Supporting Performance-Based Planning and Programming through Scenario Planning

JUNE 2016

U.S. Department of Transportation
Federal Highway Administration

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Technical Documentation

1. Report No. FHWA-HEP-16-068	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Supporting Performance-Based Planning and Programming through Scenario Planning		**5. Report Date** April 2016 **6. Performing Organization Code**
7. Authors Hannah Twaddell (ICF), Alanna McKeeman (ICF), Michael Grant (ICF), Jessica Klion (ICF), Uri Avin, Kate Ange (Renaissance), Mike Callahan (Renaissance)		**8. Performing Organization Report No.**
9. Performing Organization Name and Address ICF International 9300 Lee Highway Fairfax, VA 22031 Renaissance Planning Group 1901 North Moore Street, Suite 1204 Arlington, Virginia 22209 Uri Avin National Center for Smart Growth, University of Maryland College Park, MD 20742		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.**
12. Sponsoring Agency Name and Address United States Department of Transportation Federal Highway Administration 1200 New Jersey Avenue SE Washington, DC 20590		**13. Type of Report and Period Covered** **14. Sponsoring Agency Code**
15. Supplementary Notes Ms. Rae Keasler, Federal Highway Administration		
16. Abstract This guidebook addresses how scenario planning can be used to support and advance the practice of performance-based planning and programming (PBPP). Scenario planning can use metrics, models, data sets, and tools to estimate and evaluate scenarios based on their ability to maximize system performance and support achievement of goals and performance targets. The guidebook presents a framework for connecting established scenario planning processes with the four phases of PBPP: direction, analysis, programming, and implementation. Three case studies provide examples of agencies of varying sizes that have used scenario planning in innovative ways to advance the practice of PBPP. A section and appendix of scenario planning and performance measurement tools that can be used in, or incorporated into, scenario planning is also provided.		
17. Key Words Scenario planning, performance-based planning, performance-based planning and programming, programming, planning, PBPP, scenarios, performance measures, land use, transportation, vision, goals, objectives, targets, case studies, system performance, tools, models, MPOs, State DOTs	**18. Distribution Statement** No restrictions.	
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No of Pages** 161 **22. Price** N/A

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Acknowledgments

This document was developed in collaboration with stakeholders across the transportation industry. It was guided by an Advisory Team, which spent hours reviewing draft deliverables and providing input on the direction of the Guidebook. Members of the Team were selected based on previous work in scenario planning and performance-based planning. The Advisory Team included Metropolitan Planning Organization (MPO) and State Department of Transportation (DOT) practitioners, national industry association representatives, and an academician. Members of the Advisory Team were:

Beth Alden	Hillsborough County Metropolitan Planning Organization (FL)
Chris Caplice	Massachusetts Institute of Technology
Chris Evilia	Waco County Metropolitan Planning Organization (TX)
Marsha Fiol	Virginia Department of Transportation
Delania Hardy	Association of Metropolitan Planning Organizations (AMPO)
Matt Hardy	American Association of State Highway and Transportation Officials
Charlie Howard	Puget Sound Regional Council (WA)
Carrie Kissel	National Association of Development Organizations (NADO)
G.J. LaBonty	Utah Transit Authority
Subrat Mahapatra	Maryland State Highway Administration
Tyler Monson	California Department of Transportation
Rita Morocoima-Black	Champaign Urbana Urbanized Area Transportation Study (IL)
Marlie Sanderson	Gainesville Metropolitan Planning Organization (FL)
Rob Terry	Fresno Council of Governments (CA)
Rich Weaver	American Public Transportation Association (APTA)
Erich Zimmerman	National Association of Regional Councils (NARC)

Special thanks to Beth Alden, Rita Morocoima-Black, Rob Terry, and their agency staff for organizing and participating in site visits to gather detailed information for the case studies.

Executive Summary

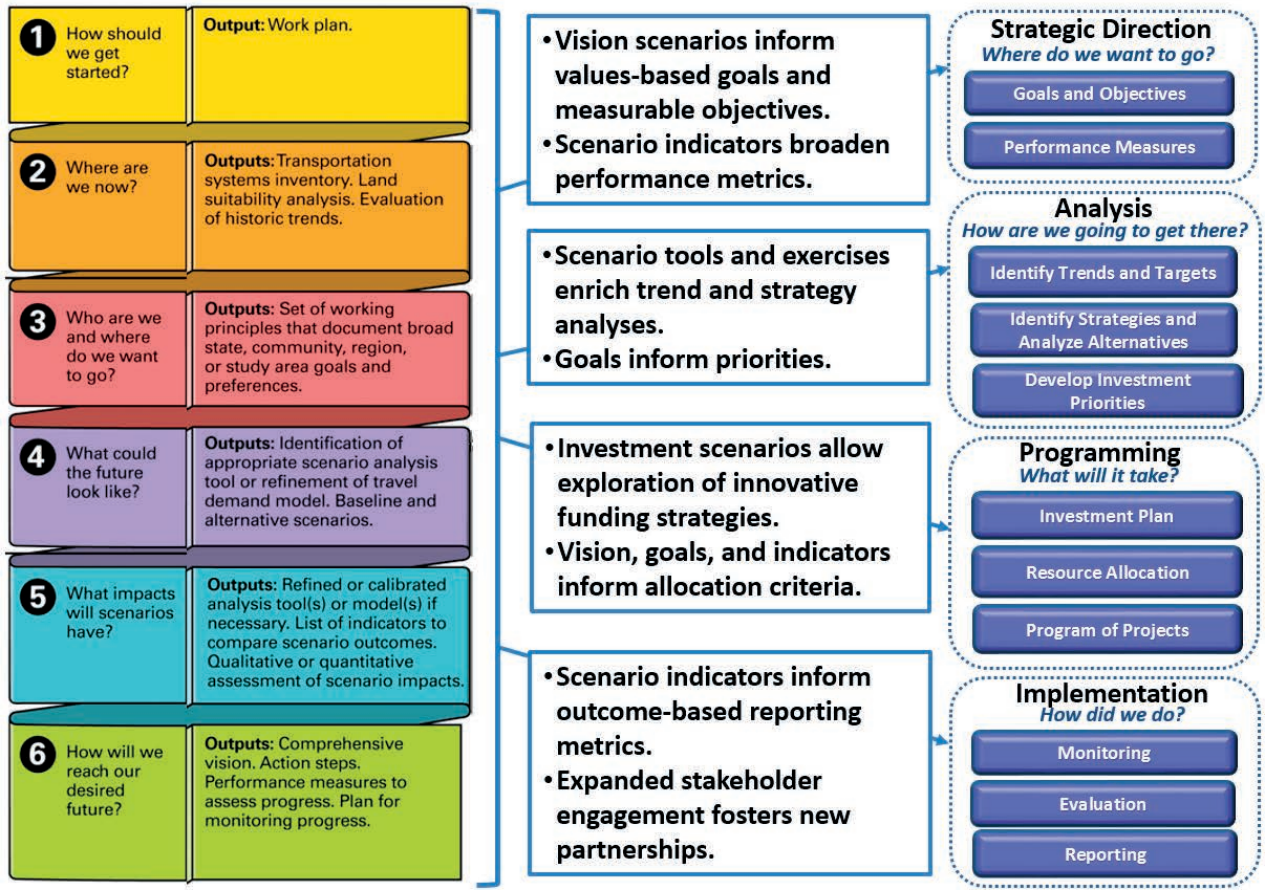
The use of performance-based methods of planning and decisionmaking continues to increase throughout the United States as agencies seek new and improved methods, tools, and practices to maximize the performance of their transportation systems. This guidebook focuses on how scenario planning can be used to support and advance the practice of performance-based planning and programming (PBPP). PBPP is the application of performance management within the planning and programming processes to achieve desired performance outcomes for the multimodal transportation system. Scenario planning has long been used by transportation agencies in the U.S. as a tool for visioning and identifying preferred land use and transportation scenarios for future growth. Many scenario planning exercises today are transitioning to a greater focus on analysis and the use of more sophisticated metrics, models, data sets, and tools to test and evaluate scenarios. This analysis is based on their ability to maximize transportation system performance and support achievement of performance goals and targets, as well as recognize the interaction with broader community goals (i.e. economic development, environment, environment, public health, housing, etc.).

This guidebook is a companion to the Federal Highway Administration (FHWA) 2013 Performance-Based Planning and Programming [PBPP] Guidebook and 2014 Model Long Range Transportation Plans: A Guide for Incorporating Performance-Based Planning. It builds on existing FHWA literature on PBPP by illustrating the ways in which scenario planning can be used to strengthen agencies' ability to engage in performance-based planning and decisionmaking. This Guidebook is organized around the four key phases in the PBPP process—Direction, Analysis, Programming, and Implementation—so practitioners can understand the applications of various scenario planning types and techniques that are most appropriate to apply at different planning phases or for different considerations and topics.

Intended Audiences – This Guidebook is intended for use by transportation practitioners involved in statewide, metropolitan, and nonmetropolitan planning and programs. Practitioners are frequently looking for ways to engage their communities in considering how to enhance the performance of the transportation system through improved decisionmaking processes, and scenario planning is important tool for accomplishing the task. Practitioners can use the information in this Guidebook to understand more fully the considerations that should be incorporated into decisions about designing and conducting a scenario planning process.

Framework – This guidebook introduces a framework, shown in Figure ES-1, which identifies linkages between the six-step scenario planning process identified in the FHWA 2011 Scenario Planning Guidebook and each of the four stages of PBPP. The six-step scenario planning process can be repeated or performed iteratively at different points in the PBPP process and for different purposes. For example, an agency might use scenario planning to conduct a visioning exercise at the beginning of its long range plan development. The agency might employ scenario planning again and scenario analysis techniques to identify the performance implications of different variations of the preferred scenario or to explore how the preferred scenario would perform, vis-à-vis other potential scenarios, if significant technological, economic, climatic, or weather-related changes were to significantly "disrupt" the transportation system.

Figure ES-1: Applications of Scenario Planning to Performance-Based Planning and Programming



Case Studies – This guidebook contains three in-depth case studies of MPOs that have used scenario planning to support PBPP in advanced and innovative ways. The **Champaign-Urbana Urbanized Area Transportation Study (CUUATS)** in Illinois used scenario planning and analysis in the development of its most recent long range plan to identify the performance implications of a trend scenario and a "sustainable choices" scenario, which assumed several potential future changes to the region. The agency found entrepreneurial ways to integrate considerations such as public health into the planning process and has used scenario planning to support development of various corridor studies. The **Fresno Council of Governments** in California used scenario planning in the development of its regional transportation plan and Sustainable Communities Strategy to consider the performance implications of four scenarios, with a particular focus on reducing greenhouse gas emissions. The agency also conducted an analysis of four revenue/investment scenarios to identify which package of projects to fund, given expected revenues and ability to flex funds between different modes. The **Hillsborough County MPO** in Florida used scenario planning to develop a regional land use vision, consider four separate investment packages with different modal emphases, and consider potential impacts of future hurricane events on the transportation system.

Keys to Success – The guidebook concludes with a chapter on key recommendations for maximizing the value of scenario planning and its potential to inform and support PBPP. These are summarized according to the following four principles, each of which is discussed in detail in Chapter 5.

- Create and Strengthen Connections between Scenario Planning and PBPP
- Use Creativity to Push the Limitations of Existing Tools
- Identify the Best Methods for Engaging Decisionmakers, Stakeholders, and the Public
- Consider the Local Context

PBPP and Scenario Planning Tools – Appendix B, which contains the information provided in the final section of Chapter 3 in greater detail, provides an overview of available PBPP and scenario planning tools, including capabilities, applicability to different phases of PBPP, descriptions of relevance and potential applications to scenario planning, and performance measures each considers.

1. Purpose and Context

The purpose of this guidebook is to help transportation practitioners build their knowledge of ways in which scenario planning methods, metrics, processes, and outcomes can enhance transportation decisionmaking across the spectrum of the performance-based planning and programming (PBPP) process.

PBPP helps transportation agencies achieve desired multimodal system performance outcomes by applying systematic, coordinated performance management strategies to long range planning, short-range programming, project development, and evaluation. This Guidebook examines ways in which scenario planning can add value to, and be enriched by, the analyses, methods, metrics, and collaboration that support the entire spectrum of PBPP. In particular, the Guidebook discusses topics such as:

- The incorporation of PBPP goals and performance measures into scenario planning and scenario analyses processes;
- The incorporation of scenario planning metrics and findings into the ongoing PBPP process;
- Opportunities to apply scenario planning methods to PBPP decisionmaking phases beyond the initial visioning stage in which scenario planning has most frequently been applied.

In recent years, transportation agencies have applied scenario planning methods to strategic planning and programming tasks, including assessments of long-term risks, financing, system management and operations, and corridor planning. In addition, they have used scenario planning techniques to consider potential impacts and implications of complex, rapidly changing demographic, environmental, economic, and technological forces that are not easy to assess with traditional models or analysis tools. Scenario planning tools have also helped planners consider the role of transportation in achieving comprehensive sustainability for communities, regions, states, and the nation as a whole. Such broader analyses help advance the principles of the Federal multiagency Partnership for Sustainable Communities initiative, which seeks to identify and implement solutions for improving sustainability by facilitating access to affordable housing, increasing transportation options while lowering transportation costs, ensuring equity, and protecting the environment (i.e., addressing the "triple bottom line" of environmental, economic, and social sustainability).

Related Resources

This Guidebook builds on a framework established in the 2011 FHWA Scenario Planning Guidebook, which serves as an essential resource for transportation practitioners seeking to understand the fundamentals of scenario planning. The 2011 Guidebook defined a comprehensive, six-step process for conducting scenario planning. It provided extensive guidance and numerous case studies on the use of scenario planning for transportation decisionmaking. It particularly supports visioning and long range planning processes that involve building consensus on a preferred future scenario in which transportation investments

complement desired land use policies, community development goals, and principles for environmental preservation and quality of life.

This Guidebook also serves as a companion to the 2013 FHWA Performance-Based Planning and Programming [PBPP] Guidebook and 2014 Model Long Range Transportation Plans: A Guide for Incorporating Performance-Based Planning. The 2013 PBPP Guidebook serves as a resource for practitioners from all types of transportation agencies on how to transition to more performance-based planning and programming processes. The 2014 Model Plans Guidebook focused specifically on incorporating performance-based planning into the development of statewide and metropolitan long range transportation plans. The 2014 Guidebook builds on existing FHWA resources on PBPP by illustrating the ways in which scenario planning can be used to strengthen agencies' implementation of performance-based planning and decisionmaking. FHWA also is developing related resources such as a "next generation" scenario planning guidebook with in-depth discussions of scenario planning typologies, methods, and analytics and recently released a primer, Advancing Transportation Systems Management and Operations through Scenario Planning, on applying scenario planning to support transportation systems management and operations (TSMO).

Additionally, through a cooperative effort between the Transportation Research Board, the American Association of State Highway and Transportation Officials (AASHTO), and the Federal Highway Administration (FHWA) following the enactment of SAFETEA-LU, several products related to scenario planning and performance measures as part of collaborative transportation decisionmaking processes were developed as part of the second edition of the Strategic Highway Research Program (SHRP2). Following

EXISTING FHWA SCENARIO PLANNING AND PERFORMANCE-BASED PLANNING RESOURCES

FHWA 2011 Scenario Planning Guidebook

FHWA 2013 Performance-Based Planning and Programming Guidebook

FHWA 2014 Model Long Range Transportation Plans: A Guide for Incorporating Performance-Based Planning

FHWA 2016 Advancing Transportation Systems Management and Operations through Scenario Planning Primer

FHWA Scenario Planning and Visualization in Transportation website

FHWA Performance-Based Planning and Programming website

FHWA PlanWorks website

FEDERAL SCENARIO PLANNING RESOURCE UNDER DEVELOPMENT

"Next Generation" Scenario Planning Guidebook (update to the 2011 Scenario Planning Guidebook)

SAFETEA-LU, the Moving Ahead for Progress in the 21st Century Act (MAP-21), and now the Fixing America's Surface Transportation Act (FAST), FHWA and AASHTO have continued working to integrate these research-based products into the "everyday business" of long range planning, programming, corridor studies, and environmental review undertaken by State Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs). This guidebook provides links to SHRP2 products (particularly PlanWorks) that are applicable to key phases throughout the PBPP process, many of which are featured on the FHWA PlanWorks website, which is profiled below on page 21.

Intended Audiences

This Guidebook is intended for use by transportation practitioners who are making investment recommendations or decisions for long or short range planning horizons; who are looking for ways to engage their communities and transportation system users in considering alternatives to address goals; and who want to examine implications for the performance of the transportation system under a variety of potential future conditions. Practitioners can use the information in this Guidebook to understand more fully the considerations that should be incorporated into decisions about how to design and conduct a scenario planning process that informs, and is informed by, the agency's comprehensive PBPP process.

MPOs, State DOTs, and transit agencies are the key agency audiences for this Guidebook. MPOs have historically led the application of scenario planning for transportation decisionmaking in the U.S. State DOTs and transit agencies, however, are increasingly examining ways to incorporate scenario planning and analysis into their long range planning processes. In addition

FEDERAL DIRECTIVES FOR PBPP AND SCENARIO PLANNING

Metropolitan Planning Organizations (MPOs) lead the cooperative transportation planning process for the distribution of Federal funds in urban regions. To encourage a data-driven approach to decisionmaking, the Moving Ahead for Progress in the 21st Century Act (MAP-21) of July 6, 2012 first required the use of PBPP by transportation agencies through the identification of performance measures and setting of performance targets with respect to those measures. It also strengthened the emphasis on the importance of scenario planning as a tool for MPOs to address the needs and complexity of their communities by considering multiple scenarios during the development of the metropolitan transportation plan (23 USC Section 134(i)(4)). Although MAP-21 specifically addressed the use of scenario planning by MPOs, State DOTs are also encouraged to explore the use of scenario planning to inform their planning processes.

MAP-21 encourages scenario planning to include potential regional investment strategies for the planning horizon; assumed distribution of population and employment; a scenario that maintains baseline conditions for the performance measures; a scenario that improves the baseline conditions; revenue constrained scenarios based on the total funds expected to be available over the forecast period of the plan; and the estimated costs and potential revenues available to support each scenario.

The Fixing America's Surface Transportation (FAST) Act, signed into law on December 4, 2015, continued MAP-21's emphasis on scenario planning as a key tool for supporting PBPP.

to serving as key stakeholders in regional and statewide scenario planning processes, transit agencies are also beginning to apply scenario planning to their own long range and operational plans.

Although some agencies have been conducting scenario planning exercises for years or even decades, others are in the early stages of considering how scenario planning can help them address their unique challenges. This Guidebook serves as a resource for these agencies by illustrating ways in which scenario planning approaches can—and should—be customized to address specific topics or issues, to work within the agency's budget, and to contribute to the agency's overall performance-based planning and programming process. Small and mid-size MPOs that are new to scenario planning, often with limited resources, will find information in this guidebook about using scenario planning to support their performance-based planning and programming process.

In addition, the Guidebook is intended to be useful for agencies of all sizes seeking to understand how they can build on experience to advance their use of scenario planning to support and inform PBPP. Some agencies profiled in this Guidebook are considering how scenario planning can be used as a tool not only to shape a vision and policy direction (through identification of goals, objectives, and performance measures), but also to analyze the impacts of unpredictable driving forces on future conditions, to support project prioritization and programming, and to improve the performance-based framework for ongoing evaluation, reporting, and system monitoring.

How to Use the Guidebook

The remaining chapters of this Guidebook cover the following:

Chapter 2: What are Scenario Planning and Performance-Based Planning and Programming (PBPP)? provides an overview of the purpose of scenario planning and of tools commonly used for scenario planning. It also discusses the PBPP process, the framework for which FHWA developed over the past few years. This chapter lays the foundation for understanding the concepts in Chapter 4.

Chapter 3: How Can Scenario Planning Inform Performance-Based Planning and Programming? Chapter 3 relates the practical applications of scenario planning to each of the four main stages of the PBPP process: Direction, Analysis, Programming, and Implementation. It also provides an overview of the potential synergies between PBPP and scenario planning tools.

Chapter 4: Getting Started: Considerations for Designing Your Scenario Planning Process is intended for use by practitioners as a self-assessment tool or guideline with questions to consider in developing a scenario planning process appropriate in the context of a specific region or State.

Chapter 5: Keys to Success summarizes the content of the Guidebook and provides a summary of the themes outlined throughout the guide that helps practitioners achieve the maximum benefit from a scenario planning process.

Chapter 6: Case Study Summaries contains three summaries of the full case studies in Appendix C that identify the practices and lessons learned of three agencies in different regions of the U.S. that used scenario planning to address unique sets of circumstances and challenges. The agencies profiled are the Champaign-Urbana Urbanized Area Transportation Study (CUUATS), Fresno Council of Governments (COG), and Hillsborough County Metropolitan Planning Organization (MPO).

The **Resources** section provides links to the guidance and examples referenced throughout the document and additional material on scenario planning and PBPP.

Appendix A contains a worksheet version of the questions provided in Chapter 4 (Getting Started) that practitioners can use for self-assessments.

Appendix B provides a table of detailed information on the PBPP and scenario planning tools that are summarized at the end of Chapter 3.

Appendix C contains in-depth case studies about the three agencies profiled in Chapter 6, including more details on practices and lessons learned.

2. What are Scenario Planning and Performance-Based Planning and Programming (PBPP)?

What Is Scenario Planning?

Scenarios are stories about the future that planners develop to consider and prepare for possible challenges and opportunities. Scenario planning helps transportation agencies work with stakeholders and the public to establish a vision and implement a strategic plan for success in uncertain times. Well-crafted scenarios inspire critical thinking about issues and events that could significantly affect a region's economy, environment, and quality of life.

In addition to using modeled forecasts based on historical trends or formulas, scenarios typically use words, pictures, and numbers to describe complex data analyses in the form of holistic, plausible illustrations of future conditions. Scenario planning typically includes both qualitative and quantitative analyses to illustrate the tradeoffs between different futures and their relative impacts on different community goals. This robust discussion of tradeoffs and identification of a preferred set of strategies based on that tradeoff discussion can lead to more thoughtful, effective, and resilient plans. Scenarios enable planners, the public, and decisionmakers to consider jointly the different variables that influence and are influenced by transportation to ensure careful consideration of different public policy and investment decisions to support a broader set of community goals.

SCENARIO PLANNING IN FEDERAL LEGISLATION

23 USC 134(i)(4) outlines the use of scenario planning by MPOs:

''(A) IN GENERAL.—[An MPO] may, while fitting the needs and complexity of its community, voluntarily elect to develop multiple scenarios for consideration as part of the development of the metropolitan transportation plan, in accordance with subparagraph (B).

''(B) RECOMMENDED COMPONENTS.—[An MPO] that chooses to develop multiple scenarios under subparagraph (A) shall be encouraged to consider— ''(i) potential regional investment strategies for the planning horizon; ''(ii) assumed distribution of population and employment; ''(iii) a scenario that, to the maximum extent practicable, maintains baseline conditions for the performance measures identified in subsection (h)(2); ''(iv) a scenario that improves the baseline conditions for as many of the performance measures identified in subsection (h)(2) as possible; ''(v) revenue constrained scenarios based on the total revenues expected to be available over the forecast period of the plan; and ''(vi) estimated costs and potential revenues available to support each scenario.

''(C) METRICS.—In addition to the performance measures identified in section 150(c), [MPOs] may evaluate scenarios developed under this paragraph using locally-developed measures.

Scenario planning is a term that describes a wide range of approaches. No two scenario planning endeavors are exactly alike. The literature on scenario planning includes several definitions and variants on how to develop and use scenarios. Despite these variations, commonalities provide structure to scenario planning, such as the following:

- Scenarios represent alternative future conditions that could materialize in response to drivers such as shifts in external forces (for example new technology, environmental patterns or global trade patterns) or the consequences of deliberate policy choices played out over time (such as land use policies or infrastructure investments); visioning is one form of scenario planning that emphasizes desired end states and outcomes rather than external forces and uncertainty.
- Scenario planning enables a wide array of people, including stakeholder or the public, to identify a range of potential consequences (e.g. impacts on the environment or public health) associated with alternative decisions, and to consider how those consequences could affect their ability to achieve goals or to experience desired community outcomes.
- By examining the impacts of alternative decisions on their ability to achieve visions and goals, planners can identify robust

CONSIDERING FREIGHT

Freight movement is an increasingly important and complex topic that agencies are incorporating into scenario planning and PBPP. Highlighted in the 2015 FAST Act, efficient freight movement is essential to achieving goals for economic competitiveness and community vitality. Freight operations also have a significant impact on air quality, land use, sustainability, and environmental conditions. Reflecting the needs and priorities of freight providers in scenario variables and evaluation criteria helps to ensure a more robust consideration of trends and issues related to overall travel demand and safety, environmental and economic concerns, and investment decisions. A few useful resources for practitioners seeking to consider freight movement more effectively in their scenario planning and PBPP analyses include the following:

- Integrating Freight Considerations into the Highway Capacity Planning Process PlanWorks application
- SHPR2 Railroad-DOT Mitigation Strategies model agreements, sample contracts, training materials, and best practices to identify and circumvent sources of conflict and to advance projects
- NCHRP Report 750: Scenario Planning for Freight Transportation Infrastructure Investment national study

strategies or policy options that best "hold up" across the spectrum of possible future conditions.

In short, scenario planning can "formalize the consideration of uncertainty in the planning process."[1] This dynamic method helps participants identify correlated and causal variables and to consider how different combinations of these variables influence outcomes. This gives people the freedom to imagine that conditions could change in the future if given enough time.

In the public sector, scenario planning is often applied to provide a forum for engaging diverse stakeholders, illustrating comparisons and discussing tradeoffs, and encouraging system-level thinking that breaks down the silos of specialization to address challenging public policy issues. Scenario planning informs, but does not dictate, agencies' identification of a vision or strategic course of action. A deliberative process that draws on empirical data and quantitative analysis, scenario planning helps people anticipate what the future might hold, envision the future they want, craft goals and strategies for realizing the desired future, and develop tactics for managing potential challenges and maximizing opportunities along the way.

Scenario planning has become a significant component of long range transportation planning among increasing numbers of transportation agencies for more than a decade. Throughout the early 2000s, most scenario planning initiatives were conducted by MPOs to envision strategies for coordinating land use and transportation plans. More recently, scenario planning in transportation has begun to examine a broader range of variable relationships beyond land use

ELEMENTS COMMON TO SCENARIO PLANNING

"While scenario planning can be implemented in many ways, the key elements include:

- Use of scenarios to compare and contrast interactions between multiple factors, such as transportation, land use, and economic development;
- Analysis of how different land use, demographic, or other types of scenarios could impact transportation networks;
- Identification of possible strategies that lead a State, community, region, or study area toward achieving elements of the preferred future; and
- Public engagement throughout the process.

Scenario planning shares common elements with both alternatives analysis and visioning exercises, but primarily differs from these processes in examining interactions between multiple factors, including both internal and external forces, as a way to assess possible future outcomes."

Source: 2011 FHWA Scenario Planning Guidebook

[1] J. Zmud, Transportation Research Board Webinar, "Applying Scenario Methods to Transportation Planning and Policy," Oct. 23, 2014.

and transportation. These include scenarios that take into account goals and objectives related to transportation system performance, housing affordability, economic competitiveness, adapting to climate change, water conservation, fiscal sustainability, public health, and energy conservation. This broadening of factors is generating plans and policies that are more integrated, as communities gain a better understanding of the connections between factors such as housing affordability and transportation accessibility or multimodal investments and better public health outcomes.

Scenario planning can be used at different stages of a planning process. The development of many long range transportation plans starts with a visioning process. Scenarios are often crafted during this stage to help identify a desirable future or preferred direction that a community wants to achieve over the long term. For example, an aspirational scenario commonly developed in regional plans over the past 20 years identified a future in which transportation investments and development patterns reduced single-occupant vehicle miles traveled by encouraging more walking, biking, transit use, and shorter car trips. These direction-setting scenario efforts often lead to new policy frameworks to guide goals, objectives, and programming decisions.

Once a clear vision or direction is in place, additional forms of scenario planning can also be useful in supporting the development of long range, financially constrained project investment plans and Transportation Improvement Programs (TIPs) for short-range funding allocations. Scenario planning can support analyses of the extent to which different funding levels or investment packages (e.g., combinations of transit services, highway improvements, bridge constructions, nonmotorized facilities) could help achieve system performance goals and objectives.

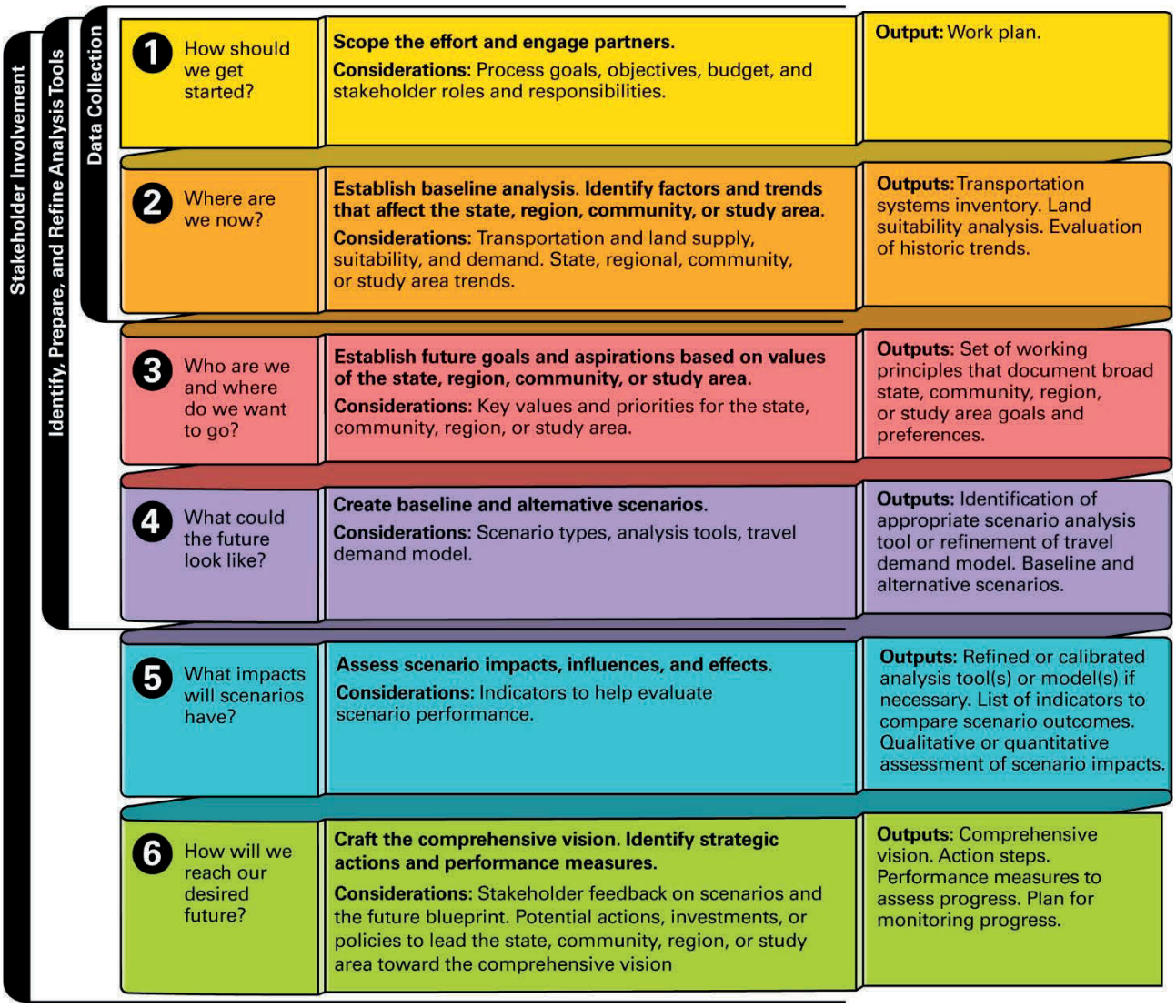
Another application of scenario planning is to test the performance of a given plan or a set of assumptions against a variety of potentially radical shifts in conditions over which local, regional, and State agencies have little or no control. These include, for example, economic conditions such as global trade patterns, environmental conditions such as weather patterns and sea levels, demographic conditions such as concentrations of age groups and urban settlement preferences, and technological conditions such as the use of connected autonomous vehicles and web-based mobile applications. Agencies can use scenario planning to consider the implications of external variables on system performance or the potential impacts of transportation infrastructure on external conditions. This allows for identification of tactics that could make the system resilient to a wide variety of uncertain but possible future conditions. For example, alternative land use and transportation scenarios could help to inform regional ecosystem and environmental mitigation plans developed with tools such as the FHWA Eco-Logical approach.

> *"A great reason to do scenario planning is to raise the profile of key decisions facing your community. Illustrating the implications of different choices draws attention to those choices, and deepens community understanding and dialogue."*
>
> - *Beth Alden, Hillsborough County MPO*

Scenario Planning Framework

Figure 2- illustrates the six-step framework defined in the original 2011 FHWA Scenario Planning Guidebook. This framework remains useful and relevant and was generated at a time when most transportation agency scenario planning efforts were geared toward shaping a vision for future land use and transportation investments. The specific inputs, outputs, and other descriptive elements of the framework can be modified to support other types of scenario analyses such as the effectiveness of financial investment packages or impacts of external driving forces.

Figure 2-1: Scenario Planning Process Framework from the 2011 Scenario Planning Guidebook



What Is Performance-Based Planning and Programming?

