate outside of the TPB planning area, which generally represent commuters living outside of the region but working within the region.
9. **Jobs accessible by auto/transit within 45 minutes:** TAZ-level analysis that determines how many jobs are accessible to households in a specific TAZ with a 45 minute or less commute via auto, transit, or walk-access transit. This factors in roadway congestion for auto accessibility, proximity to transit and quality of service for transit accessibility, and proximity to transit for walk-access transit.
10. **Air pollutant emissions:** Emissions, largely based on the travel demand indicators already described, for criteria air pollutants and greenhouse gas emissions (GHGs). Criteria air pollutants are nitrogen oxides (NO<sub>x</sub>), fine particulate matter (PM<sub>2.5</sub>), PM<sub>2.5</sub> precursor NO<sub>x</sub>, and volatile organic compounds (VOCs). NO<sub>x</sub>,

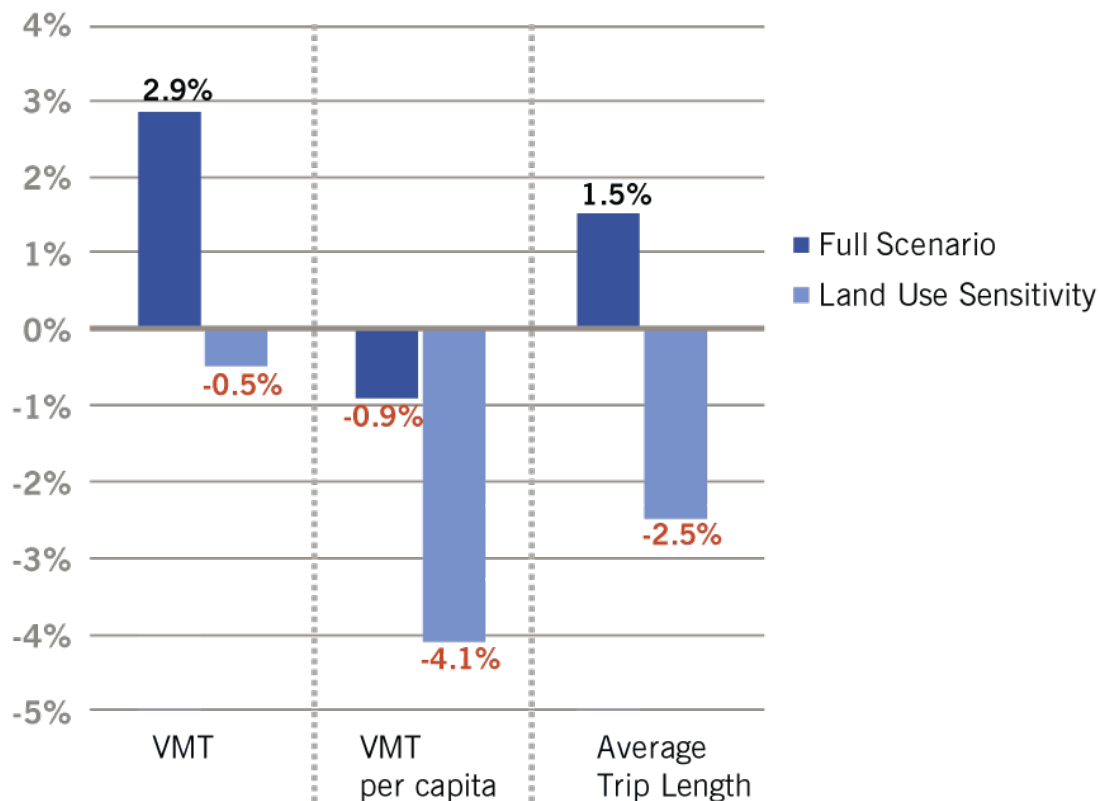
VOCs, and PM<sub>2.5</sub> precursor NO<sub>x</sub> all contribute to ground level ozone formation, which poses serious human health risks. PM<sub>2.5</sub> also poses similar health risks, such as respiratory illness and heart disease. The primary GHG of concern in this scenario is carbon dioxide (CO<sub>2</sub>), which is the largest contributor to human-induced global warming from the transportation sector.

The CLRP Aspirations scenario consists of significant land use and transportation changes to the baseline forecast for the region, such as aggressive smart growth assumptions, extensive BRT serving new and existing mixed use centers, new priced road capacity, and pricing of some existing roadways to ensure efficient road use. As expected, these changes in growth assumptions and in transportation investment resulted in measured changes to travel demand projections.

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

### 1. Driving increases in the full scenario, but decreases in the land use sensitivity.

Figure 7: Change in Driving Indicators between the Scenarios and Baseline



**Full scenario:**

Regionally, the full scenario increases baseline VMT projections by 2.9%, motorized trips by 2.0%, and average auto trip length by 1.5%. Despite these increases, VMT per capita decreases by 0.9%, indicating that the increase in population under the land use component is higher than the regional increase in VMT. Additionally, because it is assumed that the increase in jobs and households in the land use component would be attracted from just outside of the region, external auto trips decrease by 6.5%. It is likely the reduction of these trips reduced the increase in average auto trip length.