Performance-Based Planning and Programming (PBPP) is the application of performance management within the planning and programming processes of transportation agencies to achieve desired performance outcomes for the multimodal transportation system. It encompasses a range of activities undertaken by transportation agencies with other agencies, stakeholders, and the public as part of a 3C (cooperative, continuing, and comprehensive) transportation planning process. It includes development of federally required products such as long range transportation plans, strategic highway and transit agency safety plans, highway and transit agency asset management plans, the congestion management process, other plans that are not federally required, and programming documents such as State and metropolitan Transportation Improvement Programs (TIPs).

PBPP attempts to ensure that transportation investment decisions are made—in both long-term planning and short-term programming of projects—based on their ability to meet established goals. Fundamentally, the use of performance measurement to guide planning is intended to improve decisionmaking, increase transparency, and create consistency between transportation goals and objectives and the investments made to improve the performance of the transportation system.

MAP-21 first established national performance goals and placed increased emphasis on performance management within the Federal-aid highway program and transit programs, and requires use of performance-based approaches in

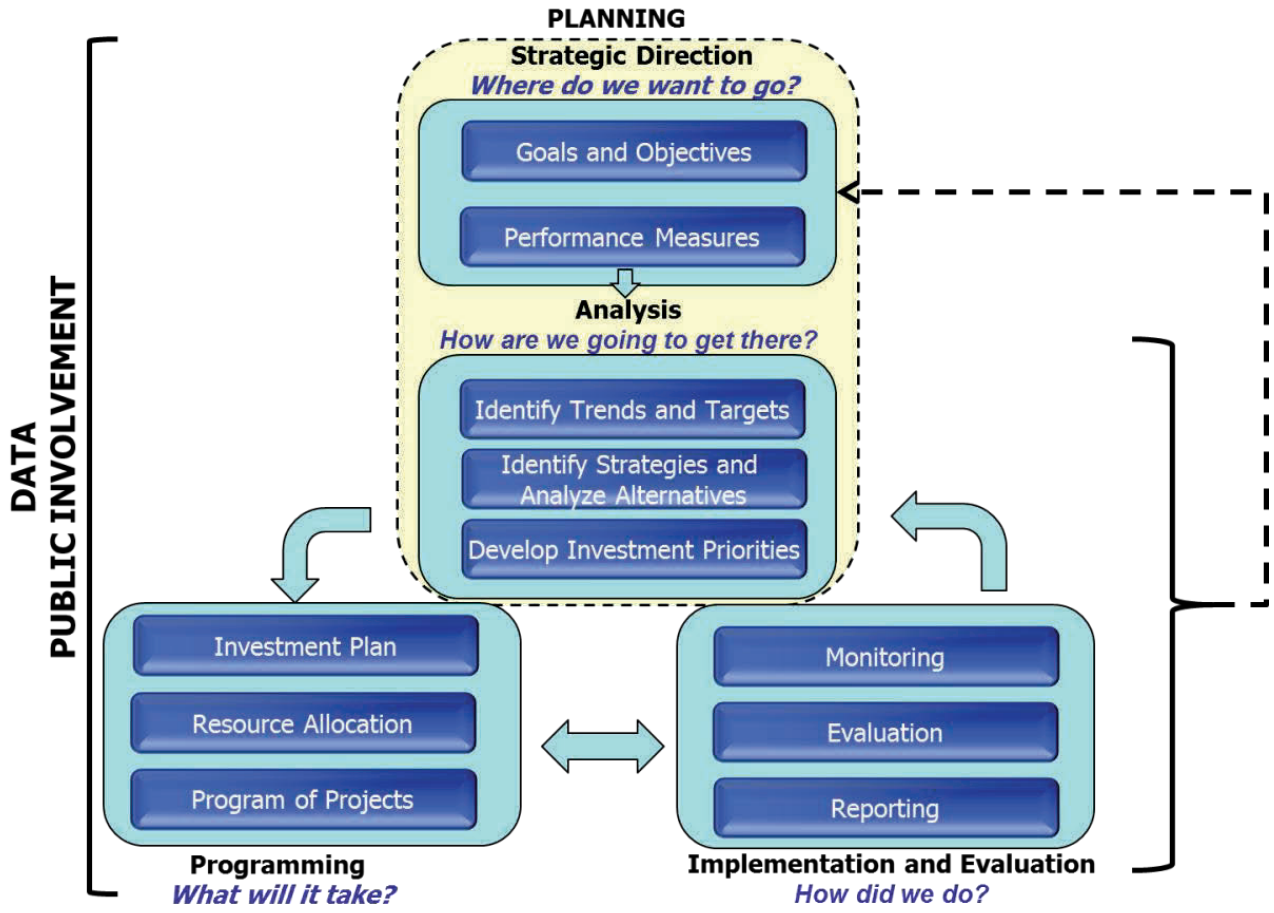
NATIONAL GOALS FOR THE FEDERAL-AID HIGHWAY PROGRAM
23 USC § 150(b)

Federal regulations require the use of a performance-based approach to support seven national goals for the transportation system. These goals serve as an important basis for developing goals that are integrated into the planning of States, MPOs, RTPOs, transit agencies, and other planning partners.

1. **Safety** - To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
2. **Infrastructure Condition** - To maintain the highway infrastructure asset system in a state of good repair.
3. **Congestion Reduction** - To achieve a significant reduction in congestion on the National Highway System.
4. **System Reliability** - To improve the efficiency of the surface transportation system.
5. **Freight Movement and Economic Vitality** - To improve the National Highway Freight Network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
6. **Environmental Sustainability** - To enhance the performance of the transportation system while protecting and enhancing the natural environment.
7. **Reduced Project Delivery Delays** - To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

statewide, metropolitan, and nonmetropolitan transportation planning. The FHWA 2013 Performance-Based Planning and Programming Guidebook created a framework, shown in Figure 2-2, for understanding the fundamental steps in a performance-based planning process.

Figure 2-2: The Performance-Based Planning and Programming Process Framework



Source: 2013 PBPP Guidebook

For the purposes of this Guidebook, PBPP is considered to have four key phases. These are described in more detail below.

Strategic Direction (*Where do we want to go?*) – In the transportation planning process, strategic direction is based on a vision for the future, as articulated by the public and stakeholders. PBPP includes:

- **Goals and Objectives** – Stemming from a State or region's vision, goals address key desired outcomes, and supporting objectives (specific, measureable statements that support achievement of goals) play a key role in shaping planning priorities. Goals can be derived from a visioning or scenario building exercise at this point and one or more scenarios can be carried forward into the subsequent phases.

- **Performance Measures** – Performance measures support objectives and serve as a basis for comparing alternative improvement strategies (investment and policy approaches) and for tracking results over time.

Analysis (*How are we going to get there?*) – Driven by data on performance, along with public involvement and policy considerations, agencies conduct analysis to develop investment and policy priorities.

- **Identify Trends and Targets** – Preferred trends (direction of results) or targets (specific levels of performance desired to be achieved within a certain timeframe) are established for each measure to provide a basis for comparing alternative packages of strategies. This step relies on baseline data on past trends, tools to forecast future performance, and information on possible strategies, available funding, and other constraints.
- **Identify Strategies and Analyze Alternatives** – Performance measures are used to assess strategies and to prioritize options. Scenario analysis might be used to compare alternative packages of strategies, to consider alternative funding levels, or to explore what level of funding would be required to achieve a certain level of performance.[2]
- **Develop Investment Priorities** – Packages of strategies for the LRTP are selected that support attainment of targets, considering tradeoffs between different goal areas, as well as policy priorities.

Programming (*What will it take?*) Programming involves selecting specific investments to include in an agency capital plan and/or in a Transportation Improvement Program (TIP) or State Transportation Improvement Program (STIP). In a PBPP approach, programming decisions are made based on their ability to support attainment of performance targets or contribute to desired trends, and account for a range of factors.

- **Investment Plan** – To connect the Long Range Transportation Plan (LRTP), which has an outlook of at least 20 years, to selection of projects in a TIP/STIP, some areas develop a mid-range (e.g., 10-year) investment plan or investment program.
- **Resource Allocation / Program of Projects** – Project prioritization or selection criteria are used to identify specific investments or strategies for a capital plan or TIP/STIP. Projects included in the TIP/STIP are selected based on performance and show a clear link to meeting performance objectives.

[2] This description of scenarios is narrower than that employed in this Guidebook. In Chapter 3, this guidebook discusses a wide range of scenarios, including investment strategy scenarios, which can be considered in this phase or earlier in the PBPP process.

Implementation (*How did we do?*) – These activities occur throughout implementation on an ongoing basis, and include:

- **Monitoring** – Gathering information on actual conditions.
- **Evaluation** – Conducting analysis to understand to what extent implemented strategies have been effective.
- **Reporting** – Communicating information about system performance and the effectiveness of plans and programs to policymakers, stakeholders, and the public.

Each stage of the PBPP process is marked by distinctive areas of focus and specific results or products (e.g., LRTP, TIP).

- In the Direction phase, the focus is on broadly desired outcomes, and the results include goals and performance measures that set the context for all remaining stages.
- In the Analysis phase, the focus is on establishing performance targets and strategies designed to help attain those targets, resulting in products such as a fiscally constrained long range plan.
- In the Programming phase, the focus is on shorter-term actions and investments, and the results could include a TIP, a STIP or other investment program, or a local capital improvement program.
- In the Implementation phase, the focus is on evaluating progress toward the goals and performance targets; results could include annual performance reports, "dashboards," and retrospective studies.

SYSTEM PERFORMANCE REPORT

23 USC Section 134(i)(2)(C) outlines the requirement that metropolitan transportation plans contain a System Performance Report, which will evaluate "performance of the transportation system with respect to the performance targets…." Specifically, Section 134(i)(2)(C)(ii) explains the requirement to include a discussion about the preferred scenario:

"For metropolitan planning organizations that voluntarily elect to develop multiple scenarios, an analysis of how the preferred scenario has improved the conditions and performance of the transportation system and how changes in local policies and investments have impacted the costs necessary to achieve the identified performance targets…"

In a PBPP approach, each step in the process is clearly connected to the next to ensure that goals translate into specific measures, which then form the basis for selecting and analyzing strategies for the long range plan. Ultimately, project selection decisions are influenced by expected performance results. Qualitative public input and quantitative data analyses are critical sources of information throughout the PBPP process. The public's vision for the future of the community plays a key role in determining goals, performance measures, and investment priorities. Analyses of system performance trends and the effectiveness of possible improvements helps to inform selection of priorities.

Like all planning, the transportation decisionmaking process is cyclical. Over time, and as planning cycles advance, goals and objectives may be adjusted, and performance measures and targets may be refined to ensure they focus on the most important and achievable priorities. Keeping the next step in mind is critical to a coherent, effective PBPP process. Toward this end, scenario planning can be used to improve the PBPP process by explicitly addressing uncertainties and by encouraging consistency among goals, objectives, and metrics as they are applied throughout each phase, from visioning and plan development through project selection and ongoing performance evaluation.

3. How Can Scenario Planning Inform Performance-Based Planning and Programming?

Scenario planning is an important tool that supports performance-based planning and programming. Scenario planning helps participants visualize and articulate, in both qualitative and quantitative terms, how a combination of strategies will help meet community goals and performance targets. PBPP attempts to ensure that transportation investment decisions are made, in both long-term planning and short-term programming of projects, based on their ability to meet established goals for improving the transportation system. Furthermore, it involves measuring progress toward meeting goals, and using information on past and anticipated future performance trends to inform investment decisions.

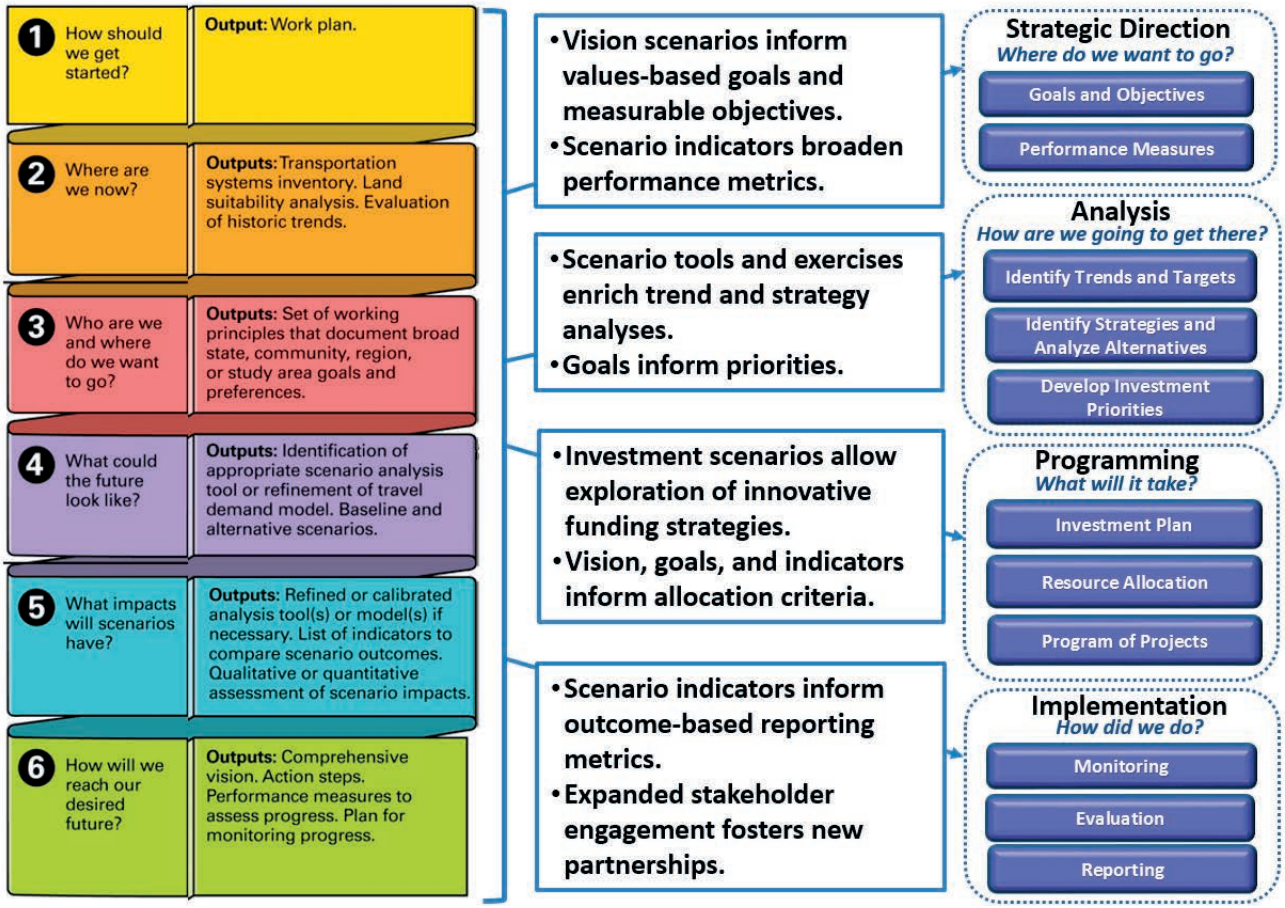
A scenario planning process conducted to support any element of the PBPP process can help agencies and stakeholders engage in strategic thinking and decisionmaking activities such as defining a shared vision and performance goals, analyzing trade-offs between possible strategies, assessing the impacts and implications of external driving forces, and identifying investment priorities that advance desired outcomes. The process can help participants consider how various factors, such as revenue constraints, demographic trends, equity issues, economic shifts, or technological innovation, can affect a State or region and the performance of its transportation system. Using performance-based scenario planning, MPOs, State DOTs, and other planning agencies can take a comprehensive approach to PBPP by exploring multiple scenarios for making a well-informed selection of a preferred alternative with the most potential for supporting goals, objectives, and performance targets.

Scenario planning can be used to support multiple points within performance-based planning and programming. This chapter discusses the potential usefulness of scenario planning applications within each of the four key phases of the PBPP process:

- Direction: Goals, Objectives, and Measures
- Analysis: Trends, Targets, and Strategies
- Programming: Investments, Priorities, and Resources
- Implementation: Monitoring, Evaluation, and Reporting

As illustrated in Figure 3-1, scenario planning can provide valuable resources to support all stages of the performance-based planning and programming process. The six-step scenario framework shown on the left side of Item 4 is process oriented and can be applied iteratively to various points of PBPP shown on the right-hand column, with variations to address the relevant considerations of each PBPP phase. The boxes in the middle column identify important connections and applications of scenario planning to PBPP.

Figure 3-1: Applications of Scenario Planning to Performance-Based Planning and Programming



For example, vision-oriented scenario planning processes can help shape goals, policies, and objectives in the early Strategic Direction stages of PBPP and provide a wide range of information and indicators for considering trends and weighing alternatives at the Analysis stage. During the Programming stage of PBPP, the values-based goals and objectives that flow from a visioning process can help guide development of resource allocation criteria, and planners can choose to develop a tailored scenario planning approach to weigh alternative investment strategies (or "packages" of strategies or projects). The Implementation and Evaluation stages of PBPP can draw on scenario planning indicators to measure broad outcomes and system performance and can benefit from the partnerships that can be fostered during the wide stakeholder outreach typically associated with a scenario planning process. Data from the Implementation and Evaluation phase that measure how actual and anticipated performance compare can be used to engage decisionmakers and members of the public who participated in scenario planning to demonstrate that performance improvements are being achieved.

Direction: Goals, Objectives, and Measures

Engaging the Public and Stakeholders

Performance-based planning and programming depends on a vision and supporting goals and objectives. These elements give performance measures meaning. A transportation agency will typically develop a vision and goals during the early stages of developing its long range transportation plan. Once the agency establishes its vision and goals, it can move on to developing objectives, identifying transportation system performance measures, and evaluating strategies.

A visioning process actively involves the public, the business community, and elected officials on a broad scale, educating them about growth trends and trade-offs and current system performance. Through this process, agencies can collect input regarding values and priorities and translate the input into quantifiable scenario evaluation criteria and guiding principles to shape scenario themes.

Visioning exercises help identify community goals using techniques such as workshops, focus groups, and other events. The vision often consists of a preferred spatial allocation of growth, design of future development, and transportation network improvements. The vision is directly connected to the goals and objectives found in the long range transportation plan.

ENVISION UTAH

Established in 1997, Envision Utah is a "nonprofit, nonpartisan public private partnership." Envision Utah engages stakeholders during the direction-setting phase of the planning process. Its work is based on the premise that the public has the right to decide what the State's future should look like, and that the entire process of scenario planning should be designed to allow the public to choose the path forward. Scenario planning conducted by the organization in coordination with partners has resulted in establishing consensus regarding the direction in which the Salt Lake City region would develop. This in turned informed feasibility analyses for projects, such as the TRAX light rail system and Frontrunner commuter rail system, both of which were ultimately completed. Envision Utah builds capacity among planners in the region for scenario planning and has played a major role in helping Utah establish a common vision for the future. Along with working on State visioning projects, the organization has worked with several local and regional agencies and developed scenario planning tools and guides. The bulk (85%) of its funding coming from private sources.

Source: *Envision Utah*

The Sacramento Blueprint adopted in 2004 is an example of a regional vision for growth and development. Regional leaders from various disciplines were concerned about the effect on quality of life of adding 1.7 million new residents to the region between 2000 and 2050. They came together to study how the growth could be accommodated through different land use and transportation patterns before arriving at a preferred scenario that the **Sacramento Area Council of Governments (SACOG)** unanimously adopted. The Sacramento Blueprint set direction for the region's Metropolitan Transportation Plan for 2035. For more than a decade, the Blueprint has served as a strong, frequently referenced vision to guide transportation and land use planning throughout the region.

Maintaining a Focus on Equity in the Direction Phase

Transportation agencies of all types and at all levels of government have a responsibility to meaningfully involve all populations in decisionmaking, to promote environmental justice, and to protect the public health, safety, and welfare of all communities. To accomplish this, agencies implement various approaches to meet the letter and spirit of Federal laws, regulations, and Executive Orders. Effective transportation decisionmaking depends on recognizing, responding to, and properly addressing the unique needs, cultural perspectives, and financial limitations of different groups, including those that have been traditionally underserved.[3] Developing an understanding of the values and viewpoints of different groups can be greatly aided by implementing a more comprehensive and inclusive approach to engaging the public in transportation decisionmaking processes. NCHRP Report 710: Practical Approaches for Involving Traditionally Underserved Populations in Transportation Decisionmaking provides State DOTs, MPOs, and other transportation agencies with a rich source of practical and effective tools, techniques, and approaches for identifying and connecting with populations that have traditionally been underrepresented in transportation decisionmaking. Agencies can use local knowledge to develop community profiles, and national data can support analyses of population characteristics and locations. Outreach and coordination based on this information can enable agencies to determine and respond to community-specific needs.

> *"The employment of scenario planning has coordinated the long-term visions and goals for our region. Its flexibility allows for each community to retain its own voice and character while discussing the broader issues, challenges, and opportunities that are likely to impact us both collectively and individually in the future."*
>
> *Rob Terry, Fresno Council of Governments*

Developing Performance Measures

Performance measures define how achievement of goals and objectives will be assessed. The process of designing and testing performance-based scenarios involves the development of indicators that could be shaped into performance measures. The metrics used for a scenario planning initiative should bear relevance to (and ideally be incorporated into) metrics used for the ongoing PBPP process. Applying the scenario planning tools and data to the development of goals and objectives in the long range transportation planning process can help shape performance measures that will inform decisionmaking throughout the process of selecting projects for plans and programs and for system performance evaluation.

Engaging the public and stakeholders in discussions about which performance measures should be used—in addition to those mandated for use through Federal rulemakings—in relation to goals and objectives is an important component of performance-based scenario planning. A

[3] Traditionally underserved groups include: low-income populations; minority populations (those identifying as Black, Hispanic or Latino, Asian American, American Indian and Alaskan Native, Native Hawaiian, and Other Pacific Islander); populations with limited English proficiency; low literacy populations; seniors; people with disabilities (including those with visual or hearing impairments); and transit-dependent populations.

performance-based approach to scenario planning in the direction-setting phase of PBPP might use measures relating to infrastructure condition, safety, traffic congestion levels, walkability, accessibility, and greenhouse gas emissions, among others. It can also include measures related to community goals and values for economic prosperity, environmental sustainability, and quality of life. Scenario planning and PBPP tools or models used to compare alternatives might need to be adjusted to use quantitative, as well as qualitative, metrics. Consequently, considering what data and tools are available, and are expected to be available on a regular basis in the future, is important when selecting performance measures for scenario planning and PBPP.

The **Metropolitan Transportation Commission (MTC)**, which conducts long range transportation planning for the San Francisco Bay Area, provides an example of how performance measures can be used in all phases of planning, including the direction phase, and how scenarios can influence the measures. MTC considered expected future trends and a variety of investment scenarios to identify performance objectives for its LRTP, Plan Bay Area, adopted in 2013. The performance measures then were used to conduct quantitative evaluations of projects to score projects on how well they would address and support the agency's goals. The vision planning step and its supporting scenario planning process is the critical link for establishing goals and performance measures.

PLANWORKS: BETTER PLANNING. BETTER PROJECTS.

PlanWorks is a web resource that supports collaborative decisionmaking in transportation planning and project development. It has four major components: a Decision Guide, Assessments, Applications of special topics, and a Library of publications and case studies.

Decision Guide: The Decision Guide describes more than 50 key decision points that present opportunities for cooperation in the planning, programming, and environmental review process. Organized into four overarching categories of Long Range Planning (LRP), Programming (PRO), Corridor Planning (COR) and Environmental Review/NEPA/Permitting (ENV), information about each decision point includes policy considerations, stakeholder concerns, data needs, case studies, examples, and links to supportive tools. The following decision points provide key opportunities for ensuring consistency and leveraging resources across scenario planning and PBPP processes.

- LRP-2, LRP-3, LRP-4, LRP-5: Approving long range plan vision and goals; Developing evaluation criteria, methods and measures; Identifying current and future transportation deficiencies; Developing financial assumptions
- LRP-7, LRP-8: Developing planning scenarios; Evaluating proposed scenarios
- PRO-1, PRO-2, PRO-3, PRO-4: Identifying program revenue sources: Identifying project selection criteria; Programming projects from adopted plan; Prioritizing projects
- COR-2, COR-3: Developing corridor problem statements; Developing corridor goals
- COR-5: Identifying corridor evaluation criteria, methods and measures
- COR-6, COR-7, COR-8: Approving range of solution sets; Adopting preferred solution; Prioritizing corridor projects
- ENV-3: Linking planning-level vision and goals to project-level purpose and need.
- ENV-5: Approving project-level evaluation criteria, methods and measures
- ENV-6, ENV-7: Approving range of project alternatives; Selecting alternatives to carry forward
- ENV-10: Approving preferred alternative
- ENV-12: Reaching consensus on avoidance and minimization strategies

Assessments: All of the three self-assessments to identify collaboration strategies for agency teams and stakeholders can help practitioners to identify opportunities for linking scenario planning processes and outcomes to PBPP decision making processes.

Applications: PlanWorks includes 16 subject-area resource pages, nearly all of which provide direction and ideas for linking methods, metrics, and outcomes of scenario planning and PBPP processes. Particularly germane topics include Economic Development (note links to the related SHRP2 EconWorks tool), Freight, GHG Emissions, Human Environment, Land Use, Natural Environment, Performance Measures, Planning and Environment, Planning and Operations, Safety and Security, Stakeholder Collaboration, and Visioning.

Analysis: Trends, Targets, and Strategies

The purpose of the analysis phase is to gather information on baseline and forecast conditions; identify problems, needs, or performance gaps; consider external factors that could impact transportation system performance; and identify strategies or alternatives that address those needs or gaps and are aligned with the goals and objectives. A transportation agency accomplishes the analysis stage by comparing different sets of strategies using a set of performance measures that can be forecasted.

Identifying Baseline Information, Trends, and Targets

Identifying baseline information and trends is a key early component of the performance-based planning scenario planning effort. This baseline information typically includes information on the existing multimodal transportation system, including its condition and performance, and factors that are likely to affect the future of the planning area and the future performance of the transportation system, including availability of financial resources. It is the establishment of baseline conditions (safety, congestion, infrastructure) and expected trends (population, employment, land use) that drives the baseline scenario, which is the "likely future" or "status quo." This story about the future helps identify the key trends from which alternative futures can be evaluated and compared.

Traditional transportation planning conducted in the analysis phase of PBPP relies on four-step travel demand models that predict system deficiencies based on locally generated forecasts of population, employment, and land use development patterns. Travel demand models have not traditionally been designed to enable consideration of broader issues and metrics associated with the values and aspirations identified in the initial direction-setting phase of PBPP. Supporting the analysis phase with a performance-based scenario planning process can complement the traditional modeling approach and enhance community engagement and perspectives on transportation investment needs by incorporating a broader array of issues and considering a variety of different future conditions beyond the trend-based forecast. For example, planners can use tools such as the FHWA SHRP2 Utility Bundle to help incorporate utility infrastructure data (e.g., water, sewer, and electricity) into scenarios of alternative transportation investment packages in order to identify potential location conflicts up front. This kind of planning-level feasibility assessment can help agencies to avoid costly delays in later stages of project development.

SCENARIO PLANNING IN REGIONS EXPERIENCING MINIMAL GROWTH

Traditional approaches to scenario planning assumed that a region or State will continue to grow and focused on how and where that growth should occur. However, a number of regions in the US are currently experiencing low or even negative population growth. Scenario planning can be conducted in a way that focuses exploration on future conditions and strategies that make sense for this context as well. Scenario planning can focus on determining which strategies will use an agency's resources most cost effectively to preserve or improve performance, and tools for scenario planning increaslying allow for making adjustments to assumptions to account for declining population growth.

The **Hillsborough County MPO**, which conducts transportation planning for a portion of the Tampa, Florida metropolitan area, provides a good example of how the identification of baseline conditions and trends within scenario planning during the analysis phase can inform the broader planning process, including development of performance measures. For its most recent long range plan, the MPO studied baseline conditions for a wide range of measures that reflected the community's overarching concerns and values, such as energy and water use, water quality, commute length, access to transit, and air pollution. By using a scenario planning process to identify and assess metrics associated with community values, the MPO could incorporate the key issues that were most meaningful and relevant to the community into the analysis phase of its PBPP process.

Developing and Analyzing Scenarios

Scenarios describe a set of future conditions that enable planners, the public, and stakeholders to envision different possible futures for policy and investment options. Stakeholders assess and compare scenarios through qualitative and quantitative comparisons, including comparisons in relation to performance targets. In the analysis phase of PBPP, practitioners typically create a baseline scenario, which assumes that current plans for transportation investment are carried out and that recent development patterns remain the same, or a "no build" scenario that assumes no new transportation investments. Alternative scenarios are then created to examine how changes in trends or investments might affect the region or State.

CALIFORNIA DEPARTMENT OF TRANSPORTATION

To develop its 2040 statewide plan, California DOT (Caltrans) utilized scenario analysis to understand better how different investment strategies would influence greenhouse gas emissions in the State. The agency evaluated the following scenarios:

- A baseline scenario, which accounted for existing Sustainable Communities Strategies plans
- A scenario with aggressive VMT reduction strategies that assumed the construction of passenger rail
- A scenario in which advanced vehicle and fuel strategies were implemented

The results of the alternatives analysis led to specific recommendations in the statewide transportation plan for 2040. Caltrans identified the following benefits from scenarios:

- Ability to understand the multiple strategy combinations to achieve GHG reduction targets
- Identify trends of the most promising and risky strategies
- Inform near-term public policy decisions
- Increase awareness of the transportation system
- Understand the impacts of the fuel network, alternative technologies, and behavioral changes.

Source: Caltrans

Some of the different types of scenarios that might be developed in the analysis phase of a PBPP process (or, at a less detailed level, in the direction-setting phase) include:

- Transportation policies or investment strategies – exploring different scenarios for packages of transportation solutions, which could include different emphases for transportation investments or policies
- Land use patterns – exploring different scenarios of distributions of population and employment, often in combination with different transportation policies or investment strategies
- External factors – exploring factors that are outside the control or influence of transportation and land use planning agencies (e.g. broad economic trends)
- Performance levels – exploring different scenarios for future performance and what is required for achieving it, such as a scenario to maintain baseline conditions or to attain target levels
- Funding levels – exploring different scenarios based on levels of funding that might be available.

SCENARIO PLANNING FOR TRANSPORTATION SYSTEM MANAGEMENT & OPERATIONS

Although traditionally the transportation planning process has focused primarily on infrastructure investment needs, transportation agencies are increasingly putting more emphasis on transportation system management and operations strategies (TSMO) to address congestion, safety, and reliability. The results of a TSMO-informed plan can influence activities such as signal coordination, incident management, congestion pricing, and ridesharing programs, to name a few. The PlanWorks "Linking Planning and Operations" Application provides resources for integrating TSMO into the overarching PBPP process.

Scenario planning can play a role in evaluating TSMO strategies, which typically are not well addressed in regional travel models. Some scenario planning methods can help agencies to explore the potential opportunities and impacts associated with new and emerging technologies before they are deployed. Meanwhile, other scenario planning processes can help an agency optimize its strategy for maintaining safe, efficient travel in an area where some changes are likely, but not yet fully defined. To support efforts such as these, the FHWA primer Advancing Transportation Systems Management and Operations through Scenario Planning was published in 2016.

As noted above, equity is a critical consideration for scenario planning, given the importance of ensuring the process is inclusive. Specifically, the scenario planning processes need to be designed to accommodate all populations, as required in:

- Title VI of the Civil Rights Act of 1964, which prohibits exclusion from participation in, denial of benefits of, and discrimination under Federally-assisted programs on grounds of race, color, or national origin.
- The Americans With Disabilities Act of 1990, which states that no qualified individual with a disability shall, by reason of such disability, be excluded from

participation in or be denied the benefits of services, programs, or activities of a public entity, or be subjected to discrimination by any such entity.

- Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, which requires Federal agencies to identify any needs for services to those with limited English proficiency (LEP), and develop and implement a system to provide those services so LEP persons can have meaningful access to them.
- Executive Order 12898, Environmental Justice in Minority Populations and Low-Income Populations, which instructs Federal agencies to identify and address instances in which adverse human health or environmental effects of their actions disproportionately affect minority and low-income populations.
- The Age Discrimination Act of 1975, which prohibits discrimination on the basis of age in programs or activities receiving Federal financial assistance.

SCENARIOS OF TRANSPORTATION POLICY/INVESTMENT STRATEGIES

State DOTs and MPOs can use scenario planning to support performance-based analysis by exploring different transportation policy and investment scenarios. This approach involves designing scenarios that involve different types or sets of transportation investments; these scenarios are then compared against a baseline and against each other, to help select a preferred alternative.

An example of an agency using this approach during the analysis phase is the **Southeast Michigan Council of Governments (SEMCOG)**, in the Detroit area, which used scenario planning in summer 2009 to analyze the effects of different investment scenarios as part of the development of its 2035 Regional Transportation Plan. SEMCOG crafted five scenarios (or "themes") in which funding allocations varied among the program areas of pavement preservation, highway capacity, bridge preservation, safety, transit, nonmotorized, and roadway operations. The first scenario represented the trend, extending recent allocations into the future. In addition to the trend scenario, the other four scenarios were:

- *Public Opinion* – Allocate more funds to programs preferred by the public
- *Preservation First* – Emphasize pavement and bridge performance
- *Transit First* – Emphasize transit system performance
- *Maximize Performance* – Balance fudning across priorities to achive relatively equal performace in each category

SEMCOG studied the five scenarios using the following performance measures:

- Percent of pavement in good or fair condition
- Hours of delay per 1,000 vehicle miles
- Percent of bridges in good or fair condition
- Fatalities per 100 million vehicle miles
- Extent of transit network
- Percentage of the population within 1/2 mile of a nonmotorized facility

SEMCOG used several tools for its analysis: its travel demand model; geographic information systems (GIS), to perform a buffer analysis for the non-motorized system); the Highway Economic Requirements System-State Version (HERS-ST); the Michigan DOT Pavement Condition Forecasting System and Bridge Condition Forecasting System; and the National Bridge Investment Analysis System (NBIAS). The MPO also used AssetManager NT to analyze and visualize relationships within and across the program areas.

SEMCOG used the scenarios as a public engagement tool to help the public better understand investment trade-offs under an economic forecast that anticipated an extended, deep recession.

SPACE COAST TRANSPORTATION PLANNING ORGANIZATION

Space Coast TPO in Florida utilized Scenario Planning in its analysis phase to test strategies for reducing projected future congestion as well as achieving other goals and objectives of its 2040 LRTP. The TPO Priority Reliever, referred to as the preferred Vision Scenario for 2040, included many high priority regional connections from the 2035 LRTP and increased transit service on popular routes. The scenario planning exercise helped identify the public's preferences for future development (e.g., more transportation choices, balancing growth with conservation, maintaining existing transportation assets), and this input informed the goals and objectives of the 2040 LRTP.

Compared to the base case scenario, or (Current Trend), the priority reliever scenario reduced vehicle miles traveled, vehicle hours of travel, and vehicle hours of delay significantly. This Priority Reliever scenario became the basis for the 2040 needs plan.

Because of the scenario planning, the TPO also developed a policy framework for local agencies to work towards the long-term goals, by identifying land use changes and new potential revenue sources to fund transportation projects that support the 2040 Vision.

Source: Space Coast TPO

Through this scenario planning process, SEMCOG was equipped with better information to support its decisionmaking. Ultimately, the MPO selected a hybrid scenario that emphasized maintenance and preservation.

Another example is the **Tri-County Regional Planning Commission (RPC)**, the MPO for the Lansing region in Michigan. During the analysis phase of its planning process, Tri-County RPC used scenario planning and technical modeling to help inform decisionmaking and project selection in the Regional 2040 Transportation Plan. To ensure consistency and transparency, the agency linked the plan's goals and objectives to performance measures that it then used to assess a set of alternative scenarios. Tri-County RPC developed eight alternative scenarios reflecting

different levels of emphasis for investments. The agency compared the alternative scenarios to base year and trend scenarios to provide a clear picture of their relative impacts on the performance measures.

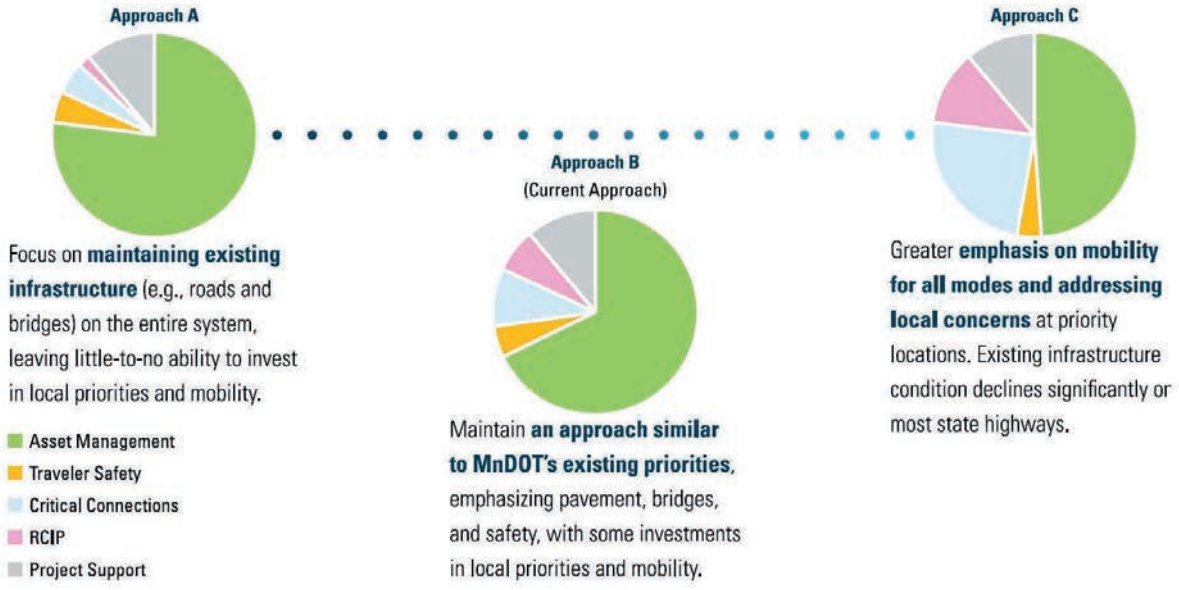
Table 3-1: Tri-County RPC Scenarios Considered in Developing the 2040 Transportation Plan

Alternative	Descriptive Name
1	High Transit
2	Medium Transit
3	Demand Reductions/Improve Operations
4	Combinations of 2 and 3
5	Combination of 2, 3, and 6a
6A	Planned Highway Options List
6B	Planned Highway Options List, 2040 Trend
7	Highways Only

Source: Tri-County Regional Planning Commission

At the State level, **Minnesota DOT** used a type of scenario analysis to examine necessary trade-offs in the development of the 2013 Minnesota State Highway Improvement Plan (MnSHIP), which links the policies and strategies in the State's Multimodal Transportation Plan to investment priorities on the State highway network. The agency developed three distinct investment scenarios and modeled expected 20-year outcomes for each. Scenarios A and C represented different allocations of funding across different investment categories, while Scenario B represented MnDOT's then-current spending across categories. Each scenario was described in terms of anticipated system performance and risks, both addressed and remaining. According to the agency, "this step allow[ed] MnDOT and the public to better understand the tradeoffs associated with different Performance Levels." The following illustrates the three different approaches.

Figure 3-2: MnSHIP Investment Approaches Developed for Scenario Planning



Source: Minnesota DOT

The public, stakeholders, and DOT staff reviewed the scenarios. The feedback received from this analysis process directly influenced the development of MnSHIP's 20-year investment priorities. To develop the preferred investment scenario, MnDOT focused on several key factors: stakeholder and public input, revenue outlook, State requirements and related risks, previous MnSHIP priorities, current and projected performance, MnDOT policy, and Federal Law (MAP-21). Using these factors and the results of the scenario analysis, MnDOT developed a 20-year Investment Plan that identifies how investment priorities in the first 10 years and in the second 10 years of the plan will be distributed among and between mobility improvements (for automobiles, bicyclists, and pedestrians), safety improvements, local and regionally driven priorities, and maintenance of the existing system, to maximize performance.

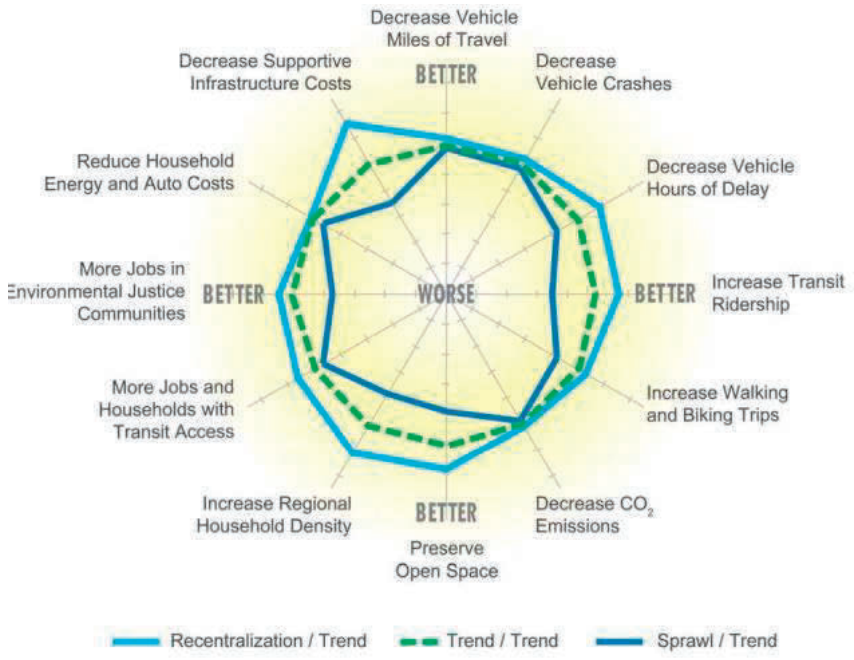
COMBINED LAND USE AND TRANSPORTATION SCENARIOS

Scenario planning often has played a key role in enhancing the planning process extending the traditional realm of considering different transportation investments to explore how land use patterns can influence transportation system performance. By developing scenarios for alternative land use patterns or distributions of population and employment, this information helps inform local governments and communities about the important role of land use decisions in transportation system performance (and transportation investments on land use decisions), equity, and quality of life, thereby bringing into the planning process a broader set of strategies and considerations. Such scenarios can be developed for both the direction-setting and analysis phases of PBPP. The direction-setting scenarios might be depicted as sketches of general development trends, designed to help planners identify desired overarching policies and goals. Analysis-level scenarios can delve more deeply into the impacts of specific investment packages or policy decisions on targeted subareas such as corridors or systems such as rail and bus transit networks.

In a performance-based planning approach, considering alternative land use scenarios can be used to help shape a common vision for the future among multiple individual local governments that play a lead role in land use planning. By articulating more clearly the performance outcomes of these land use decisions, elected officials and decisionmakers can draw connections between their local policies and the transportation system performance and conditions experienced by their residents.

The **Delaware Valley Regional Planning Commission (DVRPC)** developed a 2008 report, *Making the Land Use Connection*, which informed the agency's 2035 long range plan. Figure 3-3 shows a graphic from the 2035 plan, developed during the analysis phase, that displays the expected trade-offs between three land use scenarios with respect to twelve different measures, each of which corresponds to objectives such as improving safety.

Figure 3-3: Index Used by DVRPC to Compare Three Alternative Land Use Scenarios



Source: DVRPC

Getting to the preferred vision can inspire development of goals that set a framework for action and determine specific performance measures that can bring substantial clarity to what is important to the public, in a way that is effective in communicating to decisionmakers. Nevertheless, these values should inform the performance measures and strategies that ultimately guide the designing of specific projects. During the analysis phase, transportation agencies can explore scenarios that include combinations of different land use patterns and different transportation investment strategies.

One example is the **Denver Regional Council of Governments (DRCOG)**. Scenario analyses in successive DRCOG regional transportation planning efforts have built off previous scenario planning endeavors. For its 2035 Metro Vision plan update, DRCOG developed five scenarios that focused on changes to the urban growth boundary, density, the fiscally constrained roadway

network, the fiscally constrained transit network, and driving and transit pricing; these scenarios are shown in Table 3-.

Table 3-2: DRCOG Scenarios Addressing Changes to Land Use and Transportation Investments and Policies

Scenario	Expansion of the Urban Growth Boundary	Density Increase (2000–2035)	Change to the Fiscally Constrained Roadway Network	Changes to the Fiscally Constrained Transit Network	Pricing Changes
A	None	23%	None	None	None
B	+70 share miles	12%	+300 miles of minor arterials and collectors	None	None
C	+150 square miles	0%	+600 miles of minor arterials and collectors	None	None
D	+70 square miles	12%	+300 miles of minor arterials and collectors; +300 miles new freeway/tollway capacity	None	None
E	None	23%	−100 miles of highway capacity	Additional rail and bus rapid transit	None
F	None	23%	−100 miles of highway capacity	Additional rail and bus rapid transit	Auto operating costs doubled; transit free

Source: DRCOG

DRCOG evaluated the six scenarios on the following 12 outcome measures.

Table 3-3: Outcome Measures Used by DRCOG to Evaluate Scenarios

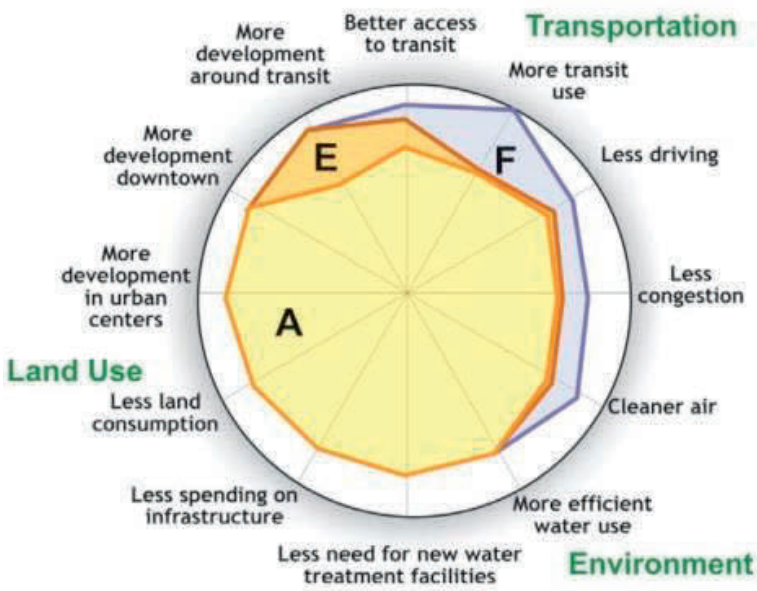
1. Increase in transit use
2. Decreased need for new water treatment facilities
3. Decrease in driving
4. Decrease in spending on infrastructure
5. Decrease in congestion
6. Decrease in land consumption
7. Improvement in air quality
8. Increase in development in urban centers
9. Increase in efficiency of water use
10. Increase in development downtown
11. Improved access to transit
12. Increase in development near transit

Source: DRCOG

The agency used visuals like the one in Figure 3-4 to show the comprehensive forecasted performance of each scenario with respect to the 12 performance goals. These goals align with the overall vision for the region, and are associated with measurable outcomes. Furthermore, the

goals are interrelated, and achieving each goal will produce co-benefits that support progress toward the other goals. The use of scenario planning in this case was an effective way to consider the cumulative benefits and co-benefits of a set of strategies.

Figure 3-4: Example Comparison of Scenarios A through F in Relation to Different Performance Goals from DRCOG



Source: DRCOG

DRCOG ultimately identified Scenario F as the one that would result in the best performance overall for the region. The scenario planning exercise gave DRCOG an improved understanding of the effects of a potential change to the region's urban growth boundary. Performance measures in the agency's 2035 plan include all of the transportation-related measures used to evaluate the scenarios, and the agency continues to track performance in these areas to improve data-driven decisionmaking.

Similarly, the **Durham-Chapel Hill-Carrboro MPO** and the **Capital Area MPO** in North Carolina worked together in developing combined transportation and land use scenarios for the development of their 2040 Metropolitan Transportation Plan. The agencies developed six alternative scenarios in the analysis phase, each comprising a transportation scenario and a land use scenario, as illustrated in Table 3-.

The MPOs evaluated the alternative scenarios based on several performance measures, including level of roadway congestion, average travel time, mode share, and transit ridership. In addition, the MPOs reviewed performance measures by transit service sub-areas and specific travel corridors to overcome diluting effects that large, regional models can have. The results of this scenario analysis then were used by MPO staff to develop a preferred scenario, which included road, bus transit, and rail transit investments.

Table 3-4: Six Scenarios Evaluated by Durham-Chapel Hill-Carrboro MPO and the Capital Area MPO

Alternative	Transportation Scenario	Land Use Scenario
1	Roadway Intensive – abundant highway projects, no light or commuter rail	Community Plan – population and employment growth occurs based on current land use plans
2	Transit Intensive – includes large bus transit improvements, extensive light rail, and commuter rail service.	Community Plan – Population and employment growth occurs based on current land use plans
3	Moderate – includes most of the highway, bus, and rail transit projects included in the 2040 MTP	Community Plan – Population and employment growth occurs based on current land use plans
4	Trend and Transit Plans – includes highway projects at current spending levels; bus and rail transit projects that are in the 2040 MTP	Community Plan – Population and employment growth occurs based on current land use plans
5	Transit Intensive – includes large bus transit improvements, extensive light rail, and commuter rail service.	All-in-Transit – Population and employment growth based on current land use plan but uses additional and more intensive transit-oriented development, and land use modeling increased attractiveness to rail and premium transit
6	Moderate – includes most of the highway, bus, and rail transit projects included in the 2040 MTP	All-in-Transit – Population and employment growth based on current land use plan but uses additional and more intensive transit-oriented development, and land use modeling increased attractiveness to rail and premium transit

Source: Durham-Chapel Hill-Carrboro MPO; Capital Area MPO

The **Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments** also conducted a CLRP Aspirations Scenario Study as part of the analysis phase during development of its 2040 Constrained Long Range Transportation Plan (CLRP). The Study was presented to the TPB in 2013. The Aspirations Scenario Study was developed to integrate the best components of previous TPB scenario studies[4] into a comprehensive scenario that could offer a promising path forward for the region. Previous TPB studies had provided conclusions about effective regional strategies for improving travel conditions, but those studies focused on issues of land use or transportation, but not both. The CLRP Aspirations Scenario combined an alternative land use scenario with more dense, transit-oriented development; a regional network of variably price lanes; and high quality bus rapid transit (BRT) and circulator bus service focused on supporting the land use plan.

SCENARIOS EXPLORING EXTERNAL FACTORS

[4] The land use and transportation components of the study were based largely on findings from previous scenario analysis – the Regional Mobility and Accessibility Study (2006) and the Regional Value Pricing Study (2008).

Scenarios can be used to explore how external, or exogenous, factors, might affect transportation system performance and investment needs. When looking toward the next 20 to 40 years, many factors beyond land use that are not commonly considered in transportation planning but could have substantial impacts on travel demand are highly uncertain. For instance, substantial changes in fuel prices, macroeconomic conditions, technologies, or climate conditions could have important implications on transportation system performance, investment needs, and the value of different types of transportation investments and policies. Scenario planning can be used to explore how well the current vision might respond to different uncontrollable or external forces and to increase clarity regarding the actions that can be taken in the face of various futures (i.e., serve as a guide to action).

"One of the reasons we do scenario planning is to look at contingencies and, as necessary, develop 'fall-back' positions. For example, we need to prepare for the possibility that the transportation funding outlook never improves, or even worsens. In our next Plan update, we may look at how quickly automated vehicles reach a saturation point on our roads, and what implications that has for congestion and an aging population."

- *Beth Alden, Hillsborough County MPO*

This approach is essentially a "stress test" for different transportation strategies. Rather than focusing on optimizing system performance within one set of assumed future conditions, planners can use scenarios to compare the resiliency or adaptability of given strategies to change. For example, the agency might assign a score (e.g., low, medium, or high) for each strategy based on how well it could be expected to perform in each scenario. Using this approach might demonstrate that some projects or strategies perform well in many different plausible future conditions. The outcome of the process could lead to the need for a shift in project priorities or strategies. It could also generate new or modified performance metrics for ongoing system monitoring. This approach can inform the long range plan and program and other efforts such as a risk-based asset management planning exercise.

An example of using this type of approach is demonstrated by the **Baltimore Regional Transportation Board (BRTB)**, which undertook, during the analysis phase, a scenario planning process addressing land use and transportation strategies and scenarios of divergent futures. In developing the Plan It 2035 transportation plan, approved in 2011, the BRTB undertook a visioning process (Imagine 2060). Ultimately, BRTB used scenario planning to develop a preferred scenario for the Imagine 2060 vision. The agency developed several land use scenarios with supporting transportation options, which they presented to the public for input (Table 3-).

Table 3-5: BRTB Options Addressed in Scenarios

Land Use Options	Transportation Options
Downtowns: new growth concentrated in downtown areas; mix of uses in downtowns; limited new suburban growth	Urban Multi-modal Transportation: light rail/commuter rail service radiating from downtown Baltimore; local bus service in the urban core and inner suburbs; downtown pedestrian and bicycle networks; increased capacity on roadways serving high density areas
Town and Village Centers: new growth concentrated in town and village centers; mix of uses in town and village centers; limited new suburban growth	Local and Regional Connections: light rail/commuter rail service radiating from downtown Baltimore; express bus service from park and ride lots to employment centers; local transit service downtown; pedestrian and bicycle networks in downtown areas; increased capacity on roads serving medium density areas and the City of Baltimore
Established neighborhoods: new growth concentrated in suburban residential areas; mostly residential and retail uses in these areas; limited new downtown growth	Commuter Options: maintenance of existing light rail/commuter rail and bus service; modest bus service from park and ride lots to employment centers; modest improvements to bicycle and pedestrian facilities; increased capacity on roadways serving high and medium density areas
Expanding Suburbs: new growth concentrated in suburban and rural areas; mostly residential and retail uses in these areas; limited new downtown growth	Expanding Roadways: maintenance of existing light rail/commuter rail and bus service; maintenance of existing pedestrian and bicycle facilities; increased capacity on all major roadways.

Source: BRTB

BRTB returned to scenario planning in the development of its next long range transportation plan, Maximize 2040: A Performance-Based Transportation Plan. BRTB focused significant effort attempting to answer the question: "How can the region make informed decisions about the future, especially when there are a lot of uncertainties about the future?" To begin answering this question, the agency surveyed the public, focusing on social, economic, technological, environmental, and political forces that could shape the transportation landscape in the future. Survey participants identified several external forces that could be highly influential in the future.

BRTB then worked with focus groups to review public input and determine the most critical of these forces to analyze further. The focus group recommended that BRTB assume two forces identified by the public (the top two vote getters in the public input process) were almost certain to happen and should be built into any scenarios as underlying assumptions. These forces are: (1) an aging, more diverse population; and (2) lack of funding to meet all transportation needs and aspirations. The group then selected three other forces on which the scenarios should focus: (1) changes in preferences with respect to travel and work; (2) sea level rise and increase in severe weather events owing to climate change; and (3) advances in vehicle-to-network and vehicle-to-vehicle technologies, including autonomous vehicles.

Based on these recommendations, BRTB developed three scenarios for possible changes between 2014 and 2014:

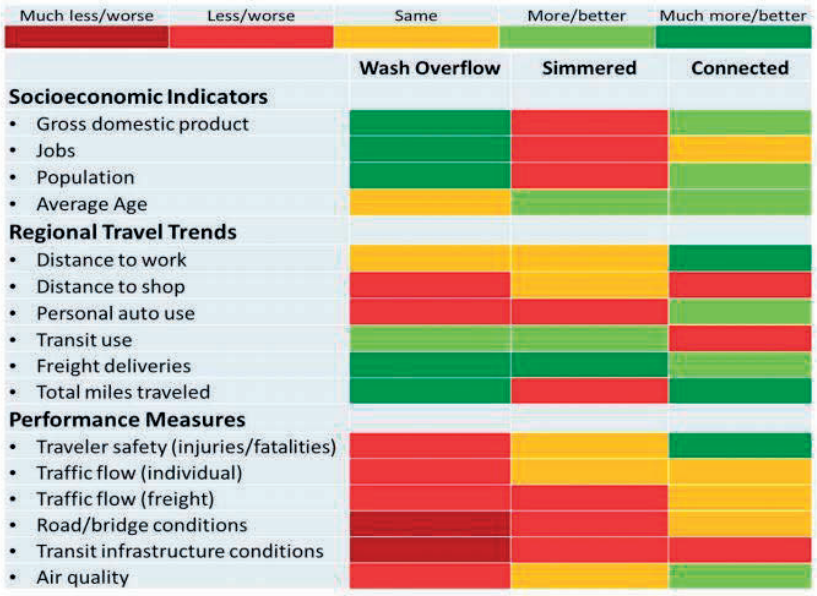
1. "Wash Overflow" – Washington DC's population and job growth extends to the Baltimore region
2. "Simmered Up" – Sea level rise and extreme weather events due to climate change
3. "Zuber Connected" – advances in vehicle-to-vehicle and vehicle-to-network communication systems and sensors

BRTB invited stakeholders from several organizations (e.g., the Public Advisory Committee, local universities and colleges, Maryland DOT, local jurisdictions, businesses, advocacy groups) to analyze the impacts of the different scenarios, using a qualitative analysis approach, as shown in Figure 3-5.

"Scenario planning enabled our region to have a reasoned conversation regarding contentious topics for which there is a significant degree of future uncertainty. The process of evaluating possible outcomes of different paths gave our region the tools to debate which outcomes were unacceptable, identify the efforts necessary to achieve the preferred outcome and whether our region had the willingness to commit to those efforts. Scenario planning was most helpful in our region's efforts to identify a preferred future vision for how Waco should develop and in identifying future resources to implement priorities within the Metropolitan Transportation Plan."

- Chris Evilia, Waco MPO

Figure 3-5: BRTB Analysis of Three Scenarios across Different Performance Measures



Source: BRTB

As the BRTB moves forward in the *Maximize 2040,* the results of the scenario planning process are helping inform the process of project evaluation and selection. In addition, the BRTB will revisit the issues raised in the scenario planning process periodically over the next several years, both to stay informed about new developments and potentially to refine goals and performance measures based on new developments.

At the State level, **Washington State DOT (WSDOT)** conducted a scenario planning analysis exercise to develop its State Freight Mobility Plan; this exercise is described in NCHRP Report 750. The agency recognized the challenge to predicting future demand for freight with a fixed growth rate, given the range of changes to economic conditions and business sourcing patterns that could influence the system in 2030 and beyond. WSDOT used scenario analysis to consider the potential effects of varying scenarios on the future of the State's freight system. The agency's goal was not to predict the future, but to better prepare itself for a variety of potential futures. The agency looked at four scenarios:

- *One World Order* – A highly regulated, "green" world in which natural resources are scarce, with high energy costs and environmental sensitivity
- *Naftástique* – A scenario in which U.S. trade is focused within North America rather than Asia
- *Technology Savior* – A scenario in which advances in technology disburse goods production and improve material abundance
- *Global Marketplace* –A scenario under which trade is relatively free and global, similar to conditions today.

WSDOT, in coordination with the Massachusetts Institute of Technology's Center for Transportation and Logistics, convened a statewide scenario planning symposium with experts representing freight carriers, shippers, industry associations, universities, and Federal, State and local governments. Participants were divided into groups. Each group focused on one of the four scenarios and identified investment priorities to best address the scenario. The exercise resulted in the following overarching conclusions. They are accurate and applicable regardless of which scenario (or combination of scenarios) is realized:

- Demand will increase on the east-west transcontinental rail system and the State Freight Waterway Economic Corridors.
- Demand for truck services along the I-5 corridor and in urban centers is also likely to grow more rapidly than indicated in a previous forecast (e.g., the FAF3 [Freight Analysis Framework, 3rd version]).

Scenario planning enabled WSDOT to improve its ability to make informed, data-driven decisions about the investments that are most likely to create the greatest future benefits in the face of changes that could occur with respect to freight demand.[5] These findings informed the identification of Freight Economic Corridors, which are roadways, railways, and waterways critical to the movement of commerce in the State. Freight Economic Corridors are used to

[5] Washington (State) DOT, http://www.wsdot.wa.gov/freight/freightmobilityplan.htm; Transportation Research Board, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v1.pdf.

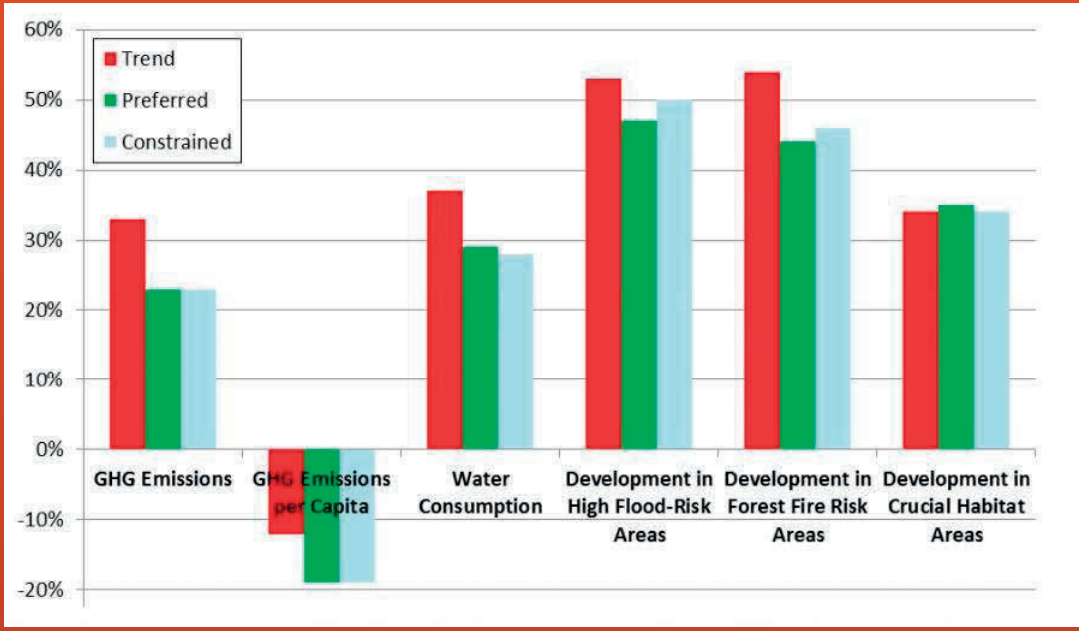
address system condition and capacity issues and develop performance measures to improve freight mobility.

The **Delaware Valley Regional Planning Commission (DVRPC)** provides another example of the use of scenario planning during the analysis phase to guide the development of its regional plan, Connections 2045. The agency assembled a group of regional stakeholder experts—a "Futures Group," which included academics, economists, and major organization leaders—that conduct parallel work but had not previously been involved in DVRPC's planning efforts. The Group went through a process to identify five "Forces of Change" that were modeled over a 30-year horizon. These forces were enduring urbanism, the free agent economy, severe climate, transportation on demand, and the US energy boom. The impacts and challenges that arose under different scenarios led to the identification of potential action steps the agency could take to position itself more strategically to confront the challenges. The agency used Impacts 2050, a sociodemographic system dynamics model (from the NCHRP 750 report series) and Rapid Policy Analysis Tool (RPAT). The agency published a Future of Scenario Planning White Paper to summarize its previous and current scenario planning work.

MID-REGION COUNCIL OF GOVERNMENTS

Through the Central New Mexico Climate Change Scenario Planning Project (CCSP), Mid-Region Council of Governments (MRCOG), which serves the Albuquerque region, analyzed transportation and land use scenarios to determine how best to manage congestion, reduce emissions, and adapt to the potential impacts of climate change. MRCOG analyzed the performance of three scenarios—trend, preferred, and constrained—with respect to a set of six potential future climate-related challenges to understand the region's susceptibility to hazards such as droughts, wildfires, and flooding. Agency staff used MRCOG's four-step travel demand model and the UrbanSim land use model to analyze the three scenarios. As the chart below shows, the preferred scenario outperformed the others on most of the climate-related measures. Although the agency ultimately adopted the Trend scenario, as it reflected existing local plans, the MRCOG policy board adopted the preferred scenario as a policy vision toward which it would continue to work. The goals in the Metropolitan Transportation Plan are aligned with this preferred scenario. MRCOG is currently working with local agencies on tasks that would support the implementation of the preferred scenario.

MRCOG modified its Project Prioritization Process to reflect the preferred scenario-based policy vision; project selection criteria that support the preferred scenario are used as part of the TIP development.



*Note: The above graph shows the percent change by 2040 from 2012 for each scenario. The data were based on an interim dataset and slightly differ from data contained in the approved plan.

Source: Mid-Region Council of Governments

GAINESVILLE METROPOLITAN TRANSPORTATION PLANNING ORGANIZATION: PEAK OIL ANALYSIS

For its 2035 long range transportation plan, the Gainesville MTPO developed and analyzed four mode-based scenarios:

- BRT Emphasis
- Highway Emphasis
- Streetcar Emphasis
- Hybrid

The MPO then developed a baseline scenario and ran each modal scenario through the agency's travel demand model, using a single set of land use patterns based on the adopted local government comprehensive plans. Gainesville MTPO evaluated each scenario based on its projected impact on vehicle travel, congestion, delay, growth patterns, and mode shares (transit, bike and pedestrian, auto)—the same performance measures tied to goals in the plan and on which the agency tracks performance.

The agency also considered the performance of each scenario under a potential future condition of "peak oil," which would represent a future in which peak global oil production occurred in 2010, after which point oil would become less available and more expensive. To incorporate peak oil into the different scenarios, the agency adjusted its travel demand model to account for how rising fuel prices would influence travel demand. The analysis assumed that rising fuel prices would lead to reduced single occupancy vehicle miles traveled. The findings from this analysis indicate that, under peak oil conditions, the region would need to prioritize energy-efficient travel modes. When applied to the different scenarios, peak oil would likely reduce vehicle miles traveled by 18 percent compared to the base scenario. Additionally, peak oil would likely reduce vehicle hours traveled by 33 to 35 percent compared to the baseline. Ultimately, the MPO used a hybrid scenario to develop its 2035 Needs Plan based on an improved understanding of the likely implications of this scenario under a peak oil future.

Source: Gainesville Metropolitan Transportation Planning Organization

SYSTEM PERFORMANCE SCENARIOS

One of the key values of scenario planning in supporting a performance-based planning approach is that it allows decisionmakers to understand alternative approaches to achieving their performance targets and optimize the use of limited transportation funds. Consequently, transportation agencies analyzing system performance scenarios should consider a scenario that, to the maximum extent practicable, maintains baseline conditions for performance associated with the national performance measures, and at least one scenario that improves the baseline conditions for as many of the national performance measures as possible.

As noted earlier, **Southeast Michigan Council of Governments (SEMCOG)** used a scenario planning approach to analyze different investment scenarios in support of its 2035 regional transportation plan. Each scenario was defined based on percentages of funding being allocated toward different program areas (transit, pavement, bridge, expansion, safety, and nonmotorized). One of the four themed scenarios was focused on "Maximize Performance" and was designed to optimize performance across each program area. SEMCOG also developed "investment versus performance" graphics that illustrated how current prioritization differed from the public's preference for goal prioritization, helping to facilitate discussions about future investments. The figure below shows baseline (2010) performance in key program areas, targets for 2030 performance under each scenario, and the funding split associated with achieving those targets. A key step in SEMCOG's approach was to examine the relationship between investment levels and performance.