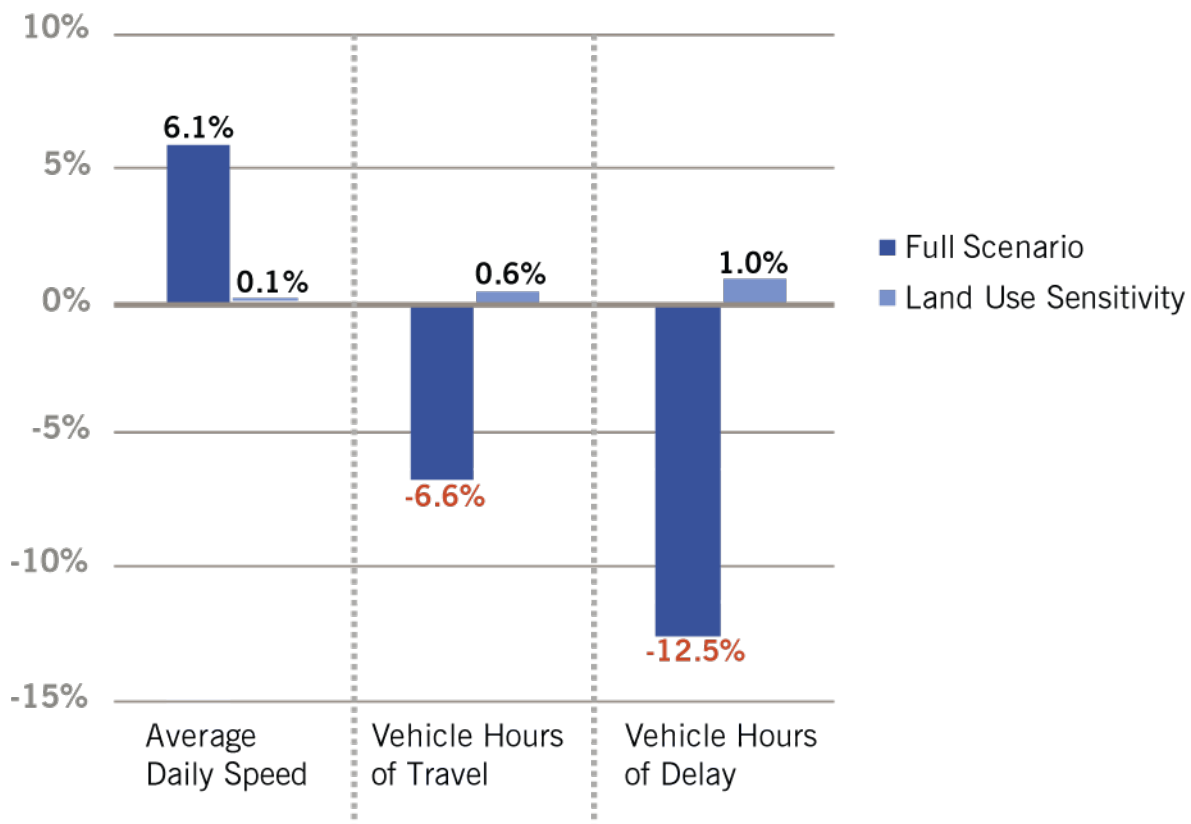
**Land use sensitivity:**

In the land use sensitivity, VMT decreases slightly by 0.5%, auto trip lengths decrease by 2.5%, and VMT per capita decreases by 4.1%. Despite these decreases, the number of motorized trips increases by 2.3%.

When compared to the full scenario, the land use sensitivity has 3.2% fewer VMT, 3.2% fewer VMT per capita, 4.0% shorter auto trip lengths, and 0.4% more motorized person trips. External auto trips decrease by 6.5% in the land use sensitivity and therefore did not change across the two scenarios.

**2. Congestion decreases in the full scenario, but remains stable in the land use sensitivity.**

Figure 8: Changes in Congestion Indicators between Scenarios and Baseline



**Full scenario:**

Overall average speeds across the region increase significantly by 6.1% and vehicle hours of delay decrease dramatically by 12.5%, signaling significant decreases in congestion.