SEMCOG continues to monitor how funding in the region is invested across the various program areas, but primarily focuses on system performance as it relates to progress toward the vision for the region. On its website, the MPO tracks progress toward a set of comprehensive performance measures for the region, which include transportation indicators related to road and bridge conditions, fatalities and serious injuries in vehicular crashes, transit ridership, and air quality.

Figure 3-6: SEMCOG Scenario Analysis

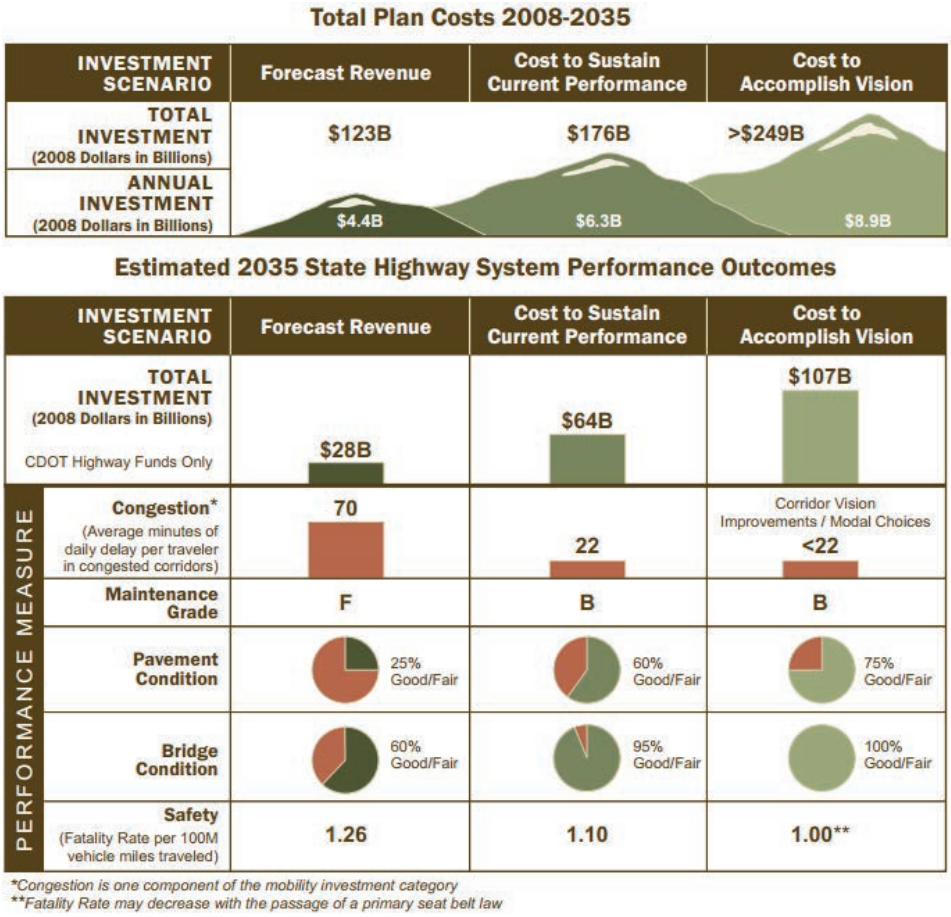
		1. Current Allocation		2. Public Opinion		3. Preservation First		4. Transit First		5. Maximum Performance	
Program Area	2010 Performance	2030 Target	Funding Split	2030 Target	Funding Split	2030 Target	Funding Split	2030 Target	Funding Split	2030 Target	Funding Split
Transit	Current system	Current System	21%	< Current System	12%	< Current System	21%	Transit Vision	41%	Transit Vision	22%
Pavement	57 % pavement in good or fair condition	57%	21%	49%	18%	85%	31%	40%	14%	97%	21%
Bridge	85 % bridges in good or fair condition	100%	6%	100%	7%	85%	3%	80%	3%	99%	3%
Expansion	2.9 hours of congestion delay per 1,000 vehicle miles traveled	2.6	10%	2.6	10%	3.0	2%	3.0	0.0%	2.3	10%
Safety	0.77 fatalities per 100 million vehicle miles traveled	0.74	0.5%	NA	7%	0.73	0.8%	0.73	0.8%	0.72	2.0%
Nonmotorized	13 % population and employment within ½-mile of nonmotorized facility	44%	0.5%	100%	5%	44%	0.5%	13%	0.0%	100%	2.0%
Roadway Operations	NA		41%		41%		41%		41%		41%

Source: SEMCOG

Another example of this approach was applied by the **Colorado Department of Transportation (CDOT)** in its 2035 Statewide Transportation Plan during the analysis phase of its planning process. The statewide plan addresses the funding-performance link by analyzing three investment scenarios, each of which forecasted anticipated performance-based on investment levels. For example, CDOT estimates that under the forecasted revenue scenario, pavement condition will deteriorate significantly (25 percent of roads in good/fair condition) and that congestion will increase to 70 minutes of delay per traveler. CDOT developed scenarios for the "cost to sustain current performance" and the "cost to accomplish vision" in the plan. This

information was valuable to make clear to decisionmakers how funding shortfalls would affect system performance.

Figure 3-7: CDOT Analysis of Cost to Sustain Current Performance

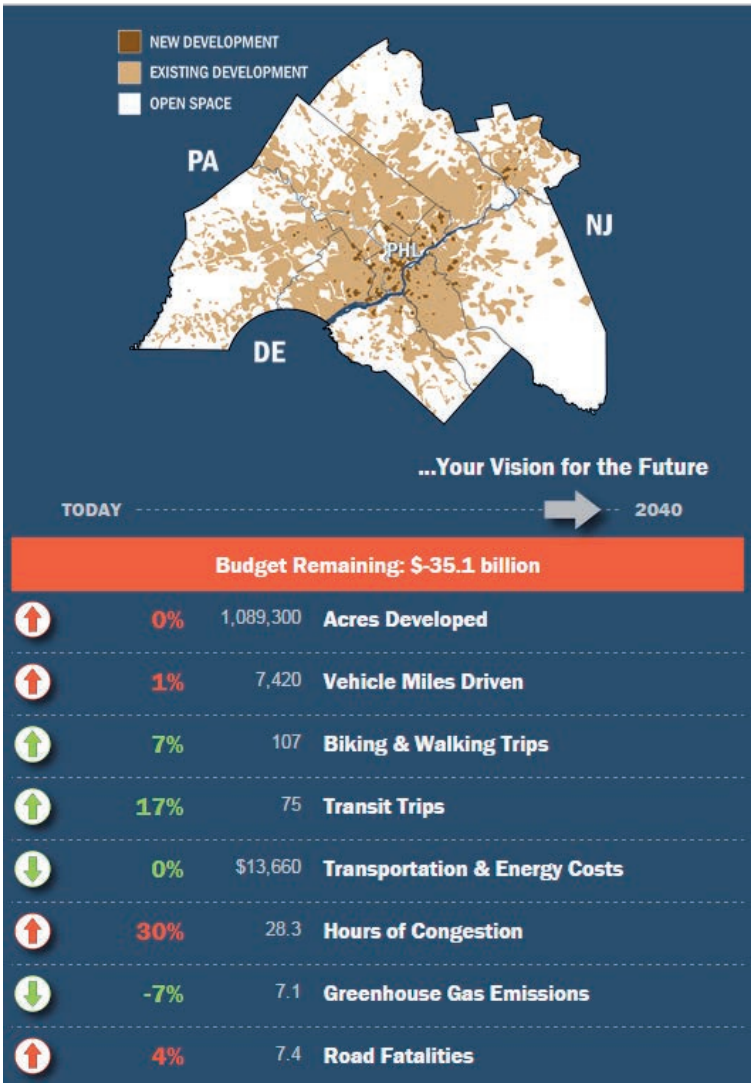


Source: Colorado DOT

The ***Delaware Valley Regional Planning Commission (DVRPC)*** combined the information collected from multiple rounds of scenario planning into an online tool called Choices and Voices, which engaged stakeholders and the public in the analysis of fiscally-constrained system performance scenarios. The tool is interactive and enables users to identify their preferred transportation focus (e.g., emphasis on roadways or on new modal choices) and preferred housing/land use development types for the region. It also gives users the option to identify the condition of different components of the transportation system they would prefer to have the region maintain and then see the cost associated with different levels of investment. By adjusting their preferences with respect to a variety of investment types and levels, and identifying specific transit projects to support, users can see the anticipated impacts on budget and performance. Regarding performance, users can see the expected outcomes on the following measures: acres of land developed; VMT; biking, walking and transit trips; transportation and energy costs; hours of congestion, greenhouse gas emissions; and roadway fatalities. The exercise requires achieving a balanced budget before submitting the vision, which forces users to comprehend and make difficult trade-offs that resemble those that must be made by agencies like DVRPC. This allows

users to see the corresponding performance results. The tool links to social media, so users can publicly share their visions with those in their social networks.

Figure 3-8: DVRPC Choices and Voices Interactive Tool



Source: DVRPC

FUNDING SCENARIOS

Although MPO plans must be fiscally constrained, and State long range transportation plans should be built with recognition of expected available funding, scenarios also can be developed to explore the impacts of different levels of transportation funding on system performance. In some cases, scenarios can be developed for issues associated with specific transportation parameters or goal areas. For example, an agency might decide to compare the impacts of different highway maintenance funding levels on pavement quality. Tools can be used to predict pavement condition associated with different amounts of investment, as it reflects different amounts of resurfacing, repair, and rehabilitation.

An agency can also use different funding scenarios to assess performance across multiple outcomes during the analysis phase of PBPP. The **Hillsborough County MPO** in Florida offers an example of this approach. In designing its 2040 long range plan, the MPO examined how low, medium, and high levels of financial investment would affect system performance for several key measures, including:

- Pavement preservation
- Highway congestion
- Transit vehicle fleet age
- Transit level of service
- Pedestrian and bicycle level of service
- Vehicle, bicycle, and pedestrian crashes

The levels of investment approach shows the low level of investment represents the recent trend extended into the future. The medium and high investment levels represent scenarios in which more funding is directed to the priority. The Hillsborough County MPO took this approach a step farther by quantifying what level of performance would be possible under different levels of overall funding. The MPO demonstrated that a new sales tax for transportation would enable it to invest in these categories at higher levels and could demonstrate just how much the additional investment would benefit the transportation system.

OREGON DEPARTMENT OF TRANSPORTATION – STATEWIDE INTEGRATED MODEL

To create the 2006 Oregon Transportation Plan, the Oregon Department of Transportation (ODOT) developed an integrated model to better understand the impact of policy changes on the State's transportation system during the analysis phase of PBPP. The model was used to analyze seven different scenarios:

- Reference scenario (baseline) – Assumes funding levels that allow the State to maintain current (year 2006) purchasing power through 2030
- High fuel price scenario (sensitivity to external changes) – Assumes major increases in fuel prices during the plan period
- Relaxed land use scenario (sensitivity to external changes) – Assumes increased land availability in rural areas and the urban fringe
- Flat funding scenario (policy) – Assumes declining purchasing power due to inflation
- Maximum operations scenario (policy) – Assumes operational improvements rather than capacity expansion
- Major improvements scenario (policy) – Assumes additional funding to meet the needs for all transportation modes; evaluates the impacts of projects included in MPO plans
- Roadway pricing scenario (policy) – Evaluates the impacts of road pricing scenarios

These scenarios were evaluated according to eight broad topics that correlate with the Oregon Transportation Plan's Vision statement. These topics include mobility and accessibility, economic vitality, effectiveness and efficiency, equity, public support for the system and financial feasibility, reliable and responsive, safety, and sustainability. ODOT developed specific performance measures for each topic to conduct the scenario analysis.

The scenario planning process allowed ODOT to better understand the implications of its potential changes to its policy direction, and as a result, informed the agency's decision to reinforce its "Fix It First" approach as an investment strategy across all modes.

Source: Oregon DOT

INCORPORATING EQUITY INTO SCENARIO PLANNING

Concern over equity has long been prevalent in planning, with the issue garnering increased attention in the past decade. Despite equity being a key concern for most planners, incorporating it into the analysis phase of scenario planning continues to be challenging, in part due to tool and data limitations. Advances in GIS technologies have made analyses of equity considerably easier in recent years and methodologies continue to burgeon. Primary challenges to incorporating equity into scenario planning relate to spatial modeling limitations, knowledge limitations, conceptual limitations, resource limitations, and lack of political traction.

As technology advances and the industry continues to place issues of equity at the forefront of planning processes, equity will more easily find its place in scenario planning. As described in resources such as the FHWA Environmental Justice Resource Guide, techniques such as the following can help incorporate equity analyses into planning processes:

- Bringing equity leaders into the conversation at the very beginning of the process;
- Including analyses that look beyond traditional land use and transportation models within scenario development and evaluation;
- Creating engagement mechanisms that balance the need for storytelling, shared learning, and problem solving;
- Paying attention to the implied versus actual influence participants have over the decisions and eventual outcomes of the process; and
- Using data and analysis as the starting point, rather than as a conclusory piece, in discussions about equity issues.

MPOs are using these methods to improve the incorporation of equity analyses into planning. For example, in developing Plan Bay Area, the **Metropolitan Transportation Commission (MTC)** created a Regional Equity Working Group. Composed of stakeholders representing equity interests from the nonprofit, public, and private sectors, the working group assisted MTC in developing and evaluating scenarios.

Expanded GIS technologies have also enabled analyses that look beyond land use and transportation. A key example is Opportunity Mapping, in which planners geographically overlay social factors to understand where residents lack social capital. These maps allow planners to assess current conditions and use the information to shape scenarios. **The Baltimore Metropolitan Council (BMC)** developed a series of Opportunity Maps and an index with six categories (Education, Housing and Neighborhood Quality, Social Capital, Public Health and Safety, Employment and Workforce, and Transportation and Mobility), each with sub-categories. Each category was mapped individually and as a composite to provide a picture of opportunity in the region. BMC's analysis illustrated the geographical connections between a variety of social factors, which provides a clearer picture of advantages and disadvantages. The exercise also helped BMC understand the relationships between different indicators, which are key for understanding disadvantage. Continued effort in research and the development of comprehensive models will allow equity concerns to be placed at the forefront of performance-based planning and scenario planning processes.

Source: Metropolitan Transportation Commission; Baltimore Metropolitan Council; University of Maryland

Programming: Investments, Priorities, and Resources

The programming phase of PBPP is where agencies, officials, and the public must consider the realities of funding rules, project readiness, fiscal constraints, and political considerations to make difficult decisions about which investments are the "best bet" for achieving desired performance levels. Programming is essentially the process of slotting projects into certain funding programs and scheduling project funding. The process is often quite complicated, given the variety of restrictions and directives associated with the blend of Federal, State, regional, local, or other funding sources that support a multimodal transportation program.

Regardless of the numbers and types of funding sources, however, the projects listed in the metropolitan Transportation Improvement Program (TIP) and the State TIP (STIP) should flow logically from the goals, objectives, projects, and priorities established in the transportation plan. Scenario planning that influences the development of a vision, goals, performance measures, or preferred strategies can add value to the programming process.

Using Scenario Planning Metrics to Inform Programming Decisions

The programming process typically has two components: identifying project prioritization and selection criteria, and evaluating proposed projects against the criteria to establish a priority list of projects for funding in the TIP/STIP. At this stage, reflecting the vision or preferred scenario developed in earlier PBPP stages is important to remind decisionmakers and the public what the region is working toward. Losing sight of the desired future is easy when one is focused on more immediate challenges.

A scenario planning process should inform the development of policies and plan recommendations and performance target setting. An MPO or other regional agency could have designed the performance metrics and scenarios with substantial public input, but the trust and buy-in emanating from a successful scenario planning initiative can quickly erode if the results are not incorporated visibly and meaningfully into plans and programs. To ensure a robust and credible PBPP process, transportation agencies need to connect the vision to institutionalized decisionmaking elements such as the project selection criteria and other prioritization methods used in transportation programming.

> *"Transportation scenario planning has been happening in Utah between UDOT, UTA and the MPOs for over a decade now. The results are evident in the development of dozens of multi-modal projects, which evolved over the course of a decade of joint planning among a variety of stakeholders. A robust analysis of six scenarios led to the final decision to move forward with the University Light Rail project. Each of the scenarios reflected consideration of a series of factors, including the impact the Light Rail line would have as part of a unified transportation system over the next 20-30 years."*
>
> - *G.J. LaBonty, Utah Transit Authority*

One of the hallmarks of a successful PBPP process is a transparent, technically sound relationship between the goals established in the long range plan and the funding allocated through the transportation improvement program. TIP project selection criteria and prioritization

processes, therefore, should clearly reflect the goals, policies, performance measures, and targets established in the direction-setting and analysis phases of PBPP. Anticipating this need, planners should consider the following points when designing a scenario planning process to support the development of a long range plan and/or a funding program:

- The results of a scenario planning exercise are unlikely to have a significant influence on funding decisions unless the process includes a focused implementation strategy for applying those results to the project prioritization and selection process. Planners should "start with the end in mind" when designing a scenario planning exercise by considering the ways in which the outcomes can be reflected in decisions made throughout the entire PBPP process.
- The project selection process is guided by the long range plan but is also subject to external rules and constraints of funding programs. When conducting a scenario planning process, transportation planners should be upfront with stakeholders and the public about the types of investments that their agencies can support, and work with partner agencies to identify and coordinate funding for strategies that could strengthen the impact of infrastructure investments, such as programs to improve public health, community development, and quality of life.
- Transportation agencies can use scenario planning processes as an opportunity to improve the ways in which they incorporate equity and environmental justice issues into long range plans and funding decisions. This can be done by developing performance metrics and conducting analyses of issues associated with topics such as neighborhood access to jobs and essential services, housing and transportation costs compared to income levels, and other indicators that can be affected by transportation investments.

The funding streams involved in the programming process reflect a legacy of transportation programs that emphasize transportation system performance. Priorities emerging from scenario planning processes that support broader community objectives, such as livability of communities, integration of transportation and land use, and environmental quality might not align with traditional interpretations of funding eligibility and purpose. More effort could be required to quantify impacts in new and different ways during the project selection process to reflect these values.

Although, some, including Federal, funding programs have become increasingly flexible over the past few years, a community could still have needs that do not align well with available funding restrictions. One solution might be to carve out subsets within specific funding sources (such as Surface Transportation Program (STP) funds) to directly support local projects that further the community's vision. **Atlanta Regional Commission's** Livable Centers Initiative is a good example. Started in 1999, the Initiative was designed to encourage planning and implementation of its livability principles on the ground in local communities. The initiative provides funds to local governments to develop plans for "livable centers"—areas in which development that occurs is consistent with the regional vision and policies—and then provides an incentive in the form of implementation dollars.

Analyzing Alternative Project Investment Scenarios

Scenario planning can be used within the programming and project selection process to explore how best to achieve given priorities under several different project funding scenarios, such as different packages of investments or schedules for project implementation. This analysis could reveal a gap between new high priority projects identified in the scenario process and the constraints of available funding sources. Due to the rules associated with various project costs or types, lower-priority projects might better qualify for available funds. Scenario planning could help planners identify additional funding criteria considerations or other changes in the decisionmaking framework that would ensure better continuity between the vision and the programming phase.

Scenario planning can also be used to explore and test the resiliency of proposed projects to potential impacts of external forces. Researchers at the Massachusetts Institute of Technology followed a traditional scenario methodology in examining uncertain future changes for a freight planning scenario framework that has been used to test selected projects. Similar to approaches used in planning analysis, the approach suggests:

- Creating three very different scenarios that describe what the future might look like. These are based on macroeconomic conditions.
- Evaluating proposed projects under each of the scenarios. The evaluation is qualitative, but is used to determine whether a project makes sense in each of three or more vastly different futures.
- Prioritizing the projects that make sense under many different future conditions compared to those that work within fewer or no scenarios.

Given the iterative nature of scenario planning, a scenario analysis exercise in the programming phase of PBPP could trigger the need to reconsider decisions made during earlier phases. A scenario planning exercise that bridges the analysis and programming phases might generate new information that could lead to modifications of previously identified strategies, packages of projects, or balances struck between the various priorities (e.g., reducing congestion vs. improving safety) competing for resources. Scenario planning, like other planning processes, is most valuable when tested or fine-tuned multiple times to account for new information or changes in conditions.

Implementation: Monitoring, Evaluation, and Reporting

The final step in PBPP is implementation, which involves monitoring system performance, evaluating the impacts of investments, and reporting progress toward achieving long range goals and performance targets.[6] Scenario planning is not typically applied during this phase of PBPP, but the work conducted in scenario planning during previous phases should be very clearly reflected in the performance measures used for monitoring, evaluation, and reporting. As the saying goes, "If it isn't measured, it doesn't count." The challenge to transportation agencies is to develop and track a full array of decisionmaking, evaluation, and reporting measures that

[6] The FHWA PBPP Guidebook discusses each of these aspects of the implementation phase, and their distinguishing features, in more depth.

meaningfully reflect their vision and goals. Scenario planning processes often require agencies to develop new metrics to address broader concerns. Incorporating those metrics into the final stages of PBPP—as is, or modified—ensures that the agency reaps the full value of its investment in a scenario planning process. Using tools like the online Chicago Metropolitan Agency for Planning "dashboard" profiled below can help agencies demonstrate to the public that their vision and concerns are reflected in the agency's ongoing monitoring and evaluation process.

The process of monitoring, evaluation, and reporting on performance provides an opportunity to monitor the outcomes of the plan implementation process, both in terms of system performance and broader goals and desired outcomes; to reflect on the usefulness of the tools and accuracy of the assumptions used in scenario planning over time (e.g., to inform possible model modifications or assumptions); and to provide information to the public, decisionmakers, and stakeholders regarding performance—in general and vis-à-vis trends analyzed in scenario planning. When designing reports and monitoring systems, agencies should consider questions such as the following:

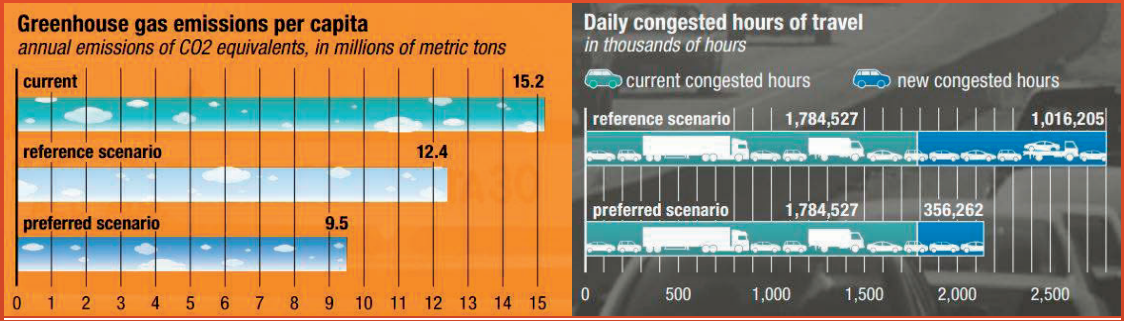
1. What performance results have been accomplished?
2. Is the vision being implemented?
3. Did the outcome of the implementation strategy provide the expected level of performance improvement (e.g., safety improvements, reduction in fatalities, and serious injuries)?
4. How is progress supporting the vision? How are we balancing multiple desired outcomes?
5. If performance has not improved as expected or projected, what factors might be influencing this outcome, and what can be done to mitigate them?

Agencies that have conducted multiple scenario planning iterations can use the monitoring phase to consider lessons learned and to improve the scope of future planning exercises. For example, an MPO that is implementing the major projects from the long range plan can use this final PBPP phase to examine how the actual results of the investment compare to those that were envisioned or predicted. The assessment might reveal a need to adjust assumptions or add variables to future analyses of similar projects or strategies. Agencies can use this phase to consider questions such as the following: Did our models produce forecasts that were relatively accurate? Were our assumptions accurate? Were the methods appropriate? The implementation phase is critical for maximizing the value of future scenario planning exercises.

Transportation agencies can also continue to monitor and respond to changes in the driving forces that were assumed in exploratory scenarios. For instance, although peak oil and high fuel prices were a common concern several years ago, increased domestic energy production and other global factors affecting oil prices have changed some of that thinking, and new or revised scenarios for the future might be considered. Meanwhile, the introduction of autonomous connected vehicles into the mainstream marketplace could happen much faster than expected. As factors like these evolve, previously developed scenarios, plans, and priorities might need to be revisited.

CHICAGO METROPOLITAN AGENCY FOR PLANNING

To develop its GO TO 2040 Plan, the Chicago Metropolitan Agency for Planning (CMAP) undertook an extensive scenario planning exercise, in which the agency received feedback from stakeholder groups and residents regarding several future scenarios. By using interactive online tools that used MetroQuest's "Invent the Future" public engagement software, and through public meetings, the agency gathered input from 35,000 residents. The input emphasized the need for a scenario in which the agency focuses on maintaining the existing system and making improvements to improve the system's efficiency. The agency used the public's input to develop the preferred Regional Scenario, which includes a combination of actions that will best prepare the region to achieve its goals for 2040. The analysis, in which the agency compared the preferred scenario to current performance and a reference scenario based on expected trends, went beyond the broad goal statements of the Regional Vision to identify the best courses of action to reach the public's goals.



One of the goals of the GO TO 2040 plan is to "track [the] region's performance to assess where to make improvement to reach the desired future." CMAP and the Chicago Community Trust (CCT) developed and now maintain the website, MetroPulse, to monitor the region's performance toward implementing Go TO 2040 plan, which will support implementation-oriented analyses to inform subsequent scenario planning cycles. MetroPulse is an online dashboard that tracks select indicators—including measures related to regional mobility—to provide information to the public and decision makers.

Sources: CMAP; CMAP MetroPulse

Performance-Based Scenario Planning Tools

Please note: FHWA does not endorse the use of any specific private sector tools or models identified in this section. The purpose of this section is solely to provide information about the capabilities and relevant uses of available tools.

A rich suite of tools is available to support scenario planning for PBPP. The selection of the right tools should take into account the different phases (direction, analysis, programming, and implementation) of the PBPP process; key driving issues and related performance metrics; public outreach and engagement goals; technical capacity; and resource needs. The case studies and examples described throughout this guidebook demonstrate that most transportation agencies engaged in scenario planning use a combination of visualization, forecasting, impact analyses, process-oriented, and community outreach tools to help them transition from the broad, policy-level strategic direction-setting to more detailed impact analyses in the analysis and programming stages.

Given the nature of many scenario planning exercises as robust processes of stakeholder and community engagement, tools are available to help design effective outreach and decisionmaking processes. Tools also have been designed specifically that create user-friendly, web-based interfaces to inform and engage the public in goal identification, scenario tradeoffs considerations, and provide input on preferences for how different scenarios perform. Traditional public outreach methods and tools (e.g., surveys, public meetings and forums, stakeholder groups) can also be easily adapted to support performance-based scenario planning efforts.

In addition to community engagement tools, a host of tools has been created specifically to support scenario planning aimed at informing policy direction and strategic planning. Common features of these tools include the ability to visualize and analyze scenarios geographically that have different development and land use policy assumptions that are influenced by or influence travel demand and travel behavior. These tools can be very helpful in clarifying comprehensive land use and transportation policy direction and incorporating cross-agency buy-in for regional performance metrics across different community sectors (e.g., transportation, economy, environment, housing, equity). The development of comprehensive scenarios that evaluate performance against key indicators can help build community buy-in for transportation system performance, land use and development goals, environmental outcomes, and cost benefit considerations. The analysis of scenarios against key indicators during the direction-setting phase can help inform the creation of specific performance measures and targets in the project programming and implementation phases for both transportation and non-transportation factors.

Tools that support building consensus on policy direction are typically supplemented at later phases with tools that support the identification of specific programmatic or project needs and evaluate those specific projects against environmental, financial, or other transportation performance measures. Many of the more detailed project needs and impact evaluation tools are also designed to focus on specific modes (e.g., highways, transit, ITS) or issues (e.g., air quality, safety, benefit costs). The use of these project-oriented tools enables a finer level of analysis to evaluate specific projects against key performance metrics and can help establish project and program priorities, performance targets and monitoring mechanisms.

While a broad suite of off-the-shelf tools is ready for supporting scenario planning for PBPP, methods and tools are continuously evolving. As scenario planning processes become more common in addressing future uncertainties or developing new performance measures, often a need develops to creatively adapt existing tools and methods or create new ones. This includes developing new assumptions about how different future conditions will influence travel demand and travel behavior, safety or operations. It can also involve creating new methods or assumptions within existing analytical tools to evaluate transportation system resiliency or transportation system performance in light of uncertain futures relative to climate change, global economic factors, fiscal uncertainty, or predominance of automated vehicles. Finally, a host of new tools and methods is emerging to better identify multimodal and active transportation (biking, walking, and transit) system needs and performance measures.

The following tables summarize different types of tools that might be helpful in supporting scenario planning for performance-based planning at the policy or project and programming phases. This list of tools is not comprehensive, but rather a sampling to illustrate types of tools and how they can produce useful synergies between scenario planning and PBPP. A more detailed list of relevant tools is included in Appendix B.

METRO OF OREGON: METROSCOPE

Some agencies have combined models that allow them flexibility to simulate various trends and policies in ways that are readily accessible to staff for scenario work. Metro, the MPO for the Portland, Oregon region, developed a set of decision support tools dubbed Metroscope. The tools include an economic model that predicts region-wide employment and households, a travel model that converts travel time by mode to comparable costs by mode, and two real estate models that predict the locations of households and employment respectively, plus related attributes like land consumed and prices. The land use forecasts created by Metroscope are adjusted to reflect local planning efforts and undergo a rigorous review process by local governments and the Metro Council. Metroscope is an integral tool that Metro uses to help inform regular decisions on whether to expand the Urban Growth Boundary, as well as providing land use assumptions that inform Regional Transportation Plan modeling. This multi-model approach represents an alternative to the use of sketch tools that produces robust results.

Source: Metro

- Engagement and collaboration tools
- Performance measure development tools
- Direction-setting tools
- Performance evaluation tools

ENGAGEMENT AND COLLABORATION TOOLS

The tools in this category can aid planners in helping scope their scenario planning and performance-based planning and programming process to engage key stakeholders, the public, and decisionmakers to ensure diverse participation and integration across different sectors. Some of the tools in this category are specifically designed to make it easy for the public to understand tradeoffs among alternative scenarios and to voice their preferences.

Tool	Relevance to Scenario Planning and PBPP
PlanWorks: Publicly available web-based tool provides a plethora of resources to help transportation professionals to anticipate, plan, and execute collaborative techniques at 44 distinct decision points in long-range planning, programming, corridor planning, and environmental review. Relevant applications: Stakeholder Collaboration, and Visioning	Useful for designing an engagement plan for a scenario planning project and for anticipating and addressing common problems with engaging stakeholders at any stage of PBPP.
CrowdGauge: Open-source online tool for designing educational/ gaming exercises that walk participants through a series of screens exploring their personal priorities for their community, the potential impacts of proposed plan elements on their priorities, and the impacts of their conceptual budget choices on their previously stated priorities.	Useful in assessing public preferences related to planning and programming scenarios or decisions.
EngagingPlans: Proprietary web based, mobile-enabled suite of tools designed to reach, inform, and involve citizens and stakeholders in public projects and decisionmaking. The EngageApps module enables participants to collaboratively map insights, visualize impacts, or explore and react to plan elements through collaborative mapping, interactive workbooks, and trade-off simulators.	Users can customize the modules to engage the public and collaborate with stakeholders at many stages of the PBPP process. EngageApps provides some basic collaborating scenario building tools.
MetroQuest: Proprietary public participation platform that allows input in many ways including ranking, mapping, budget allocation, project selection, and visual preference surveys.	Useful at all stages of scenario planning and PBPP. Can be used to understand preferences or to gain input on specific projects, which is useful in the programming stage.

PERFORMANCE MEASURE DEVELOPMENT TOOLS

This set of tools can help transportation agencies identify a range of performance metrics and targets beyond traditional transportation measures. The tools can be incorporated into the scenario evaluations and help transportation practitioners better align performance and programming decisions with community goals. Many of the performance measures identified in these tools are reflected in the previously noted scenario planning tools.

Tool	Relevance to Scenario Planning and PBPP
PlanWorks: Relevant applications: Performance Measurement	Useful for identifying performance measures for any stage of PBPP or scenario planning

Tool	Relevance to Scenario Planning and PBPP
Community Vision Metrics: Provides a list of performance measures that planners can use to match with their respective context and goals.	Useful for identifying performance measures for any stage of PBPP or scenario planning
Sustainable Communities Index: Similar to Community Vision Metrics, but this tool provides more robust information on methods for calculating the metrics and identifying data resources.	Useful for identifying performance measures for any stage of PBPP or scenario planning
Transportation and Health Tool: Tool for examining the health impacts of transportation systems; uses 14 indicators relating to transportation and public health, with data available at the State, MSA, and urbanized area-levels.	Useful for identifying health-related performance measures for any stage of PBPP or scenario planning

DIRECTION-SETTING TOOLS

The past decade has witnessed a great proliferation of computer-based tools to aid in scenario development. The spectrum ranges from complex, high-computing, multivariate models to simplified spreadsheet or sketch-planning based tools. These tools are designed to support the creation of plausible future conditions and quantitatively assess those conditions against key indicators. Many of these tools can not only generate visualizations representative of geographically based future conditions, but they also include the ability to predict scenario performance against a wealth of key indicators beyond traditional transportation metrics. Tools that incorporate predictive capabilities often incorporate research on travel behavior dynamics that can be applied over long-range planning horizons. Predictive tools developed based on empirical data from national data (e.g. RPAT, EERPAT) can be run quickly, while more detailed models (Urbanism) will require more effort to develop and often require specialized travel survey data.

The tools in this category are designed to create and analyze integrated scenarios of the future that reflect the interrelated nature of different transportation, development, infrastructure and environmental policies and conditions. When combined with the use of travel demand models or other enhanced transportation needs identification and assessment (performance evaluation) tools, these direction-setting tools can be very effective in helping set policies, identify performance metrics, and determine investments that could achieve desired performance outcomes.

These tools are categorized as follows:

- Visualization: The primary function of these tools is to visualize relationships among key variables that influence travel choices. The user will typically have the opportunity to make adjustments to input scenarios that can be quickly visualized in a GIS interface.
- Predictive: These tools are capable of producing a “forecast” of travel behavior and choices for a future year, under a range of condition and input assumptions. These tools operate and function more like models by explicitly representing households or firms.

- Analytical: These tools typically estimate changes in travel by applying factors generated from empirical research. Many analytical tools are supported by spreadsheet-based equations.

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
PlanWorks: Relevant application: Visioning [Visualization]	Stakeholder engagement Agency collaboration Environmental, Economic, and Community Considerations	Useful at the direction-setting and analysis phases of scenario planning or PBPP to identify opportunities for engagement and integration of goals, objectives, and measures across PBPP process.
Envision Tomorrow: A web-based multifaceted analysis and visualization scenario planning tool that can be used at the site, corridor, or regional scale. Scenario comparisons can help guide identification of specific project needs, produce small-area concept plans, and model complex regional issues. [Analytical]	Land Development Cost of Infrastructure Real Estate Value Housing (affordability, demand, mix) Parking (demand, costs) Jobs-to-Housing Ratio Employment Connectivity Energy Use Carbon Emissions Water Consumption Solid Water/Waste Water Return on Investment	Useful at the direction-setting and analysis phases of PBPP to identify community values and driving issues; develop and assess integrated land use and transportation policies and identify key performance metrics that can be folded into later phases of the PBPP process. Informs: Policy, Project Identification, Performance Metric Identification and Objectives

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
<u>UrbanFootprint and RapidFire</u>: Web-based and spreadsheet tools to develop integrated land use and transportation scenarios. Scenario comparisons can help guide identification of specific policy and project needs relative to achieving desired performance against a range of indicators. [Predictive]	Greenhouse Gas Emissions Air Pollution Water and Energy Consumption Vehicle Miles Traveled Transit, Walk, Bike Mode share Vehicle Emissions Capital Infrastructure Costs O&M/Public Works Costs City Revenues Household/Business Costs Public Health Impacts Housing Diversity & Affordability Access to Jobs and Services	Useful at the direction-setting and analysis phases of PBPP to identify community values and driving issues; develop and assess integrated land use and transportation policies against key performance metrics that can be folded into later phases of the PBPP process. Informs: Policy, Project Identification, Performance Metric Identification and Objectives
<u>UrbanSim</u>: A modeling tool that predicts behavior or interaction within a network or system to help illustrate the cause and effect of different scenario variables relative to environmental, transportation, economic and development goals [Visualization]	Accessibility Mode share VMT Congestion GHG emissions Jobs Land Development Demographics	Useful in direction-setting phase when to better understand issues and opportunities of different land use, real estate, housing and transportation investments or policies. Key metrics can be incorporated into later phases of PBPP. Informs: Policy, Project Identification, Performance Metric Identification and Objectives

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
<u>CommunityViz</u>: A land use scenario sketch-planning tool, often used to develop, portray, and evaluate different scenarios at the small area and regional scales across a range of performance indicators [Visualization]	Annual CO, CO2 & NOx Auto Emissions Annual Hydrocarbon Auto Emissions Commercial Energy Use Commercial Floor Area Commercial Jobs Commercial Jobs to Housing Ratio Labor Force Population Residential Dwelling Units Residential Energy Use Residential Water Use School Children Vehicle Trips per Day	Useful in direction-setting phase when to better understand issues and opportunities of different land use and transportation investments or policies. Key metrics can be incorporated into later phases of PBPP. Informs: Policy, Project Identification, Performance Metric Identification and Objectives
<u>Energy and Emissions Reduction Policy Analysis Tool (EERPAT</u>): Built on the GreenSTEP model foundation, this is a policy analysis tool that enables planners quickly to evaluate and compare a large number of scenarios based on their effectiveness in reducing greenhouse gas emissions. Meant to aid in evaluating different policies. [Predictive]	VMT GHG emissions and fuel use by vehicle	Useful at the direction-setting and analysis phases of PBPP to identify promising policies to support GHG emission reduction goals. Informs: Policy, Performance Metric Identification and Objectives

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
Rapid Policy Assessment Tool (RPAT): The Rapid Policy Assessment Tool (RPAT) evaluates policy scenarios to identify the most promising sets of policies for improving multiple policy objectives. Currently, RPAT can provide information on the following changes in a regional system regarding changes in urban form, demographics, transportation supply, and transportation policies. [Predictive]	Daily VMT; Daily trips by mode; Average travel speeds by vehicle type; Vehicle hours of delay; Fuel consumption; Regional highway and transit infrastructure costs; Regional transit operating costs; Annual traveler cost; Accident rates; Regional accessibility; Job accessibility by income group	Useful at the direction-setting and analysis phases of PBPP to identify promising regional transportation, land-use, and demand management policies. Informs: Policy, Performance Metric Identification and Objectives Useful for identifying performance measures at regional screening level of PBPP

PERFORMANCE EVALUATION TOOLS

These tools help transportation agencies identify project needs and strategies and evaluate those projects against a wide range of performance measures. These tools include needs identification tools based on specific performance targets (e.g., safety, mobility, operations, air quality, pavement conditions) and project analysis tools aimed at looking for specific cost-benefit considerations and environmental outcomes. This suite of tools can be helpful in supplementing the scenario planning tools described above when transitioning to the project-programming phase or in response to specific driving issues. These tools are best used when the direction-setting phase is complete, and more detailed analysis is desirable to prioritize specific projects relative to their impacts on key performance metrics.

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
Safety Analyst: Automates and improves many of the procedures that transportation agencies use to identify safety problems and prioritize improvements.	Crash reduction	Useful in the analysis and programming phases of PBPP.

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
Systemic Safety Project Selection Tool: Helps planners identify types of improvements that, through widespread adoption, may have a large benefit. Compliments Safety Analyst, which is more oriented towards identifying hot spots and countermeasures.	Crash reduction by type and location Safety risk factors identification Countermeasure identification	Useful in the analysis phase to determine what types of policies or improvements may have the greatest effect.
Highway Economic Analysis Requirements System (HERS) and State Version (HERS-ST): Uses Highway Performance Monitoring System Data (HPMS) to evaluate the current and future performance of the highway system under alternative investment scenarios or rules. Model can provide cost estimates for achieving economically optimal program structures, as well as predict system condition and user cost levels resulting from a given level of investment.	Cost-benefit analysis based on travel time and safety; vehicle operation, emissions, and highway agency costs.	Useful in the analysis phase—to identify needs - and during the evaluation phase to identify the most effective improvements. Brings investment scenarios into these phases.
National Bridge Investment Analysis System (NBIAS): Similar to HERS, but focused on bridges. This tool evaluates bridge investment needs and impacts on bridges of alternative investment levels.	Money spent Work performed Backlog of needs ($, bridges) User benefits (potential, obtained) Distribution of deck, superstructure, substructure ratings Structurally deficient bridges Bridge health index	Useful in the analysis phase—to identify needs - and during the evaluation phase to identify the most effective improvements. Brings investment scenarios into these phases.

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
Transit Economic Requirements Model (TERM-lite): Helps local/ regional transit agencies assess their state of good repair (SGR) backlog, level of investments to attain SGR, and the impact of variations in funding on future asset conditions and investment needs. Metrics provide performance implications of alternative project priorities and funding levels.	Metrics associated with State of Good Repair	Useful in the analysis phase—to identify needs - and during the evaluation phase to identify the most effective strategies. Brings investment scenarios into these phases.
TREDIS: A web-based economic analysis system for regional scenario or corridor planning, or project level prioritization. It utilizes economic forecast methods to enable comparison of long-term impact for alternative planning and policy scenarios, or alternative mode and corridor design solutions. Results are summarized in terms performance indicators, societal benefit/cost and economic impacts.	Cost-benefit analysis (user and societal benefit) Economic impact analysis (productivity, jobs, income, GDP) Mobility (congestion, speed, reliability) Accessibility (labor, delivery, intermodal) Safety (crash reduction and injury/death) Resource use (fuel consumption) Environment (emissions by class) Development (housing, commercial sq. ft.) Financial (revenues, tolls, fees, transfers)	Useful in scenario planning to compare the cost/benefit ratio and economic impact of different packages of investments and policies. Useful in the evaluation phase to assess alternative planning scenarios, in either economic terms or performance metric terms. Informs: Policy, Project Identification, Performance Metric Identification and Objectives

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
REMI-TransSight: A PC-based software system that provides regional forecasts of long-term benefits, costs and economic impacts. Can be used at the community, corridor or regional scale to assess alternative policies, plans and projects.	Cost-benefit analysis based on travel time, and safety; vehicle operation, emissions, and transportation agency costs. Economic impact analysis based on cost, productivity and competitiveness changes. Results in terms of jobs, income, GDP, output. Fiscal impact in terms of revenues and costs to government	Useful in scenario planning to compare the cost/benefit ratio and economic impact of different packages of investments and policies. Useful in the analysis phase to assess alternative planning scenarios. Useful in the evaluation phase to identify the most effective improvements. Informs: Policy, Project definition, and Objectives
Travel Demand Management (TDM) Models: Evaluate how TDM strategies can support vehicle trip reduction goals	Changes in mode share Vehicle-trips VMT Average vehicle occupancy and ridership	Useful in the analysis and programming phases of PBPP.
Travel Demand Models: Forecasts future vehicle travel & transit ridership on regional highway networks. Simulates trip generation, distribution, mode choice, and route assignment using aggregate socio-economic data by travel zone.	Trip generation Trip distribution Mode choice Trip assignment Congestion Freight Traffic	Useful in the analysis and programming phases of PBPP.
Simplified Trips-on-Project Software (STOPS): Identifies and evaluates transit project investments based on New Starts and Small Starts project criteria. Relies on census data, regional travel model data, and current GTFS data from individual metro areas.	Transit ridership (trips-on-project measure) for all travelers and for transit dependent Change in automobile VMT based on the change in overall transit ridership between scenarios.	Useful in the analysis and programming phases of PBPP.

Tool	Sample Performance Metrics	Relevance to Scenario Planning and PBPP
Infrastructure Voluntary Evaluation Sustainability Tool (INVEST): Self-evaluation tool transportation agencies can use to assess performance on various sustainability criteria. Includes modules for evaluation of highways at the system planning scale, project-based evaluations, and maintenance and operations.	81 criteria related to sustainability outcomes in highway system planning, project development, operations and maintenance	Useful for the monitoring and evaluation phases of PBPP; informs Policy, Project Identification, Performance Metric Identification and Objectives, and Programming Priorities
MOVES: A modeling platform supported by US EPA for multiple scale emissions analysis, from detailed "project level" assessments to emission inventories at the regional or national level, for greenhouse gases, air pollutants, and air toxics. Useful in conducting air quality analysis associated with different policy or project interventions at the State, county or project scales.	Inventory or emission rates of various GHG and air pollutant emissions Energy consumption Outputs can be summarized by on roadway facility type, vehicle type, etc.	Useful in the detailed analysis and programming phases of PBPP
Tool for Operations Benefit Cost Analysis (TOPS-BC): Estimates benefit to cost ratios for system management and operations strategies.		Useful in the analysis and programming phases of PBPP.

4. Getting Started: Designing a Scenario Planning Process to Support PBPP

This chapter identifies the factors to consider and address in designing a scenario planning process. As scenario planning is a process that can support decisions at each phase of PBPP, such planning can be done in many different ways. The intent of this chapter is not to provide explicit direction in scoping a scenario planning process. Rather, the purpose is to help a project manager or a technical committee or advisory group consider the key issues that could be addressed and some of the practical elements involved in using scenario planning to inform PBPP. The insights and notes developed by working through these questions can provide useful material and information for subsequent activities such as estimating potential costs and needed resources, developing a scope of work, describing the project in a Unified Planning Work Program, and, if necessary, writing a Request for Proposals to elicit consultant support.

The questions below are organized in a series of steps, starting with the most basic context-setting step to the advanced step of preparing a scope. The questions in this chapter, and recommended exercises for answering them, are provided in Appendix A as a worksheet.

Step 1: Evaluate Community Context

1. How is your region developing?
2. What are the major issues or drivers influencing growth and development?
3. What are the most promising opportunities that will shape development in years to come? What major issues may be affecting equity in the community; assessed with a community profile, including the identification of populations and their characteristics, and identifying data sources?

Step 2: Identify Desired Outcomes

1. What plans are due for an update?
2. What new plan(s) is your organization expected to develop soon?
3. What is your agency looking to accomplish in these updates?
4. What major trends are of greatest concern to your agency's board?

Step 3: Identify Scenario Planning Purpose

1. Which element(s) of your PBPP process could benefit from scenario planning and analysis?
2. What issues would you like to address from previous planning processes?
3. How could scenarios be used to improve plans and decisions?
4. How can scenarios improve the ongoing decisionmaking process?

5. Are there particular trade-offs your agency would like to better illustrate for the public and decisionmakers?
6. How will scenario planning help your agency define transportation performance measures and set targets?

Step 4: Identify Scenario Planning/PBPP Linkages

1. How can you apply/ build on scenario planning tools, data, and skills to support the ongoing PBPP process?
2. How could the scenario tools, models, data, or inputs inform subsequent efforts such as corridor studies?
3. How could you maximize the usefulness of the scenario analysis tools or data planning to inform other work or improve efficiencies?

Step 5: Define Scenario Planning Approach

1. At what point in your agency's PBPP process will scenario planning be deployed?
2. Do you anticipate using scenarios to identify preferred future conditions, helping to shape the region's vision, principles, or goals?
3. Do you anticipate using scenarios to test different courses of action against radically different future conditions, helping test the validity of underlying assumptions or the resiliency of planned investments?
4. Do you anticipate using scenarios to test different courses of action against relatively predictable future conditions, helping to hone strategies and set priorities?

Step 6: Define Scenario Planning Engagement

1. What information do you need from stakeholders and the public to develop scenarios and plans? How will you use the information and ideas that are offered?
2. What groups or individuals have information that is necessary for crafting and analyzing scenarios?
3. How can the public benefit from your approach to scenario planning?
4. At what point will decisionmakers be involved in scenario development or evaluation?
5. What methods will you use to engage each stakeholder group?
6. What resources do you have or need to conduct engagement activities?

Step 7: Define Resources for Scenario Planning Effort

1. How much could you achieve through scenario planning with minimal data and analysis tools?
2. What data are needed to support your preferred scenario planning approach?

3. What data are available?
4. What tools are available to conduct scenario planning and analysis?
5. What are the strengths and weaknesses of existing tools?
6. What do you want to analyze, but cannot with existing tools?
7. What other tools could help close the gaps between what you'd like to do and what you can do?
8. What are your priorities for purchasing data (if your budget will allow this?)
9. If you purchase data, will you have resources to purchase subsequent releases of the data?
10. If you can obtain desired data and tools, can scenario planning still provide value?
11. What is staff's level of experience with scenario planning?
12. What outside resources are available (e.g., universities, Federal agencies, foundations, civic groups)?

Step 8: Prepare Scope for Scenario Planning Effort

1. Will the entire scenario planning process be conducted in-house, or will consultants be hired to assist?
2. What can you budget for the scenario planning project?
3. Who needs to be involved in the scoping process?
4. How much do you and your board know about other existing plans affecting the growth and development of your region?
5. What specific questions, processes, and outcomes will this scenario planning effort address?
6. How do you plan to consult with other agencies and stakeholders in your region?
7. How will you ensure the public understands the purpose of the processes and has reasonable expectations of the results?
8. How will you communicate the scenarios and results of the analysis to stakeholders and the public?
9. How will you provide access to the scenarios and data for decisionmaking?
10. Will the scenarios continue to be used over time, creating a need for data and tool support?

5. Keys to Success

As the practice of scenario planning has evolved to consider and address increasingly complex questions, the usefulness of scenario planning as a tool to address transportation agencies' most pressing issues and challenges is greater than ever. With limited resources, agencies need to ensure they are maximizing the value of their investment in a scenario planning exercise. As this guidebook discusses, a scenario planning exercise is most valuable when it is shaped to substantively inform and link the agency's entire PBPP process. Specifically, this means that the metrics, data, and outcomes of an agency-sponsored scenario planning process are visibly reflected in adopted plans, performance measures and targets, programming decisions, project prioritization and selection criteria, and ongoing monitoring, evaluation and reporting activities.

This guidebook identifies several illustrative examples, tips, and tools for achieving the most from a scenario planning process. Four key recommendations that represent the themes and lessons learned from the practitioners profiled throughout this guidebook are discussed below.

Strengthen Connections between Scenario Planning and PBPP

Scenario planning is most beneficial to an agency when it is conducted as a key informative component of a larger PBPP process. The following are a few steps that can be taken to improve connections between scenario planning and PBPP.

- **Carefully consider ways in which scenario planning can best inform each PBPP stage** in your agency's case. In some cases, scenario planning is used in the development of a vision, while in others it is used to forecast expected performance of different scenarios and either support selection of a scenario or prompt reconsideration of the desired future scenario. In yet other cases, scenario planning can help look at packages of specific projects or different levels of emphasis on specific modes, or even to test the potential impacts of exogenous factors such as technological changes.
- Establish goals and **identify desired outcomes for the scenario planning process** itself. Practitioners should ask themselves questions that lead to the identification of desired outcomes. For example, is there a specific topic on which the agency seeks to gain more information? Is the purpose of scenario planning to understand the performance implications of an already-chosen scenario? If the latter is the case, is the exercise intended to prompt reconsideration of the chosen scenario? The answers to these questions, and others, should be clearly identified by agency staff and supported by relevant decisionmakers. In completing this step, agencies should ensure that they can formulate clear statements about what will be accomplished once the process is complete. Desired outcomes should help fill gaps or needs evident within the agency's broader PBPP process.
- **Consider the performance measures** that will be used to evaluate scenarios and **ensure they are consistent** with the objectives, performance measures, and targets in the long range plan and program, and those used to monitor, evaluate, and report system performance. If limitations exist with respect to the agencies' tools or available data, the

agency should consider whether opportunities exist to address this by, for example, considering whether proxy measures can be used to support consideration of a factor for which ideal data are not available. In addition, **the criteria for evaluating scenarios should be determined and agreed upon to at the beginning of the scenario process**. This will help ensure that the process maintains a focus on, and ultimately achieves, the desired outcomes.

Use Creativity to Push the Limits of Existing Tools

As transportation professionals and agencies are increasingly interested in understanding the connections between transportation and topics such as safety, public health, accessibility, environmental impacts, and energy and other resource usage, practitioners and academicians have pursued new and innovative ways to consider them by expanding on the capabilities of more traditional scenario planning tools. Meanwhile, agencies are transitioning to new types of travel demand modeling approaches, such as activity-based and multimodal models. Entrepreneurial creativity will continue to be needed to modify and invent tools that can meaningfully address the array of topics and questions that arise during scenario planning and PBPP.

- It is important to **consider the pros and cons of PBPP and scenario planning tools** and decide which makes the most sense to use, depending on the objectives of the exercise. The scale of the area being studied, for example, would determine whether a regional-level planning tool makes more sense than a tool that can be customized or adjusted at a more localized, or even parcel, level.
- There are many opportunities to **incorporate new and existing data sets and tools into scenario planning with creativity**. For example, the Champaign-Urbana Urbanized Area Transportation Study (CUUATS) and many other MPOs have worked to refine their travel demand models to better account for active transportation modes and to improve the accuracy of model interactions between land use and transportation. In the development of its 2040 long range plan, despite not being able to model health impacts or accessibility at the county level, CUUATS developed two additional models to evaluate conditions at a localized scale: a Health Impact Assessment to measure the relationship between the built environment and obesity, and an accessibility and mobility analysis model. Fresno COG, for example, developed an Integrated Transportation and Health Model, which relates physical activity, air pollution, and travel behaviors to specific health outcomes based on established causal relationships reported in the scientific literature for heart and respiratory disease; stroke; diabetes; cancers of the breast, colon, and lung; dementia; and depression. FHWA and other Federal agencies are developing tools and guidance on this topic—such as the FHWA Health in Transportation Corridor Planning Framework and the Transportation and Health Tool developed by US DOT and the US Center for Disease Control—to enable consideration of public health in scenario planning.
- Because of the rapid pace of innovation and development of new tools that can be incorporated into scenario planning, agencies should consider whether it will be most cost effective to **invest in developing capacity in-house** to allow for refinement of tools

and analysis capabilities that can be employed at any point in time, as opposed to only during plan update cycles. CUUATS conducts most of its modeling and analysis in-house, which has allowed the agency to use its scenario planning tools to inform several corridor studies conducted as follow-up tasks to the long range plan.

Be Strategic in Engaging Decisionmakers, Stakeholders, and the Public

Public and stakeholder involvement is a cornerstone of scenario planning and PBPP. The accuracy and legitimacy of a planning process depends on the quality of the engagement with decisionmakers, stakeholders, and the public. Having a shared regional or statewide vision is critical to ensuring plans will be implemented, which is what makes scenario planning worthwhile. Educating and involving elected officials is important to enhance the applicability and relevance of scenario planning. Discussions with these groups should maintain focus on priorities for system performance and how targets relating to these priorities can be accomplished.

- **Scenario planning can generate excitement** and help a community or State come together around a common vision informed by input received from stakeholders and the public. **Reporting on performance** in the implementation phase of PBPP helps maintain the momentum and excitement generated by scenario planning. Keeping stakeholders and the public—as well as decisionmakers and policymakers—apprised of performance improvements annually can be an effective way to promote engagement, prevent discouragement regarding the relatively slow pace of change, and demonstrate that progress has been made.
- When **scenarios are tied to performance measures**, the public has a better understanding of how investments, or types of investments, translate into different potential futures and future system performance with respect to the components they care about such as safety and reliability. The public and stakeholders also can see how well the agency is "connecting the dots" by demonstrating that the objectives and performance measures they helped establish are being used in the selection of projects.
- **Carefully considering the timeline** for scenario planning and planning for potential contingencies can help the process run more smoothly. In the case of Fresno COG, the agency found that making schedule adjustments was necessary to accommodate additional requests for review and to increase buy-in. Developing a schedule that encourages input early and throughout the process and also allows contingency time can be beneficial.
- B**e thoughtful about when the public and stakeholders will be consulted** in both the scenario planning process and the broader PBPP process it aims to inform. This decision should be aligned with the desired outcomes for a scenario planning process that have been identified. Once the outcomes and consultation periods are clear, they should be communicated to all interested parties. Having an understanding of the desired outcomes and scope of the process will make clear what considerations are on the table and which are considered to be outside the scope. Individuals or groups with special interests might

try to steer the conversation toward a topic that is not central to the discussions, so a clear understanding of the desired outcomes can help keep the process on track.

- **Creativity should be employed to improve public and stakeholder involvement** whenever possible. In addition to best practices such as providing translation and interpretation services when needed, agencies can do many innovative things to engage their constituents. DVRPC developed the "Choices and Voices" interactive online tool to help demonstrate the budget and performance trade-offs with which the agency was grappling. Universities, libraries, transit providers, telecom or tech companies, community service organizations, and many other partners can help increase or facilitate opportunities for residents to become involved. Fresno COG used a cost-effective "mini grant" program to recruit local partners to engage residents in its planning process using a variety of means including social media. For public and stakeholder involvement, **agencies should take actions to encourage the inclusion of all people and groups**, even those whose interests are not always aligned with the agency's long-term vision. This is valuable for improving understanding, identifying opportunities to collaborate and reach mutually agreeable solutions, and keeping lines of communication open.

Respect the Local Context

Another key to an effective scenario planning exercise is ensuring that it addresses the issues that are important to the community, and that it takes into account important geographic, environmental, demographic, economic, political, social, or other features of the region.

- **Identify the issues** that need to be addressed. Each region faces unique issues that might have impact(s) on the transportation system and other factors that affect transportation. In some cases, these may be exogenous factors. Examples of questions that could be asked include:
  - Is our region growing? If so, how rapidly? Where is growth likely to occur?
  - How are global trade patterns likely to affect our region?
  - Is the region susceptible to certain effects of climate change? If so, which ones?
  - Do energy prices have a significant impact on our transportation system?
  - Are any significant investments planned for our region, such as a new airport, a port expansion, or a new high-speed rail line?
  - What are the key threats to safety and security that our region faces?

- Also important is to **consider factors that are most likely to affect transportation system performance**, particularly in light of the State's or the region's unique issues, advantages, or challenges. In some cases, the strategies that are most popular or have the fewest barriers to implementation might also be those with a relatively low amount of potential to "move the needle" when it comes to performance. Scenario planning provides an opportunity to demonstrate which strategies rise to the top in terms of potential performance impact.

The self-assessment worksheet in Appendix A has been developed to help agencies identify opportunities to maximize the value of scenario planning.

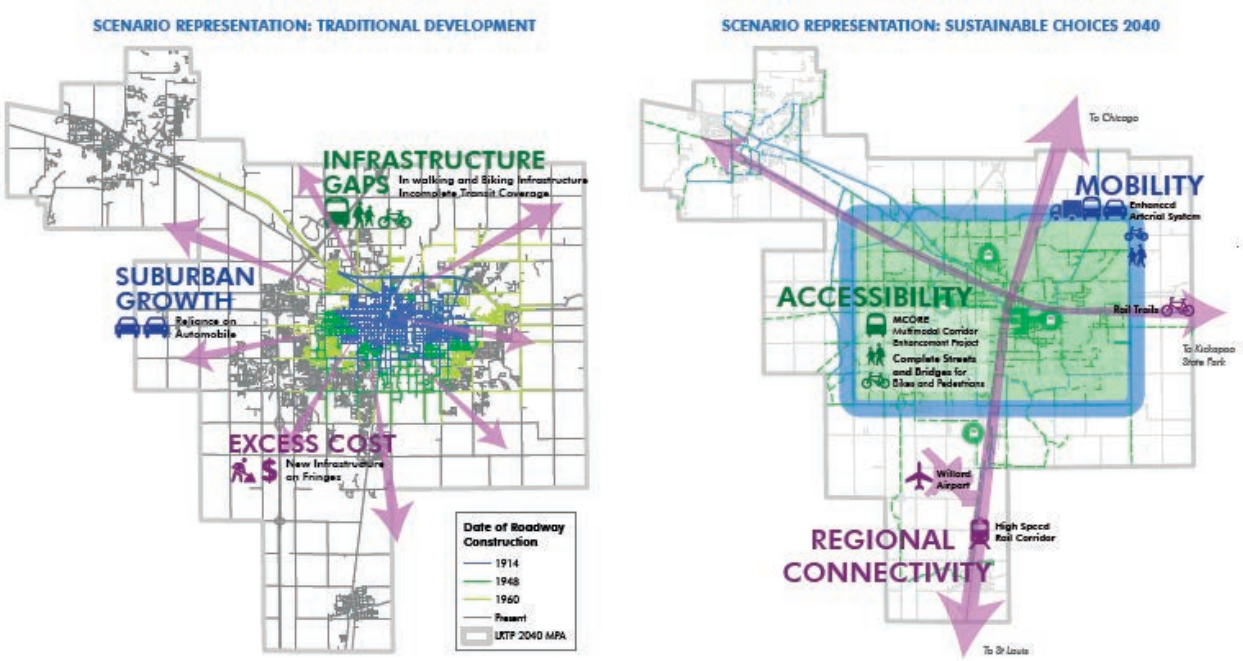
6. Case Study Summaries

This section provides brief summaries of the full-length case studies in Appendix C.

Champaign-Urbana Urbanized Area Transportation Study

The Champaign-Urbana Urbanized Area Transportation Study (CUUATS) has been using scenario planning and analysis for over a decade and has been recognized in previous FHWA publications for its use of performance-based planning to improve decisionmaking.[7] For its most recent long range plan, Sustainable Choices 2040, CUUATS analyzed two scenarios: a traditional development (or trend) scenario and a sustainable choices scenario, which was created based on input CUUATS received from the public and regional stakeholders through a very extensive public outreach process.

Figure 6-1: CUUATS' Sustainable Choices 2040 Scenarios



Source: CUUATS

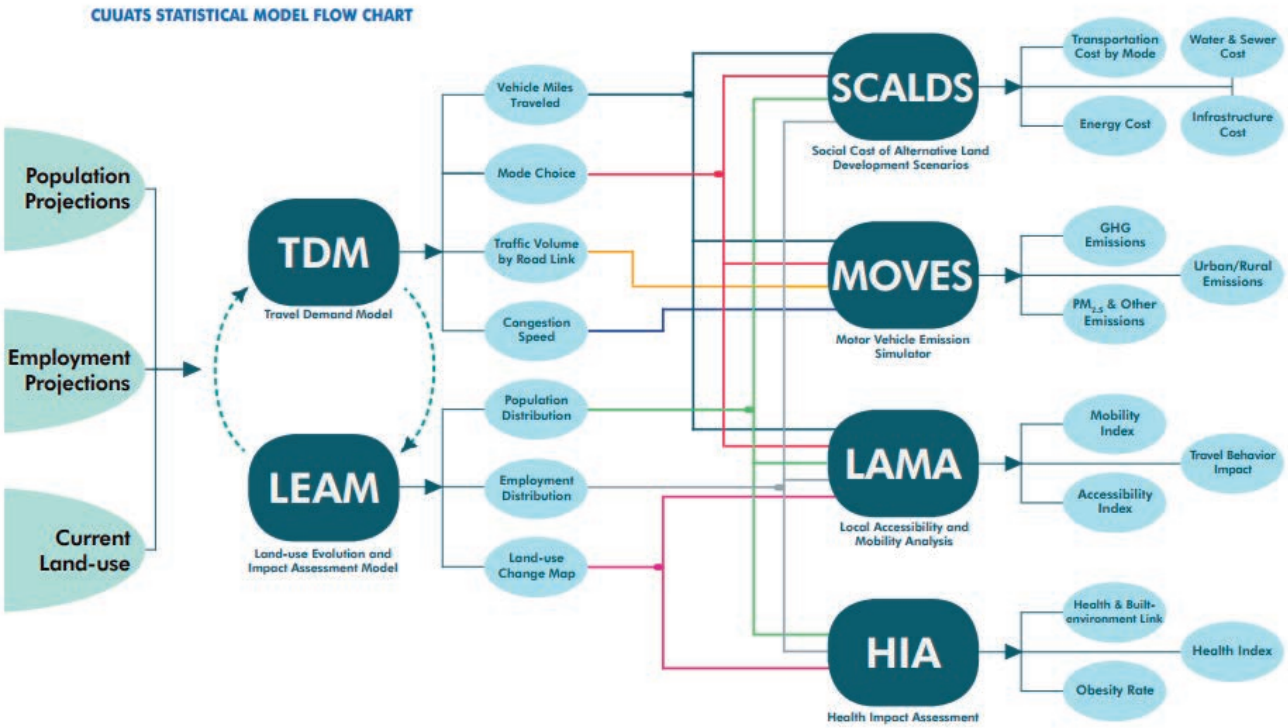
In previous scenario planning cycles (2004 and 2009) and in four corridor studies, CUUATS tested and refined many scenarios. By 2014, the public had reached consensus on how to grow and invest

[7] For more detailed information about the agency's use of performance measures and targets in planning, see the case study on the agency in the FHWA *Performance-Based Planning and Programming Guidebook*: http://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/pbppguidebook.pdf.

in transportation, so testing a single scenario that reflected the public's preferences against the "business as usual" scenario was reasonable. Limiting the number of scenarios was also logical, given the relatively slow growth in the region and that most of the transportation funding was already committed to a few major projects. As a next step, CUUATS plans to create new project prioritization criteria in the coming years based on the 2014 plan goals and objectives.

CUUATS has technically savvy staff team. The agency maintains a large and skilled team by serving as a consulting agency for the entire region and by identifying and pursuing funding sources for innovative research. CUUATS has developed models for more effectively evaluating relationships between transportation and public health, for example. More generally, the agency is continually seeking ways to update and improve its modeling and analysis capabilities.

Figure 6-2: CUUATS' Modeling Suite Used to Develop the Sustainable Choices 2040 Plan



Source: CUUATS

Strong relationships with various local and State agencies and other organizations (including the University of Illinois-Urbana Champaign) have been critical to CUUATS for obtaining data, leveraging funds, and building political support for regional initiatives. Long range planning and scenario planning processes have worked smoothly in significant part because of the high degree of collaboration and coordination among local agencies.

LESSONS LEARNED

- Strong and collaborative relationships between the MPO and the agency's member jurisdictions and other partners are extremely important; they improve the MPO's effectiveness and its ability to acquire funding to innovate. This, in turn, improves the quality of the scenario planning and scenario analyses the agency undertakes. Some examples of strong relationships from the Champaign-Urbana region that have improved the agency's capacity and ability to obtain funding include:
  - Informal lines of communication between the CUUATS and its various partners are always open. Many of these relationships date back to 1998, when the Campus Area Transportation Study (CATS) was formed to discuss transportation issues affecting the university area and to update the campus master plan.
  - Illinois DOT has frequently provided CUUATS with funding for different initiatives. In some cases, the funding is contingent on CUUATS providing technical assistance to other MPOs in the State.
  - Among CUUATS' member agencies is a strong sense of the need to do what is best for the region, even when it means "taking turns" with respect to which jurisdiction receives limited funding resources first. Strong relationships have enabled this approach.
  - The member agencies have service area boundary agreements in place to minimize interjurisdictional competition for development and jobs.
  - CUUATS worked with the Champaign-Urbana Public Health District to conduct health surveys in coordination with the 2040 plan outreach and engagement. This has been beneficial for the Health District and has enabled CUUATS to consider public health in its modeling and planning processes more fully (e.g., using HIA tools). CUUATS has worked with the Health District to obtain health-related grants for complete streets policies for two member communities. Because of strong relationships and taking specific confidentiality trainings, CUUATS staff have access to health data that allows them to analyze health on a level that is unparalleled throughout the country.