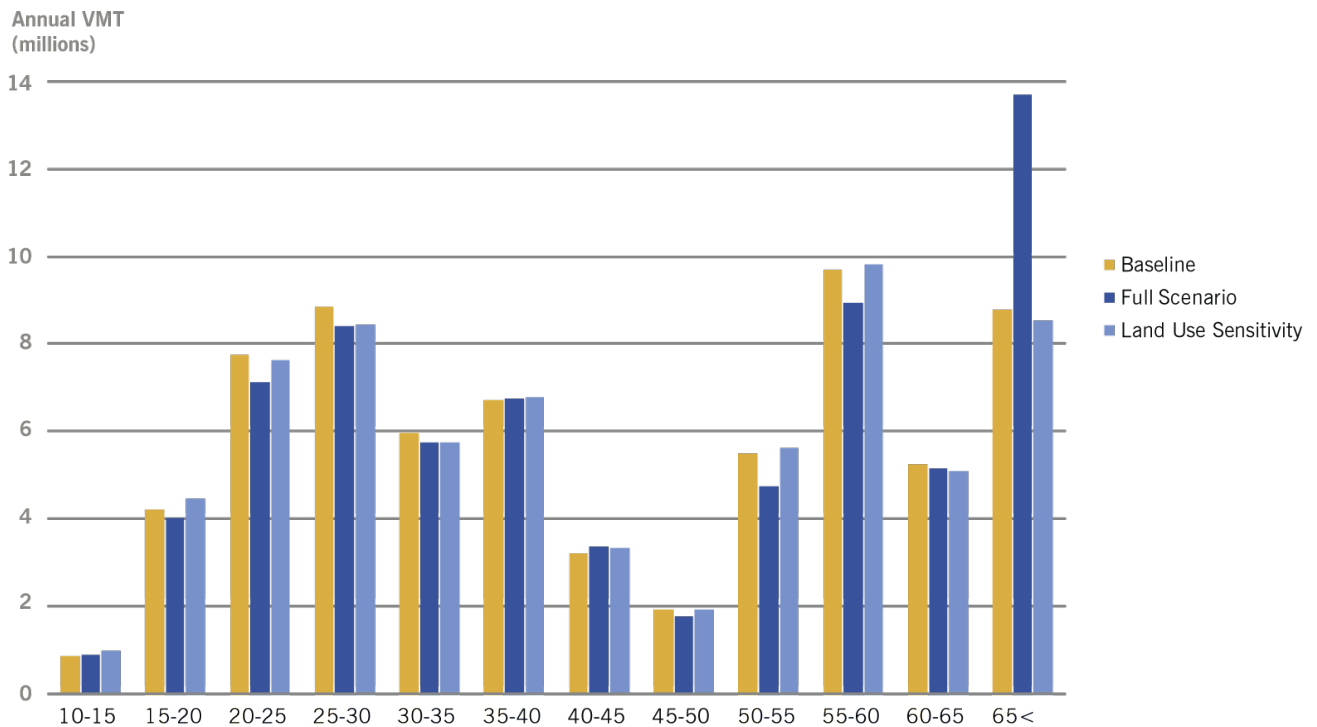
**Land use sensitivity:**

Average speeds across the region stay relatively the same in the land use sensitivity compared to the baseline. Vehicle hours of delay increase slightly by 1.0%.

The land use sensitivity does not produce any of the congestion reduction benefits of the full scenario, as expected. Average speed is 5.8% higher in the full scenario than in the land use sensitivity and vehicle hours of delay are 15.4% lower.

Figure 9 below shows a more nuanced picture of how congestion levels are changing between the baseline and the two scenarios.

Figure 9: Changes in VMT by Speed between Scenarios and Baseline



Under the full scenario, average speed clearly increases because of the 56% increase in VMT at speeds 65 mph and above. It also shows a 3% increase in VMT emissions from the 10-15 mph speed category, highlighting increases in congestion in some parts of the road system. This could point to dramatic congestion reduction on priced freeways and higher congestion on local roads, particularly around activity centers that have new access points to the priced network.

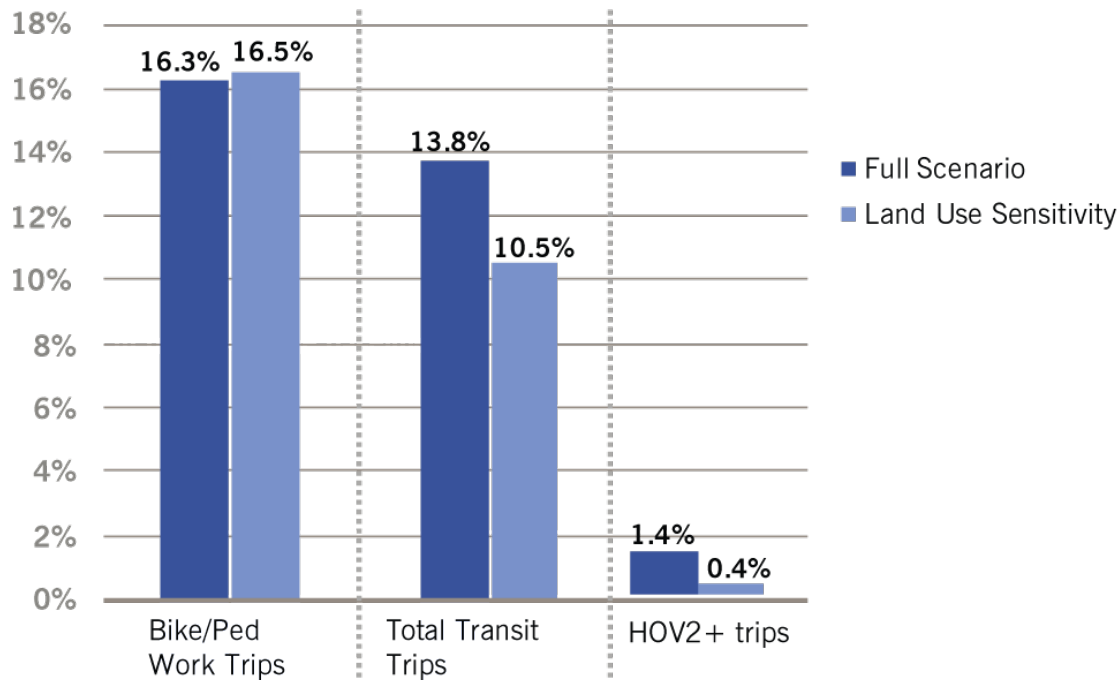
The land use scenario produces relatively small increases in VMT at slower speeds (10-



20 mph), but also shows increases in VMT at middle range speeds (35-60 mph). VMT at very high speeds (60+ mph) decreases under the land use scenario. Similar to the full scenario, this could point to higher congestion levels on local roads in activity centers, which received a significant influx of jobs and housing under the land use component.

### 3. Use of sustainable modes increases

Figure 10: Change in Sustainable Mode Trips between Scenarios and Baseline



#### Full scenario:

Transit use increases, with total transit trips increasing significantly by 13.8%, which increases the overall transit mode share by 11.6% from 5.0% to 5.6% of all trips.

Under the full scenario, bicycle and pedestrian use also increases significantly, with total bicycle and pedestrian work trips rising by 16.3%. It should be noted that only non-motorized work trips can be measured using the regional travel demand model. Given that a significantly higher portion of baseline non-work auto trips than work auto trips are projected to be less than three miles, it is conceivable that even greater increases would be seen if all non-motorized trips could be measured.

#### Land use sensitivity:

As in the full scenario, transit use increases, with total transit trips increasing significantly by 10.5% over the baseline projections. This increases the overall transit mode share by 8.0% from 5.0% to 5.4% of all trips.

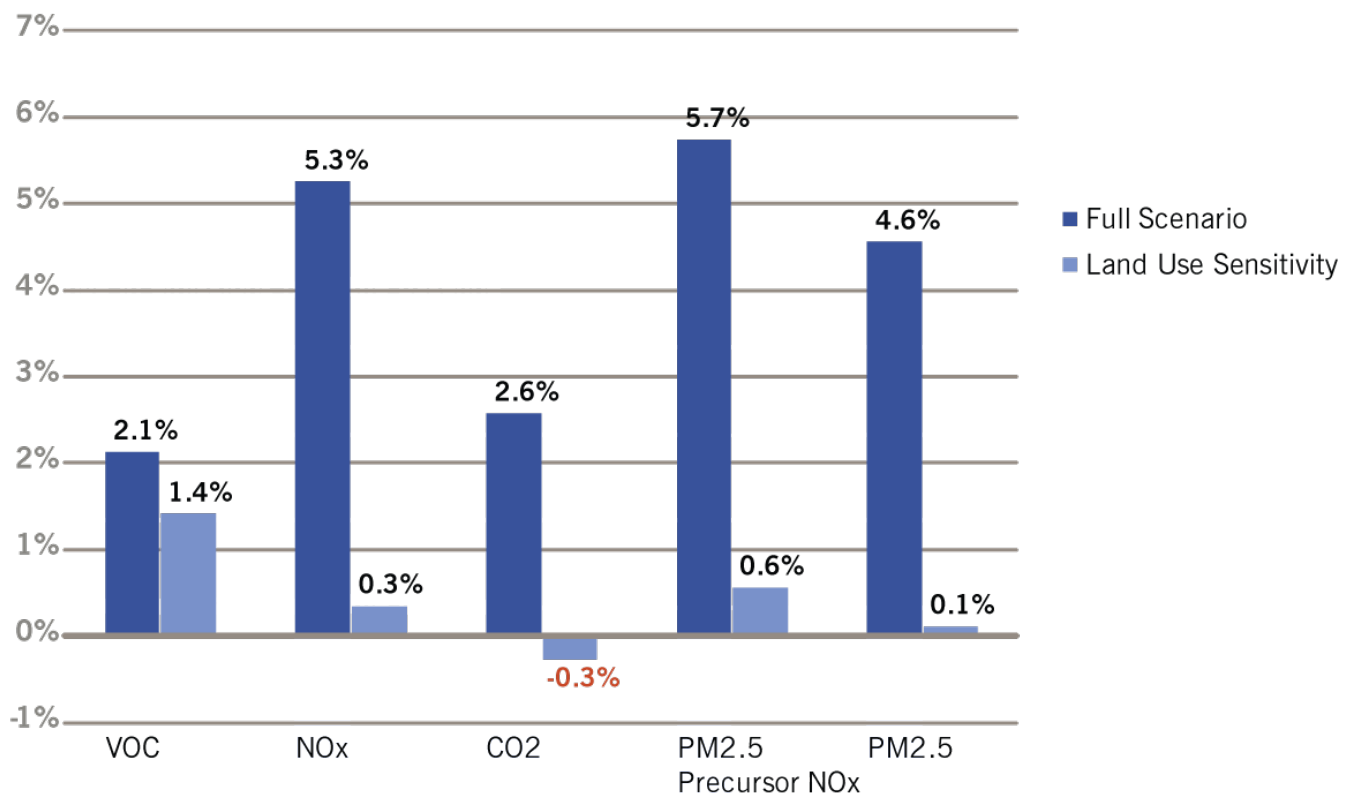


The full scenario produces 2.8% more transit trips than the land use alone, indicating that a majority of the transit increase in the full scenario is on the existing transit system rather than the extensive new BRT system.