- Building in-house capacity has been critical to the agency's continued success. In some cases, having in-house staff complete analyses can be more cost effective and can position the agency to manage future planning cycles more efficiently. Having a highly skilled team of staff allows CUUATS to function successfully as a consulting firm for the entire region; grants and individual projects (developing cities' bicycle plans, for example) account for about half of the agency's revenue.
- The presence of a university with strong planning and engineering departments can be a significant benefit, particularly for a smaller MPO. UIUC faculty have assisted CUUATS in various ways (e.g., providing expertise on high-speed rail, developing modeling tools for the

agency's use). Nearly all of CUUATS' staff members were educated at UIUC, which provides the agency a steady stream of planning and engineering graduates.

Fresno Council of Governments

Fresno COG first used scenario planning in 2006–2007 as part of the San Joaquin Valley Blueprint planning process, in which the participating agencies used the UPlan scenario modeling tool to help establish a regional land use and transportation vision to guide growth over 50 years—a period in which the population is expected to more than double. The Blueprint process positioned the agency to better respond to the 2008 mandate in California Senate Bill 375 (SB 375) that all MPOs work with the California Air Resources Board (CARB) to set greenhouse gas (GHG) emission reduction targets. To set its initial GHG emission targets, Fresno COG used the Vision California RapidFire model, a spreadsheet-based tool. The agency ran various scenarios to identify the emission reduction targets that were realistically feasible for 2020 and 2035 (approximately 4 percent and 6 percent, respectively). In 2014, Fresno COG completed the 2040 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS). The SCS, required by SB 375, demonstrates how the region will meet its GHG emission targets of 5 percent by 2020 and 10 percent by 2035 (based on 1990 levels). The agency's experience setting GHG emission targets helped them prepare for more in-depth scenario planning and analysis.

For its 2014 plan, Fresno COG first went through a series of focus group meetings to identify an agreed-upon list of 10 indicators that would be used to evaluate scenarios. The indicators chosen reflected GHG emissions reduction, housing types, residential density, compact development, transit-oriented development, land consumption, important farmland protection, vehicle miles traveled, criteria pollutant emissions reduction, and active transportation and transit.

Then, staff developed three scenarios (A, B, and C), two of which were carried over from the GHG target setting process (B and C). Scenario A reflected public input from a community workshop. Scenario D was introduced by a coalition of stakeholder agencies late in the planning process, based on their desires to see more resource growth in rural areas. The four scenarios are described in Figure 6-3. Fresno COG built and tested the new scenario on a very tight schedule, but was unable to circulate it widely for public review, given the timing of the process. For its next planning process, the agency does not plan to repeat this experience of introducing additional scenarios later in the process. The establishment of stronger "ground rules," or a well-defined scope for the scenario planning exercise, could help avoid similar situations in the future.

The MPO Board ultimately chose Scenario B, which was the most consistent with locally adopted plans and the most politically feasible of all the scenarios. Although it produced a bigger footprint than the other scenarios, Scenario B still achieved significant improvements compared to the historic trend line. The agency then conducted an analysis of four revenue/investment scenarios, to identify which package of projects to fund, given expected revenues and ability to flex funds between different modes. The differences between scenarios were slight, however, because many of the significant projects in the existing program had been approved by a local referendum.

Figure 6-3: Fresno COG's Four Scenarios Evaluated for the 2014 RTP/SCS

Scenario >	A	B	C	D
Central Theme	Public input from November 2012 workshop	Current planning assumptions	Foothill growth to City of Fresno	Foothill growth to existing communities
Proposed By...	Public	Member Agencies	RTP Round Table	Coalition of Community Organizations
Defining Characteristics	• Considers public input from November 2012 workshop • Growth in the metro area conforms to historical trend • Some rural communities receive much higher growth	• Follows current general and specific plan updates • Growth allocation follows historical trend • Includes development in Friant Ranch, Millerton, and the proposed pharmacy school	• Additional 4% of countywide growth allocated to City of Fresno along corridors and activity centers • Unincorporated growth constrained to 10 existing communities; little change in incorporated cities • Development in Friant Ranch, Millerton, and the proposed pharmacy school not included	• Developed by coalition of community organizations • Increased redevelopment and higher density for new growth • Growth reduced from the foothill communities and reallocated to existing cities and communities • Development in Friant Ranch, Millerton, and the proposed pharmacy school not included
Communities with Significant Changes in Growth Allocation*	**Less Growth** • Clovis, Coalinga, Parlier, Sanger • Auberry, Friant Ranch, Millerton, Shaver Lake **More Growth** • Firebaugh, Fresno, Huron, Kerman, Kingsburg, Orange Cove, San Joaquin • Caruthers, Easton, Lanare, Laton, Raisin City, Riverdale, Squaw Valley	Each city/community receives growth based on historical trend	**No Growth** • Auberry, Friant Ranch, Millerton, Raisin City, Squaw Valley **More Growth** • Fresno	**No Growth** • Friant Ranch, Millerton **Less Growth** • Auberry **More Growth** • Biola, Bowles, Caruthers, Del Rey, Easton, Lanare, Laton, Raisin City, Riverdale, Tranquillity

Source: Fresno COG

Public engagement for the RTP/SCS process was extensive. The COG's public information officer created a very successful mini grant program that provided local community organizations with outreach training and support. This greatly increased community participation among a wide array of demographic groups. The agency also established an "RTP Roundtable," which was specific to the RTP/SCS process and included 35 representatives from member organizations, community groups, and other agencies (e.g., transit operators and community and special-interest groups). The use of a roundtable was extremely effective in persuading all the stakeholders to collaborate and establishing widespread buy-in to the process and its results.

At the site visit, the team engaged in a detailed discussion about the different capabilities of the Envision Tomorrow scenario evaluation tool used for the 2014 plan and Urban Footprint, which the agency is considering for its next scenario planning initiative. In addition, the staff described its

four-step travel demand model, and talked about the potential of transitioning to an activity-based model that would better reflect the nuances of walking, biking, and urban design on vehicle travel patterns. The agency is also working with the State public health department to develop an Integrated Transportation and Health Model (ITHIM), which will be run in-house, to model the benefits of active transportation.

LESSONS LEARNED

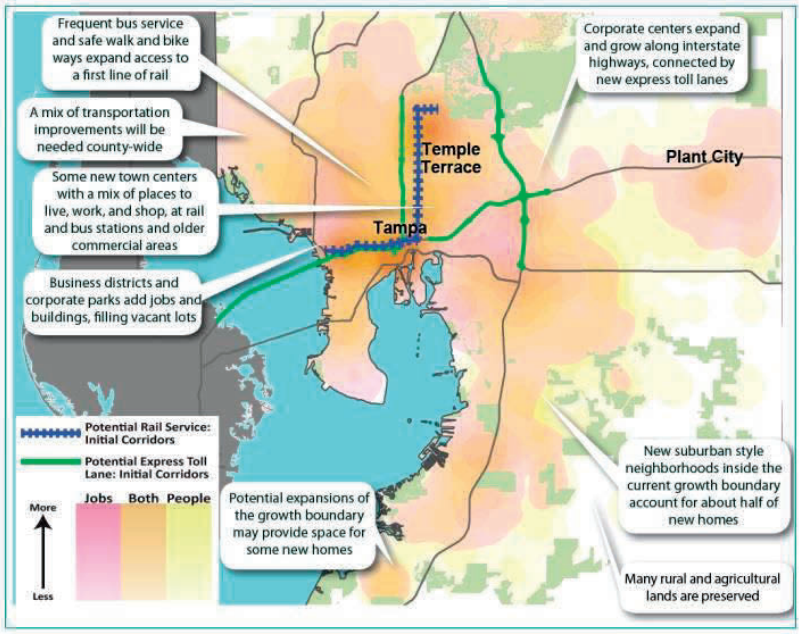
- Identifying the performance measures that will be used to evaluate scenarios early in the scenario planning process helps ensure a productive and effective process. Tying scenario planning to performance measures allows for more effective communication about why some scenarios perform better than others and the extent to which goals can be achieved under each scenario.
- In hindsight, the Fresno COG's staff found that evaluating scenarios that were not consistent with reality (e.g., those that did not take approved development plans into consideration) was not a particularly productive exercise. The lesson learned from this experience was that setting ground rules regarding what changes will, and will not, be formally considered in developing scenarios is essential. Any evaluation of expected impacts under unrealistic scenarios should be completed simply to understand the likely impacts of future decisions.
- Engaging with partners early and often throughout the scenario planning process was key for ensuring unanimous consensus in selecting a scenario and assuaging local agencies' concerns about the (perceived) need to protect their land use authority.
- The mini-grant program for local community-based organizations to engage residents in the planning process was successful and cost effective. The relationships strengthened as a result of that program have enhanced the quality of planning in the region (e.g., through the engagement of non-English-speaking communities) and resulted in greater support in the community for the smart growth principles that date back to the Regional Blueprint process.
- Having highly skilled technical staff who are responsive is important for enhancing the ability to incorporate performance measures into scenario planning and conduct analyses that improve stakeholders' understanding about planning and investment options.
- Inclusion of groups whose interests are often not aligned with the agency's (e.g., Building Industry Association in this case) is valuable to improve understanding, identify opportunities for mutually agreeable solutions, and keep lines of communication open.

Hillsborough County MPO

The Hillsborough County MPO recognizes that uncertainty is inevitable in planning. It deals with this uncertainty by using scenario analysis at nearly every step of its long range transportation planning. The MPO's most recent scenario planning endeavor was in 2013–2014 as it developed *Imagine 2040*, the region's long range transportation plan and land use vision. The MPO worked with the county's Planning Commission, which oversees land use planning for the county and its local governments, to design future land use scenarios and settle on a vision for the region's land use. The MPO then developed its LTRP. The previous (2035) LRTP included a single list of transportation priorities. Local governments wanted more flexibility and public opinion polling, however, after a failed transportation referendum challenged their perceptions of public priorities. Therefore, the MPO created packages of projects in four categories—Preserve the System, Reduce Crashes and Vulnerability, Minimize Delay for Drivers and Shippers, and Real Choices When Not Driving—and looked at how low, medium, and high levels of investment would affect performance measures for each category. Some of the key outcomes to this approach were:

- The public and decisionmakers knew what the MPO could afford with current funding.
- The process built public support for generating additional transportation revenues.
- The performance measures developed for the project provided a basis for project selection and ongoing monitoring and evaluation criteria. The MPO will continue using its performance measures to evaluate transportation performance through its Crash Management/Congestion Management Program.

Figure 6-4: Imagine 2040 Preferred Scenario



Source: Hillsborough County MPO

LESSONS LEARNED

- Considering the extent to which a planning process can affect policies related to topics beyond transportation, such as land use, is important. The Hillsborough County MPO's strong relationship with the Planning Commission (which was a lead agency in developing the plan) meant that the MPO had a reasonable chance at successfully influencing land use plans and policies to achieve a vision.
- Opinion polling can be a useful tool in helping agencies understand what matters to citizens; in the case of Hillsborough County MPO, it informed project categories and investment scenarios. Conducting opinion polling and other types of outreach can provide information that informs how scenarios are designed and which performance measures resonate with decisionmakers and the public. To the extent practicable, highly resonant performance measures should be used to evaluate scenarios.
- Using funding scenarios can be instrumental in educating the public about what current funding levels could achieve, and what would is necessary to achieve more desirable levels of performance.
- High levels of coordination between local government and MPO staff can support stronger land use-transportation coordination. The Imagine 2040 transportation plan and local land use plans were prepared at the same time and developed to be mutually supportive. This can enhance agencies' ability to implement the land use vision that will support the preferred scenario.

7. Resources

Federal Scenario Planning and PBPP Resources

FHWA Website on Scenario Planning and Visualization in Transportation, http://www.fhwa.dot.gov/planning/scenario_and_visualization/scenario_planning/

FHWA Website on Performance-Based Planning and Programming, http://www.fhwa.dot.gov/planning/performance_based_planning/

PlanWorks: Better Planning. Better Projects, https://fhwaapps.fhwa.dot.gov/planworks/

- Integrating Freight Considerations into the Highway Capacity Planning Process Application, https://fhwaapps.fhwa.dot.gov/planworks/Application/Show/16
- Decision Guide, https://fhwaapps.fhwa.dot.gov/planworks/DecisionGuide
- Assessments, https://fhwaapps.fhwa.dot.gov/planworks/Asessment
- Applications, https://fhwaapps.fhwa.dot.gov/planworks/Application
  - Linking Planning and Operations Application, https://fhwaapps.fhwa.dot.gov/planworks/Application/Show/7

FHWA 2011 Scenario Planning Guidebook, http://www.fhwa.dot.gov/planning/scenario_and_visualization/scenario_planning/scenario_planning_guidebook/

FHWA 2013 Performance-Based Planning and Programming Guidebook, http://www.fhwa.dot.gov/planning/performance_based_planning/pbpp_guidebook/

FHWA 2014 Model Long Range Transportation Plans: A Guide for Incorporating Performance-Based Planning, http://www.fhwa.dot.gov/planning/performance_based_planning/mlrtp_guidebook/

FHWA 2014 Performance-Based Planning for Small Metropolitan Areas, http://www.fhwa.dot.gov/planning/performance_based_planning/small_mpo_report/fhwahep15015.pdf

FHWA 2016 Advancing Transportation Systems Management and Operations through Scenario Planning Primer, http://www.ops.fhwa.dot.gov/publications/fhwahop16016/index.htm

Transportation Research Board Resources

NCHRP Report 750, Scenario Planning for Freight Transportation Infrastructure Investment, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_750v1.pdf

NCHRP Report 710: Practical Approaches for Involving Traditionally Underserved Populations in Transportation Decisionmaking, http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_710.pdf

NCHRP Planning Snapshot 3: Scenario Planning, http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36(120)_Snapshot2014-003ScenarioPlanning.pdf

J. Zmud, Transportation Research Board Webinar, "Applying Scenario Methods to Transportation Planning and Policy," Slides available at: http://onlinepubs.trb.org/onlinepubs/webinars/141023.pdf

SHRP2 Railroad-DOT Mitigation Strategies, https://www.fhwa.dot.gov/goshrp2/Solutions/PlanningEnvironment/R16/RailroadDOT_Mitigation_Strategies

SHRP2 Utility Bundle, https://www.fhwa.dot.gov/goshrp2/Solutions/Renewal/R01A_R01B_R15B/Utility_Bundle

Resources for Considering Equity in Scenario Planning

Equity through Transit, Metropolitan Washington Council of Governments, http://www.mwcog.org/planning/regionforward/communities.asp

The Community Engagement Guide for Sustainable Communities, Kirwin Institute and PolicyLink, http://kirwaninstitute.osu.edu/?my-product=the-community-engagement-guide-for-sustainable-communities

The Geography of Opportunity in Austin and How it is Changing, Kirwin Institute, http://kirwaninstitute.osu.edu/my-product/austi/

Opportunity Mapping: A conceptual Analysis and Application to the Baltimore Area, University of Maryland, http://www.appam.org/assets/1/7/Opportunity_Mapping_A_conceptual_Analysis_and_application_to_the_Baltimore_Metropolitan_Area.pdf

Tools to Support Scenario Planning and PBPP

BCA.net, http://bca.transportationeconomics.org/models/bca-net

CityEngine, http://www.esri.com/software/cityengine

Community Vision Metrics, http://www.fhwa.dot.gov/livability/tools/community_vision/

CommunityViz, http://placeways.com/communityviz/index.html.

CrowdGauge, http://crowdgauge.org/

CubeLand, http://www.citilabs.com/software/cube/

Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects, https://www.environment.fhwa.dot.gov/ecological/eco_index.asp

Energy and Emissions Reduction Policy Analysis Tool (EERPAT), https://www.planning.dot.gov/fhwa_tool/

EngagingPlans, http://urbaninteractivestudio.com/engagingplans/

Envision Tomorrow, http://www.envisiontomorrow.org/

FHWA Health and Transportation Corridor Planning Framework, https://www.fhwa.dot.gov/planning/health_in_transportation/planning_framework/the_framework/fhwahep16014.pdf

Highway Safety Manual, http://safety.fhwa.dot.gov/hsm/

Highway Economic Analysis Requirements System (HERS), https://www.fhwa.dot.gov/infrastructure/asstmgmt/hersindex.cfm

Highway Economic Analysis Requirements System – State Version (HERS-ST), https://www.fhwa.dot.gov/infrastructure/asstmgmt/hersindex.cfm

INDEX, http://crit.com/

Integration of Safety in the Project Development Process and Beyond: A Context Sensitive Approach (ITE publication), http://library.ite.org/pub/e4edb88b-bafd-b6c9-6a19-22e98fedc8a9

INVEST 1.0, https://www.sustainablehighways.org/

iPlaces^{3}S, http://www.sacregionblueprint.org/technology/

MetroQuest, http://metroquest.com/

Motor Vehicle Emission Simulator (MOVES), http://www.epa.gov/otaq/models/moves/

National Bridge Investment Analysis System (NBIAS), https://www.fhwa.dot.gov/bridge/nbi.cfm

PlanWorks: Better Planning. Better Projects, https://fhwaapps.fhwa.dot.gov/planworks/ and https://www.fhwa.dot.gov/goshrp2/Solutions/Capacity/C01/PlanWorks__Better_planning_Better_projects

Production Exchange and Consumption Allocation System (PECAS), http://www.hbaspecto.com/pecas/

Rapid Policy Analysis Tool (RPAT) (formerly known as SmartGAP), https://www.fhwa.dot.gov/goshrp2/Solutions/All/C10_C04_C05_C16/Advanced_Travel_Analysis_Tools_forIntegrated_Travel_Demand_Modeling, http://www.trb.org/Main/Blurbs/168842.aspx

Regional Ecosystem Framework (Eco-logical), https://www.environment.fhwa.dot.gov/ecological/ImplementingEcoLogicalApproach/default.asp

REMI-TransSight, http://www.remi.com/products/transight

Safety Analyst (AASHTO-Ware), http://www.safetyanalyst.org/

SHRP2 – Guide to Establishing Monitoring Programs for Travel-Time Reliability (LO2), http://www.trb.org/Main/Blurbs/168764.aspx

SHRP2 – Handbook for Incorporating Reliability Performance Measures into Transportation Planning and Programming (LO5), http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L05-RR-2.pdf

SHRP2 – Reliability by Design (LO7), http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L07-RR-1.pdf

SHRP2 – Incorporating Travel-Time Reliability into the Highway Capacity manual (LO8), http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L08-RW-1.pdf

SHRP2 – Tools for Assessing Wider Economic Benefits of Transportation (C11), http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_PB_C11.pdf

Simplified Trips-on Project Software (STOPS), https://www.fta.dot.gov/funding/grant-programs/capital-investments/stops-%E2%80%93-fta%E2%80%99s-simplified-trips-project-software

Social Cost of Alternative Land Development Scenarios (SCALDS), https://www.fhwa.dot.gov/scalds/scalds.html

Sustainable Communities Index: http://www.sustainablecommunitiesindex.org/

Systemic Safety Project Selection Tool, http://safety.fhwa.dot.gov/systemic/fhwasa13019/

TERM-lite, https://www.fta.dot.gov/regulations-and-guidance/asset-management/state-good-repair/term-lite

Tools for Operations Benefit Cost Analysis (TOPS-BC), http://www.ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm

TREDIS, http://www.tredis.com/

TSP eHandbook, http://safety.fhwa.dot.gov/tsp/fhwasa15089/

Transportation and Health Tool, https://www.transportation.gov/transportation-health-tool

UPlan, http://ice.ucdavis.edu/doc/uplan

UrbanCanvas, http://www.urbansim.com/urbancanvas/

UrbanSim, http://www.urbansim.com/

UrbanFootprint and RapidFire, http://calthorpeanalytics.com/index.html#software

Sources of Information for Agency Examples Provided

Atlanta Regional Commission, http://www.atlantaregional.com/

- http://www.atlantaregional.com/plan2040; http://www.atlantaregional.com/land-use/livable-centers-initiative/recipients

Baltimore Regional Transportation Board, Baltimore Metropolitan Council, http://www.baltometro.org/about-brtb/brtb-committees/baltimore-regional-transportation-board

- The Opportunity Collaborative, http://www.baltometro.org/our-work/the-opportunity-collaborative
- Plan It 2035, http://www.baltometro.org/our-work/transportation-plans/long range-planning/final-plan-it-2035
- Maximize 2040: A Performance-Based Transportation Plan, http://www.baltometro.org/maximize-2040
- Imagine 2060, http://www.baltometro.org/information-center/documents/category/90-imagine-2060

California Department of Transportation (Caltrans), http://www.dot.ca.gov/

- http://www.dot.ca.gov/hq/tpp/californiatransportationplan2040/index.shtml

Capital Area MPO (NC), http://www.campo-nc.us/

- http://www.campo-nc.us/transportation-plan/2040-metropolitan-transportation-plan

Champaign Urbana Urbanized Area Transportation Study (IL), http://cuuats.org/

- CUUATS 2025 LRTP, http://www.ccrpc.org/transportation/lrtp.php

- CUUATS Choices 2035 Plan, http://www.ccrpc.org/transportation/lrtp2/documents.html
- CUUATS Sustainable Choices 2040 Plan, http://cuuats.org/lrtp/documents/long range-transportation-plan-sustainable-choices-2040-final/lrtp-2040-executive-summary/view

Chicago Metropolitan Agency for Planning, http://www.cmap.illinois.gov/

- CMAP's 2040 LRTP, http://www.cmap.illinois.gov/about/2040
- Chicago Community Trust MetroPulse Website, http://www.cmap.illinois.gov/data/metropulse

Colorado DOT, https://www.codot.gov/

- https://www.codot.gov/programs/statewide-planning

Delaware Valley Regional Planning Commission, http://www.dvrpc.org/

- Connections 2035, http://www.dvrpc.org/connections/
- Connections 2040 Choices & Voices, http://www.dvrpc.org/Connections2040/
- Connections 2045, http://www.dvrpc.org/Connections2045/
- Making the Land Use Connection, http://www.dvrpc.org/reports/08059.pdf
- Future of Scenario Planning White Paper, http://www.dvrpc.org/asp/pubs/publicationabstract.asp?pub_id=14038

Denver Regional Council of Governments, https://www.drcog.org/

- https://www.drcog.org/planning-great-region/metro-vision

Durham-Chapel Hill-Carrboro MPO, http://www.dchcmpo.org/

- http://www.dchcmpo.org/programs/transport/2040.asp

Envision Utah, http://www.envisionutah.org/

Fresno Council of Governments, http://www.fresnocog.org

- Fresno COG RTP/SCS website, http://www.fresnocog.org/sustainable-communities-strategy-development-and-outreach
- San Joaquin Valley Blueprint Planning Process website, http://www.valleyblueprint.org/

Gainesville MTPO, http://www.mpoac.org/mpos/gainesville.shtml

- http://ncfrpc.org/mtpo/publications/LRTP2035/SummReport_061711_color.pdf

Hillsborough County MPO (FL), http://www.planhillsborough.org/metropolitan-planning-organization-mpo/

- Long-range Transportation Plan: http://www.planhillsborough.org/2040-lrtp/

- Transportation Improvement Program: http://www.planhillsborough.org/transportation-improvement-program-tip/
- Unified Planning Work Program: http://www.planhillsborough.org/unified-planning-work-program/

Metro of Oregon, http://www.oregonmetro.gov/

- Regional Transportation Plan, http://www.oregonmetro.gov/regional-transportation-plan
- MetroScope, http://www.oregonmetro.gov/forecasting-models-and-model-documentation

Metropolitan Transportation Commission (CA), http://mtc.ca.gov/

- http://planbayarea.org/plan-bay-area.html

Metropolitan Washington Council of Governments, http://www.mwcog.org/ and Transportation Planning Board, http://www.mwcog.org/transportation/tpb/

- CLRP Aspirations Study, http://www.mwcog.org/clrp/elements/scenarios.asp
- CLRP Constrained Plan, http://www.mwcog.org/clrp/

Mid-Region Council of Governments (NM), http://www.mrcog-nm.gov/

- Central New Mexico Climate Change Scenario Planning Project, https://www.volpe.dot.gov/transportation-planning/public-lands/central-new-mexico-climate-change-scenario-planning-project

Minnesota DOT, http://www.dot.state.mn.us/

- MnSHIP, http://www.dot.state.mn.us/planning/mnship/
- Multimodal Transportation Plan, http://www.dot.state.mn.us/minnesotago/SMTP.html

Oregon DOT, http://www.oregon.gov/ODOT/Pages/index.aspx

- Least Cost Planning, http://www.oregon.gov/ODOT/TD/TP/pages/lcp.aspx;
- Oregon Transportation Plan, http://www.oregon.gov/ODOT/TD/TP/pages/otp.aspx

Sacramento Area Council of Governments (SACOG), http://www.sacog.org/

- Sacramento Blueprint, http://www.sacregionblueprint.org/
- 2035 Metropolitan Transportation Plan, http://sacog.org/mtp/2035/final-mtp/

Southeast Michigan Council of Governments (SEMCOG), http://semcog.org/

- http://www.semcog.org/desktopmodules/SEMCOG.Publications/GetFile.ashx?filename=2030RegionalTransportationPlanForSoutheastMichiganNovember2004.pdf – 2035 plan

Space Coast Transportation Planning Organization (FL), http://spacecoasttpo.com/

- http://spacecoasttpo.com/plan/long range-transportation-plan/

Tri-County Regional Planning Commission (MI), http://www.mitcrpc.org/

- http://www.tri-co.org/trp.htm#

Washington State DOT, http://www.wsdot.wa.gov/

- http://www.wsdot.wa.gov/Freight/freightmobilityplan

Appendix A. Getting Started: A Worksheet for Designing a Scenario Planning Process to Support PBPP

As this Guidebook has described, scenario planning is a tool that can support decisions at each phase of PBPP) There are many different ways this can be done. This self-assessment is designed to help you think about how to use scenario planning to support your agency's PBPP process. The intent of this self-assessment is not to give you explicit direction in scoping your agency's scenario planning process. Rather, the purpose is to help a project manager and, if desired, a technical committee or advisory group, to consider the key issues that could be addressed and some of the practical elements involved in using scenario planning to inform the overall PBPP. The insights and notes you develop by working through this self-assessment can provide useful material and insights for subsequent activities such as estimating potential costs and needed resources, developing a scope of work, describing the project in a Unified Planning Work Program, and (if needed) writing a Request For Proposals to elicit consultant support.

The questions below are organized in a series of steps, starting with the most basic context-setting step to the advanced step of preparing a scope. The table includes three columns. The left-hand column poses questions to consider during the corresponding step. The middle column provides suggestions for gathering specific information to help answer the question; feel free to gather additional or different information to suit your needs. The right-hand column provides space for your responses.

Question	Information to Consider	Your Responses
Step 1: Evaluate Community Context		
1. How is your region developing?	Summarize/ map regional growth trends and forecasts	
2. What are the major issues or drivers influencing growth and development?	List top five issues/ drivers	

Question	Information to Consider	Your Responses
3. What are the most promising opportunities that will shape development in years to come? What are the most promising opportunities that will shape development in years to come? What major issues may be affecting equity in the community; assessed with a community profile, including the identification of populations and their characteristics, and identifying data sources?	Summarize/ map opportunities	

Step 2: Identify Desired Outcomes		
1. What plans are due for an update?	List plans that will be updated within 3-5 years	
2. What new plan(s) is your organization expected to develop soon?	List any planning efforts about to start or recently launched	
3. What is your agency looking to accomplish in these updates?	List five new policy emphases	
4. What major trends are of greatest concern to your agency's board?	List five concerns recently expressed by board members	

Step 3: Identify Scenario Planning Purpose		
1. Which element(s) of your PBPP process could benefit from scenario planning and analysis?	List aspects of your PBPP process that are influenced by high uncertainty, contention, and/or new aspirations	
2. What issues would you like to address from previous planning processes?	List the top 5 issues that have emerged from previous planning processes	
3. How could scenarios be used to improve plans and decisions?	List specific decision points where scenario consideration could add value	
4. How can scenarios improve the ongoing decisionmaking process?	Brainstorm ways scenario planning could help improve the overall PBPP process or framework	
5. Are there particular trade-offs your agency would like to better illustrate for the public and decisionmakers?	List trade-offs that your agency grapples with	
6. How will scenario planning help your agency define transportation performance measures and set targets?	Describe the connection between scenarios and performance measures	
Step 4: Identify Scenario Planning / PBPP Linkages		
1. How can you apply / build on scenario planning tools, data, and skills to support the ongoing PBPP process?	Brainstorm ways to make scenarios planning elements part of each PBPP phase (vision, goals, plan development, programming, project development, monitoring, evaluation of results)	
2. How could scenario tools, models, data, or inputs inform subsequent efforts such as corridor studies?	List upcoming studies that should be linked to the scenario analysis	

3. How could you maximize the usefulness of the scenario analysis tools or data planning to inform other work and/or improve efficiencies?	List other work efforts conducted by your agency and/or partner agencies that would benefit from the scenario tools and data	
Step 5: Define Scenario Planning Approach		
1. At what point in your agency's PBPP process will scenario planning be deployed?	Prepare a timeline of planning processes; indicate where and how scenario planning can influence results or outcomes	
2. Do you anticipate using scenarios to identify preferred future conditions, helping to shape the region's vision, principles, or goals?	Identify community values and goals that may be important to flesh out when describing and evaluating different stories of potential future conditions	
3. Do you anticipate using scenarios to test different courses of action against radically different future conditions, helping to test the validity of underlying assumptions or the resiliency of planned investments?	Identify game-changing trends and/or events that could significantly affect future conditions and transportation supply or demand	
4. Do you anticipate using scenarios to test different courses of action against relatively predictable future conditions, helping to hone strategies and set priorities?	Identify elements of the PBPP process that would benefit from more clearly defined priorities or focused tactics.	

Step 6: Define Scenario Planning Engagement		
1. What information do you need from stakeholders and the public to develop scenarios and plans? How will you use the information and ideas that are offered?	List inputs and insights you hope to gain through engagement; identify ways in which the input can influence PBPP decisions, documents, and outcomes	
2. What groups or individuals have information that is necessary for crafting and analyzing scenarios?	Create a list and cross-reference with the input you hope to gain	
3. How can the public benefit from your approach to scenario planning?	List benefits such as (for example) helping people communicate with your agency more effectively; engage in meaningful dialogue about key issues; address contentions or thorny subjects; etc.	
4. At what point will decision-makers be involved in scenario development and/or evaluation?	Brainstorm how and why to engage decisionmakers	
5. What methods will you use to engage each stakeholder group?	Brainstorm methods for engaging stakeholders	
6. What resources do you have or need to conduct engagement activities?	Estimate budget for existing/ acquired materials and staff time for public and stakeholder engagement	
Step 7: Define Resources for Scenario Planning Effort		
1. How much could you achieve through scenario planning with minimal data and analysis tools?	Outline an approach to scenario planning that relies on qualitative analysis	
2. What data is needed to support your preferred scenario planning approach?	List data needs and potential sources	
3. What data are available?	Match data needs with available data and highlight the gaps	

4. What tools are available to conduct scenario planning and analysis?	List tools that may help with your scenario planning	
5. What are the strengths and weaknesses of existing tools?	List pros and cons for each existing tool	
6. What do you want to analyze, but cannot with existing tools?	List gaps in existing tools	
7. What other tools could help close the gaps between what you'd like to do and what you can do?	List tools you would like to explore for your scenario planning process	
8. What are your priorities for purchasing data (if your budget will allow this)?	List data you would like to purchase	
9. If you purchase data, will you have resources to purchase subsequent releases of the data?	Consider how important the data are to have and to keep updated	
10. If you are unable to obtain desired data and tools, can scenario planning still provide value?	List potential benefits of a more qualitative approach	
11. What is staff's level of experience with scenario planning?	Evaluate staff's ability to conduct scenario planning in-house	
12. What outside resources are available (e.g., universities, Federal agencies, foundations, civic groups)	List, contact potential partners in the region to gauge their interest and potential to contribute resources	
Step 8: Prepare Scope for Scenario Planning Effort		
1. Will the entire scenario planning process be conducted in-house, or will consultants be hired to assist?	Decide what can be done in-house and what to include in a RFP for consultants	
2. What can you budget for the scenario planning project?	Estimate budget based on available funding and desired outcomes/level of effort	
3. Who needs to be involved in the scoping process?	Pull together a Steering Committee to oversee the development of the scope	

4. How much do you and your board know about other existing plans affecting the growth and development of your region?	Develop a task in the scope to review and summarize existing plans and create a repository for them	
5. What specific questions, processes, and outcomes will this scenario planning effort address?	Develop a task for the scenario development and evaluation process based upon how the results will be used.	
6. How do you plan to consult with other agencies and stakeholders in your region?	Develop a task for engaging these key stakeholders	
7. How will you ensure the public understands the purpose of the process and has reasonable expectations of the results?	Develop a task for engaging the public that counters potential misperceptions or confusion	
8. How will you communicate the scenarios and results of the analysis to stakeholders and the public?	Develop a task for communication that calls for clear and accessible presentation of the results	
9. How will you provide access to the scenarios and data for decisionmakers?	Develop a task to give access to decisionmakers, which supports integrating scenarios into on-going decisionmaking	
10. Will the scenarios continue to be used over time, creating a need for data and tool support?	Develop a task that describes ongoing support activities to keep the scenarios up-to-date	

Appendix B. Scenario Planning Tools

PBPP Tools

Please note: FHWA does not endorse the use of any specific private sector tools or models. The purpose of this appendix is solely to provide information about the capabilities and relevant uses of available tools.