As in the full scenario, bicycle and pedestrian use also increases significantly. Total bicycle and pedestrian work trips rise by 16.5% in the land use sensitivity, which is roughly the same as in the full scenario.

#### 4. Air pollution increases in the full scenario, but remains the same in the land use scenario.

Figure 11: Change in Emissions of Air Pollutants between Scenarios and Baseline



##### Full scenario:

Emissions of NOx, VOCs, PM2.5, PM2.5 precursor NOx, and CO2 all increase significantly. NOx, PM2.5 precursor NOx, and PM2.5 increase most significantly at 5.3%, 5.7%, and 4.6%, respectively. VOCs increase by 2.1% and CO2 increases by 2.6%.

##### Land use sensitivity:

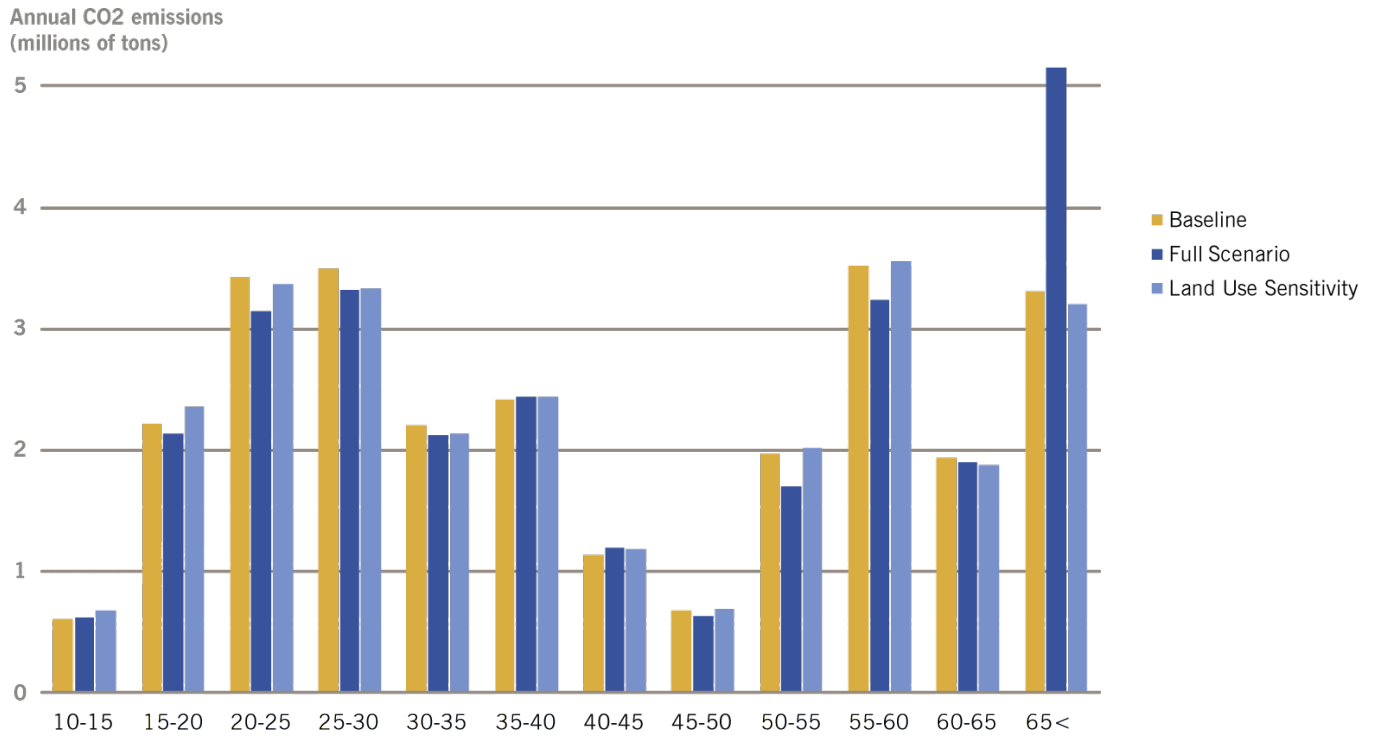
All emissions for the land use sensitivity have only slight decreases or increases and thus overall are relatively similar to the baseline forecast. Emissions of VOCs increase the most significantly at 1.4%. NOx and PM2.5 precursor NOx increase very slightly at 0.3% and 0.6% respectively. PM2.5 does not change. CO2 decreases by 0.3%.

Emissions of each pollutant can vary according to unique sets of factors, such as number of trips, VMT, and speed. For instance, VOCs are highly sensitive to number of trips, while CO<sub>2</sub> is highly sensitive to speed. CO<sub>2</sub> emissions rates per mile vary with speed according to a U-curve, where very low speeds and very high speeds produce significantly higher per-mile emissions rates than the middle speed range of 30-60 mph. NO<sub>x</sub> and VOC also vary by speed, but exhibit much flatter curves than CO<sub>2</sub>. This is further discussed in the next section of this report.

Variations in emissions rates are modeled in Mobile 6 (the current EPA emissions model used for conformity purposes) for NO<sub>x</sub> and VOCs, but are not yet for CO<sub>2</sub>. As a result, off-model calculations were completed to determine CO<sub>2</sub> emissions by speed. In order to better understand the changes in CO<sub>2</sub> emissions between the scenario and the baseline, the graph below shows the difference in CO<sub>2</sub> emissions by speed for both the full scenario and the land use sensitivity.

Figure 12 (on the next page) clearly shows how changes in speed have contributed to higher CO<sub>2</sub> emissions in the full scenario as compared to the baseline, particularly when compared with Figure 9 on VMT by speed. The full scenario shows a 56% increase in CO<sub>2</sub> emissions from the 65+ mph speed category. There is also a relatively small increase in emissions from the 10-15 mph category, which are largely offset by decreases in emissions from the 15-35 mph categories. The increase in very high speeds with only small decreases in low-range speeds, as well as significant decreases in emissions in the middle range (50-60 mph), which have the lowest CO<sub>2</sub> emissions rate, translate into higher overall CO<sub>2</sub> emissions. The land use sensitivity tracks more closely with the baseline because there is little change in speeds throughout the system. The most significant change is a 12% increase in baseline CO<sub>2</sub> emissions from the 10-15 mph speed category, which results in lower CO<sub>2</sub> reductions than VMT reductions from the land use sensitivity.

Figure 12: Changes in CO2 Emissions by Speed between Scenarios and Baseline



# Discussion

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Ultimately, the results described in the previous section were driven by five major effects produced by the CLRP Aspirations scenario.

## 1. More road capacity + pricing

The provision of new priced road capacity resulted in significantly higher speeds and less delay throughout the region. The congestion reduction benefits are substantial, indicating that implementing a pricing strategy can be highly effective at relieving ever-worsening regional congestion. Although the major congestion reduction benefits are clearly a result of the extensive, new priced network, the land use sensitivity indicates that to some degree, concentrating land use to allow for shorter trips also serves reduce congestion. Under the land use sensitivity, population increased 3.5% while congestion levels remained relatively flat.

However, the congestion reduction indicators of higher speeds and less delay also led to negative impacts that move the region further away from meeting transportation goals. More road capacity and priced lanes mean that more people can drive longer and faster, which resulted in more driving and longer trips. The VMT increase produced by the full scenario over the baseline is in part caused by a rise in population, but is also caused by more road capacity and faster auto travel options. The increased trip lengths in the full scenario also occur because people can drive longer faster. The provision of priced lanes extending into the outer suburbs and beyond make longer trips more convenient, which has the potential to encourage people to live further out, far from work sites. In this way, the land use and pricing components of the scenario can be seen as being at odds with one another, where the latter encourages dense, concentrated development and the former encourages a more sprawling development pattern.

The increases in driving and higher speeds combine to also produce higher emissions of harmful air pollutants. High increases of 5% or higher are produced by the full scenario for NO<sub>x</sub>- and PM<sub>2.5</sub> precursor NO<sub>x</sub>. Higher VMT and much higher speeds than the baseline cause this increase in pollution. Similarly, increases in CO<sub>2</sub> occur for this reason. As previously mentioned, CO<sub>2</sub> calculations were done off-model because of current emissions model constraints, but used outputs from the regional travel demand model, which currently only models speeds 65 mph and below. This inability to model speeds higher than 65 mph (which constitute 19% of total scenario VMT) largely underestimates CO<sub>2</sub> emissions because CO<sub>2</sub> emissions rates rise rapidly as speeds beyond 65 mph increase. VOCs also increase, but to a lesser degree because it is more sensitive to the number of trips (resulting from starting the vehicle) than to VMT. The full scenario produces a higher increase in VMT than trips, indicating longer trip lengths.

## 2. More population and employment

In order to meet density and jobs/housing balance goals, a 3.5% increase in households and a 1% increase in jobs were included under the land use component of the scenario. Higher population clearly results in more people traveling. Under the full scenario VMT rose, but VMT per capita decreased, signaling that the overall VMT rise is due in part to increased population. On the other hand, the land use sensitivity, which also included the same population and employment increase, resulted in a slight VMT decrease. The increased density clearly led to higher transit, bicycle, and pedestrian mode shares, which reduced VMT. Therefore, it is possible that the smart growth orientation of the land use actually limited the growth in VMT in the full scenario rather than caused it. Without the densification and mixed use land use the results indicate that increases in bicycle and pedestrian use and a majority of the transit increase would not occur, which counteracted the increases in driving that the priced road network allowed.

## 3. Fewer people commuting into the region from outside of the region

The aforementioned regional increase in population and employment was assumed to result from the moving of jobs and households in the jurisdictions just outside of the TPB region but within the much larger modeled area. The effect of this land use change is the reduction in “super-commuting,” which are very long trips made largely for work from households well outside of the region to jobs inside of the region, or vice versa. The elimination of these trips was expected to result in shorter trip lengths, which likely happened, but was offset by the mobility afforded by faster speeds on the value priced lanes.