PBPP Tool (and Applicable PBPP Phase)[8]	General Description/ Purpose	Inputs, Outputs, and Scale[9]	How does or could the tool inform scenario planning and vice versa?	PBPP-SP Tool Relationship Challenges and Information/Suggestions for Addressing Challenges[10]
TIP prioritization calculator/ scoring sheet (P)	Enables decisionmakers to determine funding priorities and select projects, using evaluation criteria weighted according to local policy priorities.	Inputs: Long range plan, asset management plan, financial forecasts, project studies Outputs: Prioritized list of projects for short-term funding program. Scale: Project	The tool could provide locally important performance metrics to consider in evaluating scenarios. Scenario planning could provide a basis for adding new performance metrics to inform scoring of projects, particularly outcome-oriented measures (e.g. health, economic dev.)	Some traditional TIP metrics may not be easy to forecast for scenarios (e.g. safety). Some scenario planning metrics may be qualitative and/or difficult to assess at the project scale (community quality of life, economic equity, etc.). Hillsborough County provides an example of forecasting safety and reliability.
Economic Simulation Models: TREDIS and REMI-TranSight (A, P, I)	Compare costs, benefits, and economic impacts at community, regional, or corridor level. Useful in roadway, transit, or rail scenario planning in the programming and analysis phases to compare the C/B ratio, economic impact or financial consequences of different investments. Come pre-loaded with local economic data. Use inputs from a travel demand model;	Inputs: Travel model trip tables, including trips, travel times and costs Outputs: Benefit/ Cost ratio; Economic impact (Jobs, income); Financial impact (revenues, expenditures) and Development impact (housing, commercial and industrial development) Scale: All	The tool could be used to compare cost/benefit ratios and economic impacts between different transportation investment scenarios. The tool can also be used for analysis of wide range of impacts, which is compatible with scenario planning. Scenario planning could provide the alternative transportation investments to run through the model for comparison.	These tools are focused on quantitative transportation metrics and their monetary value in terms of either societal benefit or impact on the economy of a predefined region. They require the use of travel demand models, which may not otherwise be needed for scenario planning.

[8] The applicable PBPP phases are: direction (D), analysis (A), programming (P), implementation (I), or all.
[9] Scale could be project, corridor, study area, region, or State.
[10] Challenges include: data/scale compatibility, ability to forecast, quantitative/qualitative, etc.

	TREDIS allows engineering estimates for project-level analysis.			
TDM Evaluation Model (A, P, I)	The TDM Evaluation Model is an FHWA tool for evaluating relative benefits of different investments. It deals with TDM strategies and how they support vehicle trip reduction. Using this model in scenario planning may require the dedication of substantial time towards model development and deployment. Useful in the analysis and programming phases.	Inputs: Come from 4-step travel models, plus impact on cost or travel time by mode. Outputs: Changes in modal share, vehicle-trips, VMT, average vehicle occupancy and ridership expressed at a market level defined by the user Scale: All	The tool can provide basic information needed to evaluate a TDM heavy scenario. Scenario planning may call for a focus on TDM.	The tool is focused on transportation; land use would be constant between different scenarios. The tool requires use of a travel demand model, which may not otherwise be needed for scenario planning.
PlanWorks (All)	PlanWorks is a web-based resource that supports decisionmaking in transportation planning, programming, and environmental review. The tool helps practitioners identify whom to engage and how. It can also be used to set up an engagement plan for a scenario planning project.	Inputs: No technical inputs Outputs: For each key decision point, Plan-Works provides policy and stakeholder questions, data needs, case studies and examples, and links to tools that can help support the decision. Scale: All	The tool provides techniques for overcoming common problems with engaging stakeholders – an issue at each stage of PBPP and in scenario planning.	
Tool for Operations Benefit Cost Analysis (TOPS-BC) (D, A)	TOPS-BC is a tool managed by FHWA that transportation planners can use to estimate benefit to cost ratios for different system management and operations strategies.	Inputs: Geographic scope of analysis; strategy types; size, scope, and implementation of deployment; time horizon; operating parameters of TSM&O strategy; average c/v ratio for entire facility (all lanes); arterial link length; free-flow speed Outputs: Impacts of operating strategies; B/C tools most relevant to the needs of specified analysis;	The tool could provide locally important benefit, cost and other metrics to consider in evaluating scenarios.	

		life-cycle cost of TSM&O strategies; congested speed; VMT; VHT; # of crashes; fuel consumption; congested speed; annual benefit; B/C ratio. Scale: Project, corridor. Allows for combinations of strategies.		
Safety Analyst (A, P, I)	This tool automates and improves many procedures transportation agencies use to identify safety problems and prioritize improvements. It can also be used to compare costs and benefits of alternative safety improvements at specific locations or across locations. It is especially useful in the analysis and programming phases of PBPP.	Inputs: Database of roadway characteristics, traffic volume, and crash data. Outputs: Identification of sites for improvements, counter-measure selection, economic appraisal of counter-measures, C-B ratio of counter-measures and ranked list of sites and improvements, before/ after evaluations. Scale: All	The tool supports identification of goals. May also be used in evaluating scenarios, and the network screening tool can identify hot spots for safety improvements. Scenario planning supports the tool by setting priorities, one of which may involve reducing crashes.	The scale is an issue for counter-measures. Safety Analyst is not set up to evaluate non-site specific safety improvements.
Infrastructure Voluntary Evaluation Sustain-ability Tool (INVEST) (All)	INVEST is an FHWA-developed self-evaluation tool that agencies can use to assess performance on various sustainability criteria. It includes modules for evaluation at the system planning scale, project-based evaluations, and maintenance and operations. The tool requires little technical expertise.	Inputs: Answers to self-evaluation questions Outputs: Score of gold, silver, or bronze (which are connected to a numeric value). Scale: All	The tool evaluates the sustain-ability of different scenarios. Scenario planning establishes a vision and preferences.	

Highway Economic Analysis Requirements System (HERS) **and** **Highway Economic Analysis Requirements System-State Version (HERS-ST)** (A, P, I)	HERS-ST uses Highway Performance Monitoring System Data (HPMS) to evaluate current and future performance of the highway system under alternative investment scenarios or rules. It can be set to select roadway improvements over funding period based on investment rules and budget. It calculates B-C ratios, and examines options such as pavement preservation; reconstruction of existing pavement (w/ and w/o new lanes); new lanes; and widening of roadway or shoulder. Scenario are compared to each other and to regular highway maintenance. HERS-ST then recommends improvement types or no improvement for the funding period. It uses pavement measures such as IRI, present serviceability rating (PSR), and cracking for roadways.	Inputs: As input, HERS-ST accepts highway-section records in the Highway Performance Monitoring System format. Outputs: For each highway section, model predicts future condition and capacity deficiencies based on section-specific information. Model identifies improvements to correct each deficiency and determines a B-C ratio for each potential improvement. The most economic-ally attractive improvement for each facility is identified. Projects to be implement-ted are determined by comparing the relative merit (e.g., B/C ratios) of each candidate improvement. Scale: All, however the network will be limited by data availability.	The HERS-ST software simulates the selection and implementation of highway capital improvements consistent with the principles of incremental benefit-cost analysis. The analysis considers travel time, safety, vehicle operating, emissions, and highway agency costs. The model optimizes highway investment given funding constraints or performance objectives specified by the analyst. Scenario planning could be used to set investment parameters (such as high, medium, low), set goals for highway performance, and select the critical indicators that the tool would help to measure.	Possible issues of scale/ jurisdiction given the use of highway section data. Much of the network may be unavailable for HERS.

Systemic Safety Project Selection Tool (All)	Guides user through a risk-based approach (rather than locating hot spots with high crash rates) to safety mgmt. that complements traditional site analyses and countermeasure selection. It can help planners identify improvement types that, through widespread adoption, have large benefits. As such, it nicely compliments the Safety Analyst approach. It is especially useful in rural areas and on local streets where crash rates are low, but risk factors may be high.	Inputs: Crash data, roadway characteristic data, traffic volume data Outputs: Safety risk factors identification, countermeasure identification Scale: Region	The tool could help set performance targets, goals, and/or vision for a region. Can help elevate discussions on safety and point to high-risk areas and trends. Scenario planning could call for an emphasis on safety, in which case this tool could be used to go beyond traditional site analyses and countermeasure selections and instead focus on areas of high risk and system wide countermeasures that might produce the most bang for the buck.	Challenges include lack of data, especially at local level and rural areas and a potential lack of analytical technical skills. Training and technical assistance can help solve these challenges.
Highway Safety Manual Parts B and C (All)	The HSM, like several other tools in this table, represents advancements in predicting crashes and estimating reductions from counter-measures. Its primary focus is introduction and development of analysis tools for predicting impacts of transportation projects and decisions on road safety.	Inputs: Crash data, roadway characteristic data, traffic volume data Outputs: Statewide network screening, diagnosis, counter-measure identification, economic appraisal, project prioritization and evaluation Scale: Network, corridor, study area, region	The tool identifies alternatives that are preferred safety solution. Scenario planning identifies safety patterns in the region and establishes priorities for safety expenditures.	Challenges include resources, lack of data, and analytical capabilities. Resources to improve data for all public roads and training in data and analysis will help combat these challenges.
Integration of Safety in the Project Development Process and Beyond: A Context Sensitive Approach - Chapter 4 (P, I)	This report conveys a common understanding of and approach to how substantive safety, or performance-based safety, should be integrated into project development and throughout the project life cycle.	Inputs: Crash data, roadway characteristic data, traffic volume data, SHSPs, HSP, and TMPs Outputs: Project evaluation, alternative analysis Scale: Project, network, corridor, study area, region	Provides information that helps planners and other stakeholders incorporate safety quantitatively with flexibility in design when considering the community context. Scenario planning identifies safety as a pressing concern to which the agency should dedicate more funding, while also providing information about the context in which the	Challenges include resources, analysis capabilities and local roadway and volume data availability. Training and technical assistance will help combat these challenges.

			improvements would be made.	
TSP eHandbook (All)	Provides State DOT and MPOs with a framework for navigating the fundamentals and advanced methods of safety data collection and analysis; demonstrates how the results of that analysis can be applied to PBPP to develop safety goals, objectives, performance measures and targets; identify and prioritize projects; and evaluate progress towards safety priorities.	Inputs: Safety data: crash data, roadway characteristic data, traffic volume data, and safety information from public/stakeholder input Outputs: Identification of safety projects eligible for HSIP funds; set of safety evaluation criteria for transportation projects Scale: All	The tool provides performance metrics to evaluate scenarios; could be used to compare safety-related outcomes among scenarios. Scenario planning provides additional metrics related to safety, to inform project evaluation.	The tool is focused only on highway safety. It could be used alongside a more robust scenario planning tool to add an additional dimension to project/plan evaluation.
National Bridge Investment Analysis System (NBIAS) (P)	NBIAS, like HERS, is used to determine relationships between investment levels and performance measures. It produces the results, useful for target setting, by relating investments for bridges to outcomes. It evaluates bridge investment needs and the impacts on bridges of alternative investment levels using data from the NBI. NBIAS calculates user cost impacts of all potential improvements and provides programs of investments based on budget levels and on the B/C analysis of potential improvements. NBIAS provides future forecasts of the same bridge condition data items as in the current year NBI data. NBIAS can be	Inputs: Bridge inventory (from NBI); deck, super-structure, and substructure condition; element level data can be imported or predicted from a set of synthesis, quantity, and conditions (SQC) models; other data: cost data reported to FHWA, element models derived from state data, user cost parameters from HERS Outputs: Determines 20 year cost scenarios for highways bridges for two scenarios: maintain conditions and performance and improve conditions and performance Scale: All	The tool can be used to prioritize funding for necessary bridge infrastructure improvement. Scenario planning allows for varying funding scenarios to be considered to determine optimal investment levels.	The tool is specific to bridges only.

	used to evaluate investment needs and the impacts on bridges of alternative levels of investment, using the data from NBI.			
Transportation and Health Tool (A)	Provides access to data that practitioners can use to examine health impacts of transportation systems; uses 14 indicators relating to transportation and public health.	Inputs: Geographic area of interest Outputs: Data reported for 14 health/transportation indicators reported at the state, MSA, or UZA-level Scale: State, MSA, UZA	The tool could provide additional performance metrics for long-term program/project evaluation. Scenario planning could provide a basis for consideration of transportation-related health goals or objectives.	This tool does not allow for the consideration of additional scenarios, it only reports "what is."
BCA.Net (A, P, I)	Web-based decision support tool that assists Federal, State, and local authority decisionmakers in evaluating the benefits and costs of highway projects; forecasts transportation and non-transportation effects of highway investments and maintenance strategies, and estimates the economic value of these effects over the useful life of projects in dollar terms	Inputs: Benefits including: travel time; vehicle costs; safety; emissions; induced travel; reliability, noise, construction impacts, habitat and water quality, economic effects, community impacts, parking costs, equity and option value benefits. Costs include: initial costs, continuing costs, rehab costs, end of project costs Outputs: B-C ratio; net present value; cost effectiveness; internal rate of return; payback period; graphical representations Scale: All	The tool can help determine if a project should be undertaken; can compare various transportation improvement options/scenarios; and can help establish project priorities. Scenario planning can provide alternatives for BCA analysis.	The tool requires detailed data on benefits (some which are difficult to monetize) and costs
TERM-lite (A, P, I)	TERM-lite is an analysis tool that helps transit agencies assess their SGR backlog, level of investments to attain SGR, and the impact of funding changes on asset conditions and investment needs. It simulates long term impacts of constrained funding on the priorities of asset condition, safety,	Inputs: Inventory of capital assets Outputs: Current SGR backlog; assets conditions; multi-criteria prioritization rankings (based on agency goals); long-term SGR plan Scale: Regional, local	The tool can be used to prioritize limited investment funds and assess the impact of investment on future conditions. Scenario planning can provide alternatives and help prioritize projects/investment packages.	The tool is limited to transit capital assets and is only useful at the local or regional scale.

	security, reliability, and O&M cost impact.			
SHRP2 - Guide to Establishing Monitoring Programs for Travel-Time Reliability (LO2) (D, A)	This guide helps users design systems and methods for gathering data related to travel time reliability. This data can then be used to establish a baseline condition and identify areas in need of improvements.	Inputs: Nonrecurring factors of congest-ion incl.: incidents, weather, work zones, fluctuations in demand, special events, traffic control devices, and inadequate base capacity Outputs: Estimated travel time reliability Scale: Freeways, toll roads, urban arterials	The tool can be used to establish a baseline travel time reliability condition and identify area where improvements can be made. Through scenario planning, a varied combinations of improvements can be tested to understand where investments will have the greatest impact on travel time reliability.	The tool requires inputs of specialized data that may be difficult to collect.
SHRP2 - Handbook for Incorporating Reliability Performance Measures into Transportation Planning and Programming (LO5) (A, P)	The handbook helps DOTs and MPOs better-integrate reliability data into their planning and programming in order to improve transportation-related decisionmaking	Inputs: Travel time reliability data Outputs: Programming decisions that consider travel time reliability Scale: Freeways, toll roads, urban arterials	The tool helps ensure that a robust set of factors are included when making decisions. Differing travel time reliability scenarios can be used to evaluate decisions.	Specialized data and tools (above and beyond those needed for scenario planning) are required to effectively incorporate reliability into the planning and programming process.
SHRP2 – Reliability by Design (LO7) (P, I)	This guidebook is designed to assist users with choosing and implementing highway design interventions to mitigate travel-time reliability problem areas	Inputs: Non-recurring congest-ion and travel time reliability data Outputs: Highway design treatments that may reduce congestion and improve travel time reliability Scale: Urban and rural freeways	New highway design treatments could inform the development of different scenarios to be assessed. The potential impacts of highway design interventions can be assessed to help inform investment in infrastructure.	The tool requires existing data on nonrecurring congestion and travel time reliability in order identify problem areas.
SHRP2 - Incorporating Travel-Time Reliability into the Highway Capacity Manual (LO8) (A)	This publication presents "a new analytical procedure which enables planners and engineers to estimate travel-time reliability performance measures."	Inputs: Travel times, ideally over a one-year period Outputs: Travel-time reliability statistics Scale: Corridor (major freeways and urban arterials)	Incorporating travel time reliability will help assure robust scenarios for consideration. Proposed changes/ investments can be incorporated to model impacts on travel time reliability.	The tool requires complex data, time, and resources to implement.

SHRP2 - Tools for Assessing Wider Economic Benefits of Transportation (C11) (A, P)	A suite of analysis tools used to assess a highway project's potential economic impact.	Inputs: Proposed highway project Outputs: Regional economic impact Scale: Unknown	The tool can provide economic impact data to help inform scenarios. Differing scenarios can be compared to determine which scenario results in the greatest economic impact.	
Eco-Logical (P, I)	9-step process that: organizes current methods for natural resource identification, avoidance, minimization and mitigation related to infrastructure impacts through integrated planning; builds relationships; and uses performance metrics.	Inputs: Vary Outputs: Vary Scale: All	The tool could provide an identification of an agreed upon priority of conservation areas, potential mitigation measure, and performance metrics. Scenario planning allows for expedited alternative analysis.	Challenges include agency collaboration, data sharing and data management. Identifying stakeholders to be responsible for central data storage and management will help combat these challenges.
Travel Demand Models (All)	A common tool used to estimate existing and future origin-destination (OD) demands at the county/regional scale. Oriented towards auto trips and roadways, provides detailed information to help identify needs and performance against common mobility factors. Relies on experienced travel demand forecasting professionals and generates transportation needs based on socioeconomic data.	Inputs: Highway and transit network; zone-to-zone travel times, costs, etc.; land use data. Outputs: Trip generation Trip distribution Mode choice Trip assignment Congestion Freight Traffic Scale: County/region	When combined with use of land use and sketch scenario planning models, it helps identify different travel demand/ transportation needs for different scenarios to identify roadway capacity needs. It can demonstrate how different scenarios perform against indicators such as congestion. In a PBPP approach, an agency uses the model to identify projects that will perform best regardless of future changes. Using scenarios can tie into risk-based asset management planning as well.	Analysis with standard tools, such as a travel-demand model, is more complex and may require a higher level of resource investment to conduct a meaningful exercise.
Simplified Trips-on-Project Software (STOPS) (A, P)	Intensive transit travel demand model, STOPS helps transportation practitioners identify and evaluate transit project investments based on New Starts and Small Starts project criteria.	Inputs: Census data, regional travel model data and current GTFS data from individual metro areas. Outputs: Transit ridership (trips-on-project measure) for all travelers and for transit dependent. Change in auto-mobile VMT	When combined with other land use or sketch scenario planning tools, it can help identify specific transit needs associated with different scenarios. It can also test out transit ridership associated with different land use and investment decisions. If agency is	Similar to the travel demand model, the tool requires detailed socio-economic and specific transit investments to be well defined.

		based on the change in overall transit ridership between scenarios. Scale: Region	targeting a mode split or level of ridership at the corridor or system level, it can evaluate different transit investment to achieve goals.	
MOtor Vehicle Emission Simulator (MOVES) (A, P, I)	Motor Vehicle Emission Simulator - emission modeling system that estimates total emissions & energy use from all on-road sources (cars, trucks, buses, motorcycles) at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics.	Inputs: Meteorology, fuel, I/M program, age distribution, speed distribution, VMT by vehicle type, road type distribution, ramp fraction, VMT by hour, day, and month, vehicle (source type) population Outputs: Total emission inventory in units of mass (g, kg, lbs., tons) and emission rates per mile or vehicle of criteria pollutants, green-house gases, and air toxics including NOx, VOC, and PM for time and place specified Scale: National, county, and project by hour, day (weekday or weekend), month, or year	The tool is useful in testing how different transportation investment strategies impact existing levels of emissions and air pollutants. If scenario planning exercises are driven by goals for emission or air pollutant reduction, MOVES model can help evaluate most effective set of strategies.	The tool could eventually include other mobile sources (e.g., non-road, marine, locomotive, aviation sources).

Scenario Planning Tools

Please note: FHWA does not endorse the use of any specific private sector tools or models. The purpose of this table is solely to provide information about the capabilities and relevant uses of available tools.

Scenario Planning Tool (and Applicable PBPP Phase)[11]	General Description/ Purpose	Inputs, Outputs, and Scale[12]	How does or could the tool inform PBPP and vice versa?	PBPP-SP Tool Relationship Challenges and Information/Suggestions for Addressing Challenges[13]
CommunityViz (D)	A land use scenario sketch-planning tool, usually used to develop regional long range visions.	Inputs: Existing development, local land use plans, environmental features, etc. Criteria selected from pre-established set contained within tool. Outputs: Alternative land development patterns, associated impacts on selected criteria Scale: Region	Provides a basis for a long range vision & policies. It provides new evaluation criteria to be applied to the analysis, programming, and/or implementation phases. Travel demand model data can build a baseline and initial forecasts. Existing policy priorities can help to identify appropriate evaluation criteria and weights.	A primary challenge is that CV data scale/ polygons may not match up with travel demand model or other datasets used for planning process. A potential solution is to integrate/match up existing local data sources with CV data when creating base data for the scenario process.
INDEX (D, A)	A tool that simulates impacts associated with land-use and transportation scenarios.	Inputs: ESRI ArcView shapefiles with transportation system attributes, socioeconomic and land-use data. Outputs: 56 indicators: land consumption; housing and employment density; proximity to transit; emissions. Outputs expressed as tables and maps showing performance of each sketch; indicators expressed per unit (e.g. persons/sq. mile, vehicle trips/capita, auto cost in $/ capita). Indicators can be displayed according to the zone (input) geography defined by the user and compared across alternatives. Scale: All	The tool helps establish direction (vision) by clearly illustrating impacts for difference scenarios. It could also help identify new measures to carry through to programming and evaluation phases. PBPP could help the user cull the 56 indicators and select those most important.	It is unclear if the tool provides rigorous quantitative tools needed to compare projects, which are critical for the programming phase.

[11] The applicable PBPP phases are: direction (D), analysis (A), programming (P), implementation (I), or all.
[12] Scale could be project, corridor, study area, region, etc.
[13] Challenges include: data/scale compatibility, ability to forecast, quantitative/qualitative, etc.

Rapid Policy Analysis Tool (RPAT) (D)	This tool, formerly known as SmartGAP, can be used by planners to evaluate smart growth policies on travel demand. It is a fairly simply model that is not intended to evaluate the cost and benefits of specific projects. However, it can be useful at the visioning and direction-setting phase to identify promising smart growth policies and investments.	Inputs: Pop. And employment by place type; daily auto and transit trips per capita; VMT by functional class; employment and number of firms; expected future employment growth; base and future population by age; base and future avg. per capita income; truck and bus VMT by functional class; lane miles and transit revenue miles; % growth by place type; % increase in auto operating cost; % increase in lane miles and transit revenue miles per capita; % of employees offered commute options; % road miles with ITS treatment; auto operating surcharge per VMT; bicycle ownership and usage; increase in parking cost and supply. Outputs: VMT; vehicle and transit trips; avg. travel speeds by vehicle type; delay; fuel use; emissions; infrastructure costs; transit operating costs; annual traveler cost; regional accessibility; accident rates; walking increase; job accessibility by income group. Scale: All	The tool can help with scoping and bounding. A scenario writing exercise is needed to scope the analysis.	A set of input elasticities and other parameters are needed for the analysis. Some of this can be derived from travel models; the remaining parameters need to be established from direct sources (BLS, DMV, et al)
Regional Eco-system Framework (Eco-Logical) (D, A, P)	A process for overlaying transportation infrastructure on regional natural and cultural resources to identify priority areas for conservation, avoidance, and mitigation. This is a useful process for evaluating different plans and scenarios and understanding how they may affect natural resources.	Inputs: Natural resource data, cultural resource data, transportation infrastructure, land cover. Outputs: Map of ecological priorities (and intersections with transportation infrastructure). Scale: Region	The tool could provide different versions of the map, showing how ecological priorities would change based on different ecological inputs or transportation build-out scenarios. PBPP could provide a basis for new types of data to be included in REF (sea-level rise, high-development with more land developed).	

Energy and Emissions Reduction Policy Analysis Tool (EERPAT) (D, A)	Planners can use this high-level scenario analysis tool to evaluate effects of various GHG emissions reduction strategies at the statewide level. It includes sub-models addressing household characteristics, travel demand, fuel economy, electric vehicles, energy consumption, and tailpipe / electricity CO2 emissions. It can evaluate GHG reduction strategies and strategy interactions not directly addressed by conventional travel demand and emissions models. It may not be not suitable for evaluating effects of projects.	Inputs: Transportation system characteristics, population, VMT, etc. Outputs: GHG emissions, vehicle miles traveled, travel delay, and other measures. Scale: State	The tool is helpful in the direction-setting phase for states looking to reduce GHG.	The tool is developed for the State scale, limiting its application in scenario planning, which has most often been conducted at regional scales.
Community Vision Metrics (All)	This FHWA-developed tool helps planners identify performance measures relevant to their context and goals. It provides a customized list of metrics but does not provide information about how to calculate the measures or identify data sources.	Inputs: Check boxes for livability area of interest, geographic scale, setting/density, and transportation mode. Outputs: List of applicable performance measures. Scale: All	The tool can help in the identification of performance measures. PBPP influences the tool by setting parameters for areas of interest, geographic scale, setting/density, and transportation mode.	The output is simply a list of measures without instruction on methods or data resources.
Sustainable Communities Index (All)	Similar to Community Vision Metrics, however, this tool provides more robust information on methods for calculating the metrics and identifying data resources.	Inputs: Lists topics and the user can drill down in various topics to find measures and information on how to calculate the measures and data resources. Outputs: List of applicable performance measures. Scale: All	The tool can help in the identification of performance measures.	The output is simply list of measures with some instruction on methods and data resources.

UrbanSim (D, A, I)	This program is a complex and powerful modeling platform available to simulate metro real estate markets and impacts of land use and transportation plans. Used to predict behaviors or interaction within a network or system to illustrate the cause and effect of different scenario variables relatives to environmental, transportation, economic, and development goals. Can be used in conjunction with activity-based travel models to analyze alternatives and explore strategies to achieve target outcomes. It's a free, open source program but may require technical assistance to use.	Inputs: Transit investments, roadway improvements by type, pricing strategies, TDM/ bike-sharing; comp. plans, zoning codes, parking availability and pricing, TOD, urban villages and centers, subsidies, impact fees, Financing, UGBs, protection of environmentally sensitive areas Outputs: Housing Units by type, density, price (affordability), Non-residential buildings by type, density, price, Acreage in agricultural land, forest, open space, households by income, size, life cycle, employment by sector and building type; transportation accessibility, mode shares, VMT, delay, emissions Scale: All	The tool has a wide array of outputs, many of which are consistent with common PMs, making it relatively easy to address common PMs and new PMs simultaneously. The tool is useful in the direction-setting phase to help illustrate issues and opportunities of different land use, real estate, housing, and transportation investments or policies. Key metrics can be incorporated into later phases of PBPP. Travel demand model data could help to build baseline and initial forecasts. Existing policy priorities can help to identify appropriate evaluation criteria and weights.	The tool uses a python-based programming language, which has a steep learning curve
Envision Tomorrow (D, A)	A set of urban and regional planning tools that can be used to model development feasibility on a site-by-site basis as well as create and evaluate multiple land use scenarios, test and refine transportation plans, produce small-area concept plans, and model complex regional issues	Inputs: Unknown Outputs: Infill development or redev., cost of infrastructure, building value and revenue, housing mix, affordability, parking costs, jobs-to-housing ratio, distribution and employment space, connectivity, land cover and availability, impervious cover in special areas (e.g. aquifers), water, wastewater, energy consumption, enhanced ROI, building energy consumption Scale: All	The tool is built to produce a set of indicators that the creators recommend be monitored for performance over time. Existing performance measures could inform the set of indicators that are evaluated by the tool.	The tool requires ArcGIS and Network Analyst, an extension of ArcGIS.

UrbanFootprint (D, A)	UrbanFootprint gives users access to land use, policy, and resource planning tools across a range of sectors. Its detailed data 'canvas' of existing buildings, land uses, and other details of the built environment, combined with functionality for testing the application of land use or policy changes, serves to inform policy, planning, and funding decisions and aid in implementation and monitoring.	Inputs: Data from ArcGIS-based systems. Outputs: Carbon emissions, travel behavior, pollution, energy and water use, fiscal and cost consequences, public health impacts, land consumption and conservation impacts, housing mix and affordability Scale: Local to Regional - but seems best suited for regional work	Useful in the direction and analysis phases of PBPP to identify values and driving issues. Useful for developing and accessing integrated land use and transportation policies against performance metrics that can be folded into later phases of PBPP. Travel demand model data can help build baseline and initial forecasts. Existing policy priorities can help to identify appropriate evaluation criteria and weights.	
iPlaces^{3}S (D, A, I)	Web-based modeling platform for scenario planning currently managed by SACOG. Evaluates how alternative development approaches or transportation investments may impact indicators. Developed by the CA Energy Commission (CEC), the CA Dept. of Transportation and the U.S. Dept. of Energy. Private company provides programming, maintenance and web hosting. Internet-based, so no specialized hardware or software is required.	Inputs: Interactive menus prompt input on some key regional variables (like VMT, for example), and other data is uploaded in shapefile form. Common shapefiles include parcel-level land use, transportation and energy use data. Outputs: Employees, dwelling units, population, water consumption, jobs by sector, vehicle trips per household, vehicle miles traveled per household, transit ridership, pedestrian friendliness, pedestrian and bike trips, electricity / natural gas / gasoline demand, ROI Scale: All		The tool was originally meant to be open source, but not widely distributed or supported.
UPlan (P)	Companion to iPLACES3S; can be used to determine what policy types are needed to implement the vision from that program. Software runs in ArcGIS and is available at no cost online. It is available through UC-Davis.			
PECAS (A)	PECAS is a spatial economic input-output model supporting the MEPLAN and TRANUS systems. PECAS assesses two	Inputs: Industry, government, household data. Outputs: Activity allocations by activity category by zone, commodity flow		

	components of planning to model economic flows-"space" (including both land and floor space), and "activity allocation."	quantities from production zone to consumption zone via exchange zone, imports and exports by exchange zone and exchange prices by commodity by exchange zone. Scale: State, Region		
PlanWorks Visioning and Transportation Application (D)	This Application includes a model approach, a step-by-step process, case studies, and a guide for generating consensus and shared outcomes for transportation projects. Intended to help practitioners assess the possibilities of visioning, in identifying steps when engaging in visioning, and in establishing links between outcomes and transportation planning and project development processes.	Inputs: Not applicable. This is a guide that details the steps in a visioning process, organizing the timeline and providing answers to frequently asked questions. Outputs: Not applicable. This is a guide that details the steps in a visioning process, organizing the timeline and providing answers to frequently asked questions. Scale: All	The tool is a viable template for the visioning stage, so it can be incorporated into the direction component.	The tool is solely qualitative, helping to guide stakeholder discussions rather than inform decisionmaking.
RapidFire (All)	RapidFire is a spreadsheet-based tool that is a companion to Urban Footprint. It is used to evaluate scenarios at the national, state, regional, and local scales. It constitutes a single framework into which data and research-based assumptions about the future are loaded to test the impacts of varying land use patterns and policies across a range of critical metrics.	Inputs: Demographic projections, travel behavior projections, technical factors for fuel and energy emissions, residential/commercial development allocation assumptions. Outputs: Land consumption Transportation costs/emissions/VMT Public health costs Water, energy use Fiscal impacts. Scale: City, county, region, state.	Useful in the direction and analysis phases of PBPP to identify community values and driving issues; develop and assess integrated land use and transportation policies against key performance metrics that can be folded into later phases of the PBPP process. PBPP should form the basis for all data inputs, projects, and performance measures.	The tool likely requires technical assistance to use to its full potential, or a significant learning curve is needed to incorporate new users.
CrowdGauge (D)	Scenario visioning tool available as open source software. Participants walk through series of screens exploring their personal priorities for their community, the potential impacts of proposed plan elements on	Inputs: Citizen voting on predetermined categories. Outputs: Unknown Scale: All	The tool is used visioning or as a means of gaining public support for priorities after the analysis phase. The tool helps visualize the tradeoffs in costs and benefits of proposed projects and policies, so the tool	The tool is not a forecasting or analysis tool.

	their priorities, and the impacts of their budget choices on their previously-stated priorities.		can have potential project costs and benefits stemming from the analysis phase added as inputs.	
MetroQuest (D, P)	Public participation platform that works on kiosks, tablets, and smartphones. Versatile interfaces that allow voting, ranking, mapping, and other types of inputs. It has a tool to detect and negate ballot-stuffing. Offers cloud-based data storage.	Inputs: Citizens can add comments to maps, rank priorities, answer survey questions, allocate money. Outputs: Unknown Scale: All, but best suited for corridor or study area.	The tool is useful at all stages of scenario planning and PBPP. Can be used to understand preferences or to gain input on specific projects, which is useful in the programming stage.	The tool is not a forecasting or analysis tool.
CityEngine (D, A, P)	An ESRI visualization tool that creates a 3D model of the city. This tool can be integrated with ArcGIS and used to compare land use planning scenarios, or to perform simple network analysis.	Inputs: GIS files, python scripts, drawing, Open Street Map, zoning rules. Outputs: 3D models, maps, reports based on scenario comparison, network and shadow analysis, viewsheds, traffic impact analysis. Scale: All	Useful for evaluating design aspects of projects, stakeholder engagement, and scenario planning for programming phase. PBPP should form basis for all data inputs, projects, and performance measures.	
UrbanCanvas (D, A, P)	Similar to CityEngine, but integrated with UrbanSim. Provides 3D visualization and scenario comparisons but with lower analytical capability than CityEngine. Some components it lacks may be available through UrbanSim.	Inputs: Parcels, buildings, zoning, projects. Uses .shp format. Outputs: 3D models, simulations, maps, graphs. Scale: All	The tool is useful for evaluating design aspects of projects, stakeholder engagement, and scenario planning for programming phase. PBPP should form the basis for all data inputs, projects, and performance measures.	The tool only accepts polygon files, so it may not be useful for transportation projects. The tool should only be used in conjunction with UrbanSim.
CubeLand (A, P)	Part of Cube modeling software, Cube Land forecasts land use and land price by simulating the real estate market under different economic conditions. For a user-defined scenario, Cube Land forecasts the supply and the demand for different types of properties, and estimates the location of households and non-residential activities.	Inputs: Regulation specifics. Jobs and households. Land supply. Outputs: Uses bid rent functions to test economic growth scenarios. Scale: Region	The tool could help determine the economic ramifications of land use policies. PBPP could influence the projects selected for use in the tool.	It is unclear as to the validity of the forecasting methodology, but the details are publicly available, so the tool can be vetted.