## 4. More concentration of development around existing transit

The analysis of the land use sensitivity versus the full scenario indicates that the higher transit use produced in both scenarios may occur mostly on the existing system rather than the extensive new BRT system. The land use sensitivity scenario results in a transit increase only slightly lower than the full scenario, indicating that even with a constraint on Metrorail capacity from 2025 beyond there may be efficiencies that can be gained on the existing transit system by concentrating land use around transit infrastructure, particularly around underutilized stations. Creating mixed use centers and transit-accessible jobs throughout the region would likely balance transit usage geographically, allowing for less directional congestion, more reverse commuting, and increased transit use without new infrastructure. Regional travel demand model results do not provide enough information to determine transit congestion levels; however, it is likely that the land use sensitivity, which includes no new transit services, would increase transit congestion, possibly quite significantly.

## 5. Higher density, mixed use activity centers

It is clear from the analysis of the land use sensitivity model tests that the scenario's higher density, mixed use activity centers created conditions where jobs and housing were much closer together, allowing for more walking and biking to make short work trips. The land use sensitivity and the full scenario produced the same substantial increase in bicycle and walk trips, implying that all of the walking and biking gains are from the land use changes. That being said, the increased transit service and road capacity cannot be diminished as they provide important regional connections that impact the decisions of residents and businesses to locate in concentrated activity centers by making them more convenient overall.

### Does the CLRP Aspirations Scenario Meet Regional Goals?

The CLRP Aspirations Scenario set out to better meet the goals of the TPB Vision than is currently projected under the 2008 CLRP and land use forecasts. In many ways the scenario does provide an aspirational growth and development path for the region, providing solutions to long-standing problems, such as congestion reduction and revenue generation. In other ways, the scenario falls short and contributes to the many problems that the region has been attempting to move beyond, such as poor air quality and future sprawl development.

The scenario is remarkably effective at reducing congestion, which is the one of two major benefits of creating a regional priced lane network. The second of these two is the ability to raise needed revenue for services to maintain equitable mobility and accessibility if lanes are to be priced. Under the scenario, it is assumed that toll revenues would be used to facilitate provision of the BRT network, which does produce an increase in transit use. The scenario also includes a land use vision that produces several note-worthy benefits that directly correspond with the TPB Vision. Creation of walkable, transit-oriented, and mixed use activity centers directly allows for substantial bicycle and pedestrian trip increases and major transit use increases on the existing system, as well as on the BRT system, which would likely be necessary in some form to relieve existing and projected transit congestion. Additionally, the land use shows that significant population growth can be accommodated smartly, without increasing road congestion, air pollution, or VMT.

It is unlikely that a large-scale regional plan can be created to have only positive impacts and no unintended negative consequences. The CLRP Aspirations scenario produces some results that counter the goals set forth in the TPB Vision and in RMAS, such as improving environmental quality and producing shorter trips that result in a reduction of VMT. For example, reducing congestion increases auto accessibility in many parts of the region causing driving and trip lengths to increase, allowing for faster and longer trips and higher VMT. This effect likely counteracts the concentrated growth patterns the land use component attempts to reinforce. Of course, the major negative result of

more auto trips, more VMT, and much faster speeds (above 65 mph) is that air pollution increases.

Overall, the CLRP Aspirations scenario set out meet goals such as creating: “economically strong regional activity centers with a mix of jobs, housing, services, and recreation in a walkable environment”, “a web of multi-modal transportation connections which provide convenient access”, “a user-friendly, seamless system”, and a combination of land use and transportation options that result in the “reduction of per capita VMT.” It also sought to capitalize on existing transit infrastructure through transit-oriented development, address geographic imbalances in development, and reduce congestion and commute times by getting jobs and housing closer together.

The CLRP Aspirations Scenario largely achieved these things. Although VMT rises in the full scenario, VMT per capita decreases. Geographic imbalances are evened out to an extent because of the heavy concentration of future growth around existing transit stations, particularly around Metrorail stations in Prince George’s County that do not currently have mixed use, walkable, and in some cases even transit supportive densities. These stations on the eastern portion of the region received a great deal of growth to make the surrounding station areas more walkable and mixed use. Although trip lengths increase, jobs and households are closer together allowing for substantial increases in bike and walk trips. Lastly, the BRT system provides new, high quality transit connections allowing for more convenient access. Although the specific use of the new system is not known from the information available, it is likely the BRT system helps reduce transit congestion, especially on the Metrorail system, and particularly supports circumferential activity center connections.

The scenario highlights the difficulty in combining strategies that, when implemented on their own, produce positive results. There are clear synergies when combining the land use and transportation strategies, but as may be expected, there are also conflicts and unexpected results that can inform future analysis.

## Future Work

There are certain limitations of the scenario that can be used to drive future work. For instance, it is possible that the land use component and the pricing component exerted forces that work against one another by both encouraging short trips and long trips at once. This, along with model limitations, made analysis of the efficacy of the BRT network difficult. As a result, it would be beneficial in the future to examine the BRT network in the absence of pricing and additional road capacity in addition to examining the combination. The BRT routes would likely need some level of redesign to reflect what is physically feasible if new priced capacity cannot be used as pseudo-dedicated running-way. This issue reflects the complexity involved in combining the one-dimensional strategies tested in previous TPB scenarios. Interactions between strategies can clearly have unexpected consequences that necessitate further study.



Similarly, the value priced network could be modified in future analysis to test the impacts of pricing less new capacity and to increase the amount of existing capacity that is priced. The priced network was originally formed based on policy inputs from the state DOTs and FHWA, which included pricing of only new capacity in Maryland and Virginia, and only existing capacity in D.C. and on national parkways. It is clear that the extensive new priced road capacity contributed heavily toward lengthening trips and increasing VMT; therefore, it is possible that studying the increased pricing of existing lanes could better reinforce use of the extensive transit network. This analysis would not be without significant political and technical hurdles; however, this study highlights the importance of adequately studying a variety of combined pricing-transit-land use options to ensure that the region's goals and objectives are met.

Additional modifications to the scenario could also be pursued. The priced network in the full scenario, which was taken from the 2008 TPB variably priced lanes study, included many interchanges between the toll lanes and perpendicular roads, many of which are arguably unnecessary. Interchanges are extremely costly at \$132 million per interchange. For future studies, the transit and toll lane network could be modified to focus accessibility gains in the targeted growth areas by limiting access to the tolled network only at activity centers and other targeted growth areas. Preliminary assessment indicates that 96 interchanges could be converted to slip ramps, which are significantly less costly. Focusing access in this way is not only expected to reinforce concentration of growth in these areas, but also to reduce the total construction costs of the toll network.

Future work can also be done to account for behavioral changes that are currently not reflected in the regional travel demand model. For example, the TPB recently completed the 2007/2008 Regional Household Travel Survey, which highlights significant behavioral changes toward increased walking, biking, and transit use. In general, there has been a greater willingness in recent years to use alternative modes of transportation for a wide range of trip purposes, beyond just recreation. Therefore, it is likely that with the new survey results incorporated into the regional travel demand model, increases in transit, bicycle and pedestrian trips would be more pronounced. In 2011, the TPB will begin using a new travel demand model version 2.3, which will incorporate numerous improvements on the current model version 2.2. Among these improvements are a longer analysis period with a horizon year of 2040, which will be particularly useful in analyzing the potential impacts of changes in land use forecasts; use of the 2007/2008 Household Travel Survey; a near doubling of the transportation analysis zones, which allows for finer-grained analysis of travel demand impacts particularly in activity centers; the generation of non-motorized trips for all purposes, which will improve sensitivity to impacts in bicycling and walking since the current model only forecasts work trips; and an updated truck model, which will allow further integration of freight impacts into scenario work.

The CLRP Aspirations Scenario did not and to be fair could not address all of the questions and issues that emerged from the extensive RMAS outreach efforts. In

particular, the outreach efforts clearly shed light on the collective skepticism about the capacity of leaders to implement a regional strategy of concentrated development and transportation investment without causing negative impacts at the local level. Further analysis could be done to determine what the localized impacts of the pricing and BRT system would be, particularly when combined with an aggressive land use strategy.

In a similar vein, more detailed analysis could be done to determine what the effects of the land use component would be on the existing transit system specifically. The sensitivity shows that even without adding transit service, land use changes alone could induce substantial increases in transit use to be accommodated on the existing system. It is possible that since the land use creates transit-oriented mixed use centers across the region, the existing system could handle more riders because of increased efficiency. Instead of traveling uni-directionally from one end of the system to the center core area, which results in directional transit congestion, transit users would be boarding the system at any of the activity centers and traveling to job sites that also are in any of these centers. It is also possible that shorter transit trips are encouraged as housing and job opportunities are concentrated in each of the over 60 centers, so that as one passenger exits to his/her destination, another could be boarding. Each center thus serves as both an origin and a destination, allowing the transit system to work most efficiently. On the other hand, given current issues with the Metrorail system, which is projected to suffer from increasing levels of congestion, more analysis would need to be done to truly understand the effects on the existing system from concentrating significant amounts of households and jobs around transit. It is possible that more balanced transit use occurs, allowing the transit system to operate more efficiently with greater ridership; however, it is also possible that this type of development would lead to crippling transit congestion in the absence of significant capacity-increasing investment. More analysis is necessary to illuminate this issue.

The results of this study do not form a simple story with an entirely positive outcome, but rather are nuanced and reflect the difficulty in meeting multiple, sometimes competing objectives. The scenario results in drastic reduction in congestion. It also increases transit, bicycle, and pedestrian use, as well as driving and air pollution at the same time. No plan can ever please everyone and as such there must be a method of balancing the costs and benefits to determine whether it is worth doing. The TPB has recent experience in developing comprehensive cost-benefit analysis for transportation projects through its two recent TIGER applications and this methodology could be adapted and applied to this scenario in the future. A comprehensive cost-benefit analysis would provide a layer of analysis to put the scenario's impacts in perspective and make better sense of the results.