EngagingPlans (D)	An online portal to share progress and gather public input online for a successful engagement strategy with community members.	Inputs: Idea wall; discussion & comments; surveys, polls, instant results. Outputs: Updates, event timeline, document library, FAQs, email subscription, social media links, image gallery. Scale: All	The tool helps stakeholders engage in strategic thinking and decisionmaking activities. PBPP can be used to collect data form users and inform goals, objectives, and priorities.	The tool is unlikely to reach a representative audience or collect useful data. Feedback is qualitative. It is best to use it for engaging participants and keeping them informed, but not for collecting data or forecasting trends.

Appendix C. Case Studies

Synthesis and Comparative Table of Case Studies

	Champaign-Urbana Urbanized Area Transportation Study	Fresno Council of Governments	Hillsborough County MPO
Context			
Population	145,400 (2010 Census)	965,974 (2014 estimate)	1,291,600 (2013 estimate)
Character of study area	Smaller metropolitan area, university town with well-educated workforce	Lower income, high unemployment; high Hispanic population, agricultural	Large metropolitan area
Power distribution	Dominant core area	Dominant major city	Multiple cities and MPOs
Number of jurisdictions	5	16	4
Motivation for Scenario Planning	Help the public understand the benefits that can be achieved by pursuing a more sustainable scenario	Compliance with Senate Bill 375 and Sustainable Communities Strategy requirement	Considering how the county should grow (rapid growth already occurring)
Scenarios			
Number	2	4	3 for each approach used in the Imagine 2040 LRTP
Nature of scenarios	Status quo/business as usual vs. sustainable choices (high level of investment in transit and bike/pedestrian infrastructure)	Status quo; metro less dominant; local plans; more growth, Corridors and centers; redevelopment and higher densities	Status quo (Suburban Dream), increased density and mix of uses (Bustling Metro), and focus on job centers (New Corporate Centers). For the investment scenarios: High, Medium, and Low levels of investment.
Models used	Travel demand model, land use model	4-step travel demand model	Regional 4-step travel demand model and REMI econometric modeling tool (storm surge vulnerability analysis)
Tools used	SCALDS, MOVES, LAMA, HIA	RapidFire, Envision Tomorrow	MetroQuest and social media (public outreach), GIS (for level of service),
Number indicators	74 in 2040 long range plan; 22 in latest annual report card	40 reduced to 10	31 (analysis), 13 (visioning approach), 3 (investment approach)
Nature of indicators	Multi-disciplinary	Transportation and land use including prime farmland; smart growth oriented (TOD, Density, multi-	Multi-disciplinary and transportation-oriented

		modal)	
Range of variance among scenarios	Selection of two highly differentiated scenarios led to relatively significant variation (in relation to the region's relatively small size)	Relatively minor	Significant difference between arrangement of land uses and transportation networks and significant differences in funding levels
Implementation	The region continues to focus its investments on key projects identified in the current and previous LRTP, as well as heavy investment in the regional bicycle and pedestrian network.	Selected scenario reflects all existing land use and transportation plans; region is investing in significant transit improvements in the core area.	To be determined. The biggest challenge according to the MPO is implementing through the TIP.
Special features			Consideration of a hypothetical hurricane that follows the path and is the same strength as a hurricane that struck in 1921
Relation to PBPP			
Nature of PBPP work	Extensive use of performance measures throughout plans and processes; annual report card published.	Target setting on GHG emissions	Extensive use of performance measures to evaluate land use and transportation scenarios. Use of scenarios during analysis phase to compare performance under different funding levels and priorities.
Impact of scenario work on PBPP	Helped agency understand performance implications of scenarios	Helped agency understand performance implications of scenarios	The land use/transportation scenarios supported the development of goals and objectives. The approach to investment scenarios supported the selection of priorities by the MPO.

Champaign-Urbana Urbanized Area Transportation Study

The Champaign-Urbana Urbanized Area Transportation Study (CUUATS) is the transportation division of the Champaign County Regional Planning Commission (CCRPC)—the region's MPO. The Champaign-Urbana (C-U) area is located in Central Illinois, 2-3 hours' drive south of Chicago and about two hours' drive west of Indianapolis. The CUUATS Policy Committee has representatives from Champaign County, the Cities of Champaign and Urbana, the Village of Savoy, the University of Illinois-Urbana Champaign (UIUC), the Champaign-Urbana Mass Transit District (C-U MTD) and the State of Illinois.

The Champaign-Urbana area had 145,361 residents at the time of the 2010 Census, while the region's MSA was home to 231,891 residents. Between 2000 and 2010, the urbanized area saw a 17.3 percent increase in population, and the population is projected to increase by approximately 30 percent between 2010 and 2040. The Champaign-Urbana area is a regional employment center because of the presence of educational, health care, and manufacturing employers in the area, particularly UIUC. With a student body of nearly 45,000, the University serves as the region's economic and cultural center.

Public policies and investments to promote more efficient land use and development patterns seem to be taking hold in the urban area. While the population and employment opportunities have continued to grow since 1990, population and residential density have leveled off and increased, respectively, in the last five years. The proportion of commuters who bike, walk, or take transit to get to work is 22 percent, which is higher than the rate in many peer regions. Between 2009 and 2014, the region increased its mileage of bicycle facilities by over 60 percent. Over the same period, carsharing use and Amtrak ridership increased, while vehicle ownership decreased.

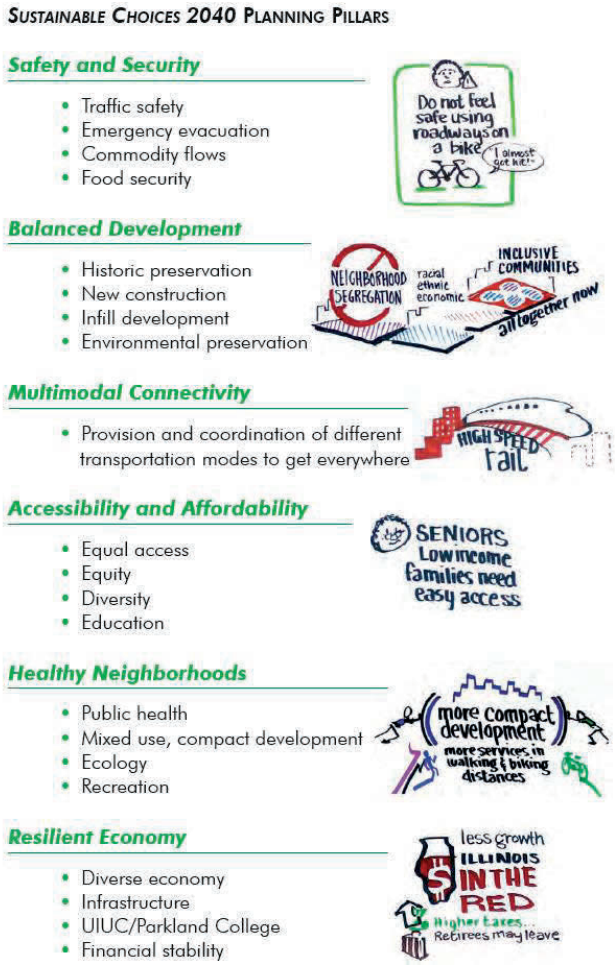
PBPP EXPERIENCE

CUUATS' use of performance measures and targets, performance monitoring, and data-driven decisionmaking has been profiled in various FHWA publications, including the *PBPP Guidebook* and *Model Long Range Transportation Plans Guidebook*. Since 2004, CUUATS has used Measures of Effectiveness (MOEs) to monitor progress toward specific goals and objectives. Since 2011, the agency has published an annual Report Card to demonstrate how the region is doing on the objectives and measures identified in the long range plan. This requires the agency regularly to take stock of how well the region is doing, as well as identify areas in which performance has not been as strong. The most recent annual report provided performance results for 22 MOEs. The annual report is an effective tool for informing member agencies and elected officials about progress that has been made and the direction in which the region is moving. In turn, many elected officials reference the report in their discussions with community members, and a few local governments in the C-U region, such as the City of Champaign, have begun to use report cards to track their performance as well.

In December 2014, CCRPC approved the long range transportation plan for the Champaign-Urbana Urbanized Area, Sustainable Choices 2040. The agency's previous plan, from 2009, was LRTP 2035: Choices. The agency first set performance targets in its 2035 Plan; these targets varied

between realistic and aspirational targets, depending in part on the availability of data. The goals and objectives in the 2040 plan were formulated based on a public input along with MAP-21 priorities, State transportation policy factors, local knowledge, and current local planning efforts. The Sustainable Choices 2040 plan groups performance goals according to the following six "planning pillars," each of which is clearly aligned in the plan with Federal, State and regional goals (shown in Figure C-1):

Figure C-1: Sustainable Choices 2040 Planning Pillars



Each planning pillar is divided into a number of Specific, Measurable, Agreed upon, Realistic, and Time-bound (SMART) objectives (between 5 and 15), and each objective is tied to a performance measure and data source. Multiple strategies are identified in the plan for accomplishing each objective, as well as the party responsible for leading implementation of each strategy.

The Sustainable Choices 2040 plan contains 59 objectives and 74 performance measures. They include a mixture of both outcome and output measures, and are discussed in more depth below in

the context of their alignment with the performance measures CUUATS used to evaluate its scenarios.

As described below in the Scenario Analysis Tools section, CUUATS uses a variety of tools and data sources for measuring performance on each LRTP objective. Most of the modeling data is generated by CUUATS or by local and regional agencies (e.g., transit service providers, local governments, school districts).

SCENARIO PLANNING EXPERIENCE

CUUATS used scenario analysis processes in developing two previous long range plans, which were finalized in in 2004 (LRTP 2025) and 2009 (Choices 2035). For LRTP 2025, CUUATS considered 15 scenarios in all. First, CUUATS developed three scenarios that varied in terms of the projects and land use developments expected. Scenario 1 reflected transportation projects and land use developments already in the pipeline for implementation during the 20-year plan horizon; Scenario 2 was similar to Scenario 1 but also included additional developments and introduced an "enhanced arterial fringe road concept," which would create a higher-speed, limited access corridor around the urbanized area; and Scenario 3 was similar to Scenario 2 but included the enhanced arterial fringe roadway system with specific study areas (i.e., corridor studies to determine the exact route of the system, whereas the route was assumed in Scenario 2). In addition, CUUATS initially considered three land use and transit service "alternatives" (i.e., scenarios—Alternatives A, B, and C), which ranged from dispersed development patterns (the status quo) to compact, activity center-focused development.[14] CUUATS used indicators such as total vehicle miles traveled (VMT), roadway congestion, transit usage and ridership, housing near transit, population density, and infrastructure costs to evaluate combinations of the investment scenarios and land use alternatives. The scenarios were largely roadway-based (i.e., did not consider land use variations), which was due primarily to the limitations of the tools the agency used. CUUATS began developing its first travel demand model in 2000, which was used for the 2025 plan. The model used TranPlan and developing it required the agency to build its TAZs; staff did everything in-house. Because this process was the first in which the agency had a model to use, the member agencies wanted to test a variety of scenarios, which were generally developed based on questions raised by members, such as, "What if we expand [example] roadway?" Ultimately, the agency ended up evaluating five alternatives (rather than the initially planned three), which resulted in consideration of 15 scenarios. Another outcome of the 2025 Plan process was the identification of specific corridors needed to be studied in more depth to identify the most appropriate recommendations.

In the Choices 2035 plan process, CUUATS considered three different scenarios: a 2005 Base Year Scenario, a 2035 No Improvements Scenario, which assumed no changes to the network, and a 2035 Full Improvement Scenario, which reflected future conditions if all proposed improvements were made to the existing network. In essence, the scenario analysis process involved identifying how much proposed changes would improve future performance and conditions. A limitation to this analysis was the travel demand model's lack of accuracy as a mode choice model; mode choice

[14] Champaign-Urbana Urbanized Area Transportation Study, LRTP 2025, Appendix 6: Scenarios and Alternatives Information: http://www.ccrpc.org/transportation/pdf/LRTP/Appendix-6_Scenarios.pdf.

improvements to the model were not completed in time for this plan update, so the model that was used simply assigned 6-7 percent of all trips to transit (and none to biking or walking). For the first time, however, the agency's model did consider land use; the agency divided its set of Traffic Analysis Zones (TAZs) into smaller TAZs to achieve a higher level of accuracy. Scenario planning for the 2035 plan also took into consideration the local jurisdictions' comprehensive plan and other plan updates. The Choices 2035 plan compared scenarios based on population projections, VMT (total, per household, and per capita), vehicle hours traveled (VHT) (total, per household, and per capita), and total trips by both transit and auto.[15]

Following the 2035 plan development experience, CUUATS updated the agency's travel demand model (TDM) to incorporate active modes of transportation. The agency also developed additional models to complement the TDM outputs. Since 2004, CUUATS has completed five corridor studies, four of which used specific scenario techniques to develop scenarios to present to the public. The corridor studies ultimately informed recommendations about design to accommodate freight needs and alleviate the use of the interstate system for local trips. The corridor studies helped the agency reach an approach of "mobility around the city, and multimodalism in the community." The preferred scenarios that were identified in these corridor studies, as well as comments received through the corridor study processes, informed both the 2035 and 2040 plans.

To develop the Sustainable Choices 2040 Plan, CUUATS first conducted public outreach and initial modeling to develop goals and objectives. The agency's goal was to confirm that the agency had an accurate understanding of the changes most residents wanted to see in the community. CUUATS Sustainable Choices 2040 public outreach was extensive. The agency used social media, a website, videos (to explain what an MPO and a long range transportation are), newspaper ads, youth outreach events, surveys, four public visioning sessions, and a community conversations bus, which traveled to 29 different areas throughout the region, to engage the public to provide input for the plan.[16] A professor from UIUC served as a facilitator for the public visioning meetings, which helped to ensure a neutral presentation of information. A graphic artist created sketches throughout meetings to reflect the comments made by members of the public. CUUATS' heavy investment in thorough public engagement was made possible through additional funding provided by Illinois DOT and the donation of the community conversations bus by CU-MTD. In total, CUUATS received 1500 public comments from 35 public events and 23 agency presentations; the comments confirmed that the agency was moving in the right direction by continuing to follow the principles in the 2025 and 2035 plans.

[15] Choices 2035 Plan: http://www.ccrpc.org/transportation/lrtp2/Documents/Final%20Plan/Complete%20Plan.pdf (for the full list of indicators, see page 131 of the plan).
[16] Details available in Appendix A of the plan.

Figure C-2: Graphic Artist's Sketch of Public Input

The insights generated from this outreach and during the process of developing the Sustainable Choices 2040 scenario also led the agency to conclude that it was critical to define more broadly the role of transportation in achieving larger community goals and outcomes. According to the plan, "the transportation network is intricately tied to many other conditions in the community such as land-use, public health, the environment, and the economy. The overall built environment operates most effectively when all these different processes can work together to facilitate safe and efficient access and mobility from different points in the community to serve each of our daily needs."

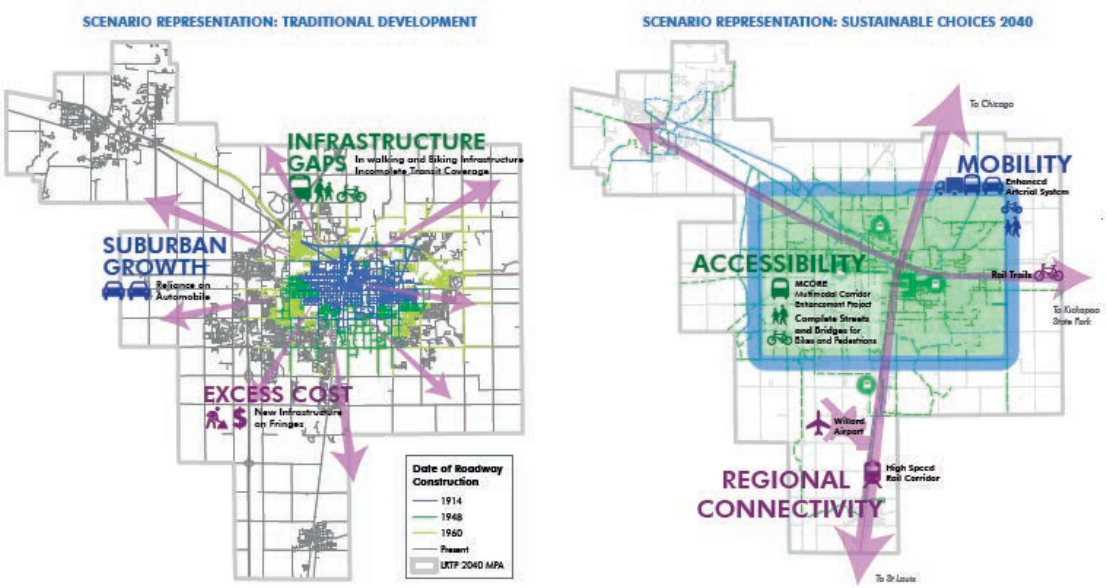
Based on public input, agency input, local plans, and existing data, CUUATS staff then developed and analyzed the scenarios. The scenario analysis was conducted after the majority of public input had been collected, to illustrate strategies and to explore potential impacts of future trends and events, rather than as an up-front visioning or goal-setting tool. To develop the scenarios, CUUATS identified performance in the year 2010 as the baseline scenario, against which the other two scenarios would be compared. The agency then developed two scenarios, Traditional Development and Sustainable Choices, each described and depicted (in Figure C-3) briefly below.

The **Traditional Development** scenario represented expected conditions based on historic system growth trends and patterns. It included development projects that are relatively certain to move forward based on plans and projects already approved from MPO member agencies.

The **Sustainable Choices** scenario was built to reflect ideas and input that CUUATS received from the public. It included several significantly different assumptions about transportation and land use compared to the traditional scenario: 1) a high speed rail corridor between Chicago and downtown Champaign would serve as a significant catalyst for growth in downtown Champaign, downtown

Urbana, the University Avenue corridor, the University Research Park, and industrial area around Olympian Drive; 2) an intensive transit corridor system linking downtown Urbana and Champaign; 3) increased density on and around University Avenue and Campustown, and 4) more frequent transit service on additional and existing routes.

Figure C-3: Visual Representations for Traditional Development and Sustainable Choices 2040 Scenarios



The comparison of the traditional development scenario to the sustainable choices scenario identifies the scenario that best represents the public's vision for the future while also identifying the forecasted outcomes under each scenario. The inclusion of the high-speed rail corridor project between Chicago and downtown Champaign adds an externally influenced component to the Sustainable Choices scenario.

The use of only two scenarios is not typical of MPO scenario planning processes, most of which involve three or more scenarios. CUUATS' approach was built upon lessons learned from previous scenario planning efforts of LRTP 2025 and Choices 2035, as well as scenario planning exercises conducted for four of the corridor studies completed between the LRTP 2025 and LRTP 2035. Also in a departure from typical practice, the scenarios were not labeled in a value-neutral manner. Rather than using objective titles like "A" and "B" or numbers, to avoid implying that one scenario is better than another, the Sustainable Choices 2040 scenario is an illustration of an ideal future envisioned by the public, which explains the use of an idealistic title for the multi-faceted scenario. The purpose of CUUATS' approach was to evaluate the feasibility and benefits of the public's preferred scenario, rather than to decide which of the two scenarios better represents the public's vision. CUUATS' decision to use only two scenarios was influenced by the fact that the public reached a remarkable consensus about the overall vision for the future, as well as by the agency's previous experience, which indicated that differences in performance are hard to measure in a small

region (fewer permutations of projects and plans also results in fewer scenarios). In addition to the public engagement activities discussed above, CUUATS consulted with other key agencies including the region's transit agency and Illinois DOT.

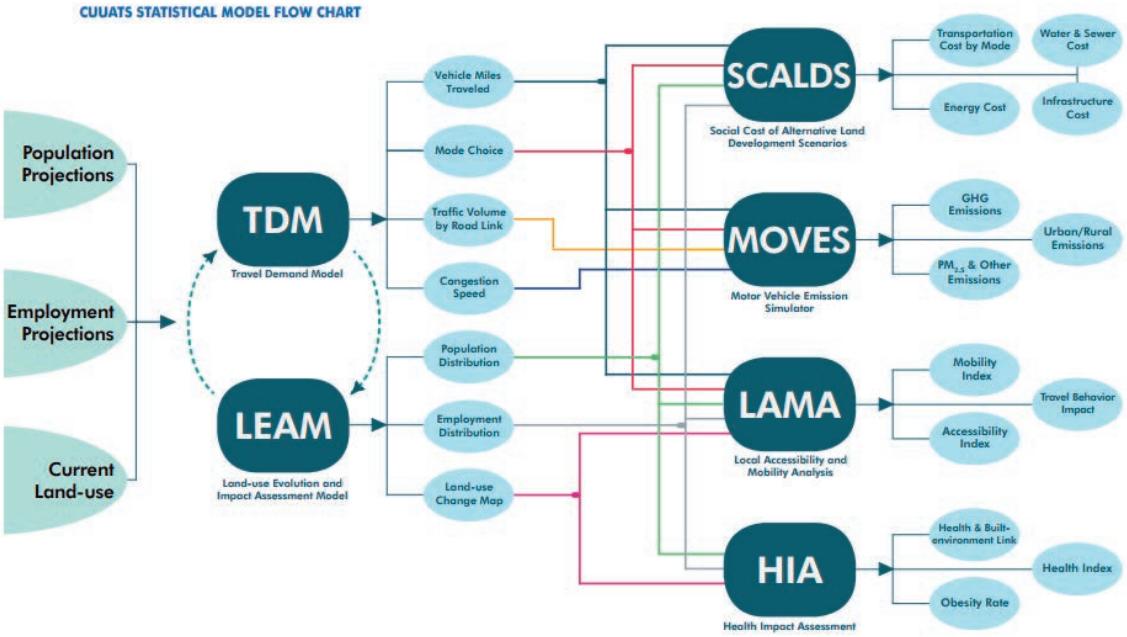
A notable component of the 2040 Sustainable Choices scenario was the incorporation of a high-speed (220 miles per hour) rail corridor running through Champaign-Urbana from Chicago to St. Louis. The high-speed rail corridor would have huge impacts on the region—reducing travel time to Chicago from 2.5-3 hours to 45 minutes, making C-U a possible bedroom community of Chicago and opening up Chicago-based job opportunities to C-U residents. Significantly, the rail line would enable frequent commutes between two major University of Illinois campuses. Through the 2040 plan public engagement, CUUATS found that the overwhelming majority of area residents want the high-speed rail line, and are actively campaigning for a route that would serve the area. To understand the implications of the high-speed rail line for the area, CUUATS worked with a UIUC professor with expertise in high-speed rail in Taiwan, who conducted a feasibility study for the high-speed rail corridor.

SCENARIO ANALYSIS TOOLS

CUUATS uses travel demand modeling for long range plan development as well as corridor and other studies. Since the development of the 2035 Plan, CUUATS has worked to refine its travel demand model to better account for active modes of transportation and better model interactions between land use and transportation, as well as the impacts of transportation on livability, social costs, greenhouse gas emissions, and public health. In developing Sustainable Choices 2040, CUUATS used four county-level models as well as two additional models to evaluate conditions at a localized (neighborhood) scale: The Health Impact Assessment (HIA) and Local Accessibility and Mobility Analysis (LAMA).

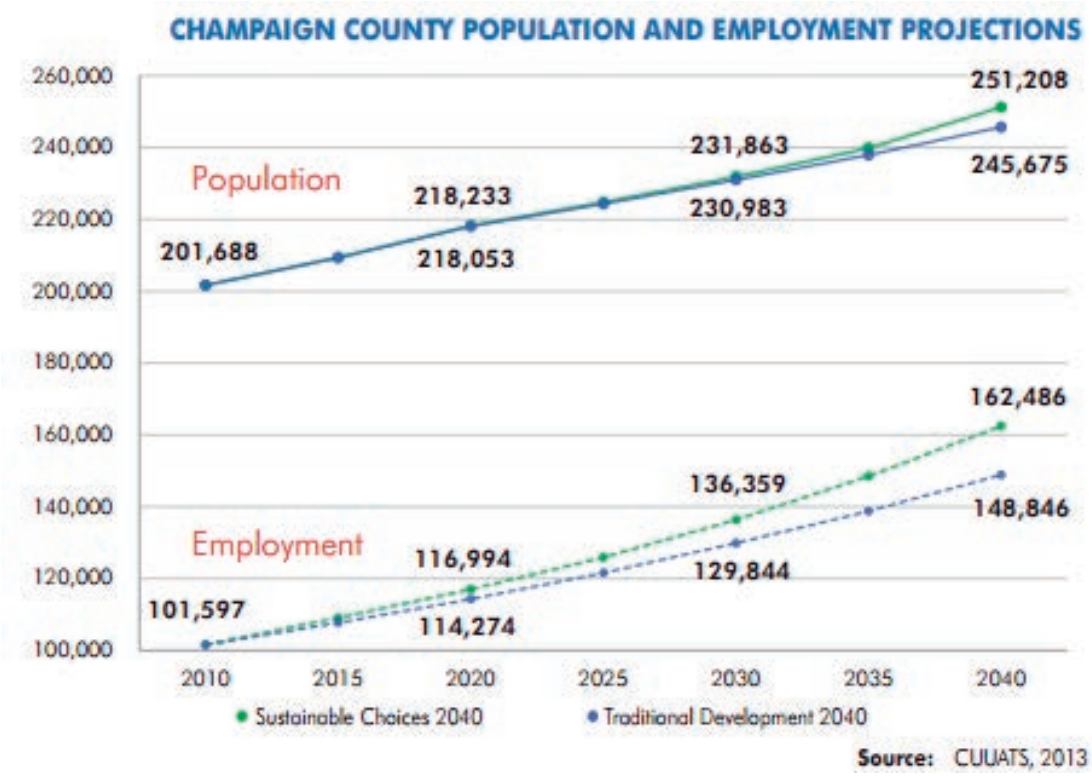
Figure C-4 below provides an overview of how these various models work together to identify projected impacts. The plan emphasizes the strong connections between the transportation system and other factors that affect quality of life, which explains why the agency chose to evaluate its scenarios based on a variety of performance measure types and topic areas. The plan states: "The CUUATS modeling suite is designed to provide a holistic approach to planning analysis through the integration of localized transportation, land use, emission, social costs, accessibility, mobility, and population health at the County level and at the local level in the Champaign-Urbana area."

Figure C-4: CUUATS' Statistical Models



Population and employment projections are key inputs to the CUUATS modeling and analysis process. To project county-level population changes shown in Figure C-5, CUUATS used HandyAndy, an interregional cohort-component model created by Dr. Andy Isserman of UIUC. Dr. Isserman also developed TrenDandy, an Excel workbook tool that uses Regional Economic Information System (REIS) data to perform employment projections (using geo-coded Business Analyst industry employment data, cross-referenced with local data). Current land use data is identified using GIS software and local knowledge of the area.

Figure C-5: Regional Population and Employment Projections under Traditional and Sustainable Choices Scenarios



Two important modeling tools used by CUUATS are a Travel Demand Model (TDM) and a Land-Use Evaluation and Impact Assessment Model (LEAM). The TDM is a person-trip model built using the Cube Voyager software platform. It employs a traditional four-step travel forecasting process to evaluate auto and transit trips for daily and peak hour scenarios. First developed at the University of Illinois, LEAM is a suite of interconnected models that predict changes in land-use over the planning horizon. The model is used primarily to identify spatial distribution of population and employment growth in the region.

The TDM was integrated with the LEAM to account for the interrelationship between land-use and transportation. The integrated TDM/LEAM identified expected mode share, VMT, and congestion under each scenario. CUUATS runs both models every five years, so that the outcomes become inputs for the next planning cycle. Staff have made significant modifications to the TDM and LEAM to indicate which land is most desirable for development and where growth is most likely to take place.[17] The next section will explain in further detail the tools and corresponding measures used to identify expected impacts under each scenario.

[17] CUUATS staff indicated that LEAM is a tool better suited to larger metropolitan areas to use in simulating growth patterns without requiring a high degree of accuracy (e.g. at the parcel level).

SCENARIO ANALYSIS PERFORMANCE MEASURES

Using the findings under different scenarios from the integrated travel demand and land use model, CUUATS calculated the expected impacts under each scenario for other aspects of quality of life. The specific tools used, and the measures used by each, were:

The Social Cost of Alternative Land Development Scenarios (SCALDS) – CUUATS used this FHWA-developed model to test the impacts of the two different land use scenarios. CUUATS localized some of the model's inputs to estimate social costs and development impacts more accurately. The model identified the scenarios' impacts on:

- Housing (LEAM output, SCALDS input)
- Local new infrastructure costs
- Annual operating cost of all services (per resident and per employment)
- Daily water use (per resident and per employment)
- Annual energy use per resident (in MMBtu)
- Transportation Personal Miles Traveled for driving, transit, biking, and walking

The MOtor Vehicle Emission Simulator (MOVES) – CUUATS used this EPA-developed model to identify expected emission/air quality impacts of transportation-related activities under each scenario. The agency used its TDM and other local datasets to develop detailed inputs for the model. The measures generated from this model were:

- GHG emissions
- $PM_{2.5}$ and other pollutant emissions

Local Accessibility and Mobility Analysis (LAMA) – LAMA is a qualitative and quantitative analysis of accessibility and mobility in different neighborhoods or planning areas in the region. Quantitative measurements of built-environment variables are combined with public input to present a more comprehensive assessment of the existing conditions at the local level.

- Mobility Index (e.g., availability of bus routes, bike lanes, sidewalks)
- Accessibility Index (availability of jobs, grocery stores, and other services)

These indices provide an understanding of the impact of accessibility and mobility on travel behavior and transportation costs.

Health Impact Assessment (HIA) – CUUATS completed an HIA to establish a relationship between the built environment and the local obesity rate. The HIA rates factors based on their strength in the model. CUUATS found that obesity rates were generally lower in neighborhoods with higher population density, better land use mix, higher accessibility to jobs and services, and better transit connectivity.

- Relationship between built environment and obesity rate
- Health Index (Uses built environment variables to identify physical activity implications)

The narrative of the project identification section of the plan reiterates the key aspects of the Sustainable Choices 2040 scenario—in particular, its emphasis on increasing non-automobile mode share. Generally, projects identified in the plan appear to be consistent with the Sustainable Choices 2040 scenario and vision. While the majority of the projects listed in the plan are roadway projects, most of them include bicycle and pedestrian facilities. There are also seven non-roadway improvements, including the proposed high-speed rail line, and over 700 bicycle and pedestrian projects that have been compiled from other area plans.

The performance measures used to evaluate the two development scenarios are closely linked to objectives and performance measures in the 2040 plan. The plan includes many more measures than those used to evaluate the scenarios because the scenario evaluation process was focused on long-term outcomes and with the scenarios serving as broad approximations, whereas the plan development models incorporated more system performance output measures. As shown in **Error! eference source not found.** below, although the performance measures used to evaluate scenarios differ from those in the 2040 plan, the connections between the two are very clear.

Table C-1: Example of the Alignment of Performance Measures used to Evaluate Scenario and the Performance Measures in the Sustainable Choices 2040 Plan

Scenario Analysis Performance Measures	**Relevant Performance Measures in Sustainable Choices 2040 Plan** *(selection)*
Mobility Index (e.g., availability of bus routes, bike lanes, sidewalks)	▶ Miles of existing non-ADA compliant sidewalks upgraded along paved roads in the urbanized area ▶ Number of miles of different types of trails and bicycle infrastructure (two measures) ▶ Percentage of the C-U MTD [transit agency] service area contained inside the urbanized area ▶ Number of new rural transit trips connecting to the urbanized area ▶ Percentage of transportation projects fully adhering to the CUUATS Complete Streets Policy ▶ Number of transit, bicycle, and/or shared use connections leading to a downtown area

Accessibility Index (Availability of jobs, grocery stores, and other services)	► Miles of existing non-ADA compliant sidewalks upgraded along paved roads in the urbanized area ► Number of short term projects completed according to various C-U SRTS Project plans ► Number of new pedestrian and coordinated bicycle plans (two measures) ► Number of ordinances [to provide year-round access to sidewalks, bike paths, and transit stops] implemented by municipalities within the urbanized area ► Number of direct transit routes and links between neighborhoods and community interest points and major employers ► Number of Zipcar locations and new car share programs in the area (two measures) ► Percentage of transportation projects fully adhering to the CUUATS Access Management Guidelines ► Number of areas with improved scores according to LAMA ► Miles of new sidewalks connecting to bus stops ► Number of new bicycle facilities located within a 1/4 mile of affordable housing ► Number of mixed use developments with bicycle, pedestrian, and transit access ► Combined transportation and housing costs as a percentage of median income

CUUATS used scenario analysis to validate priorities and identify projects and strategies in the Sustainable Choices 2040 plan. In the coming years, CUUATS plans to:

- Incorporate the LAMA and HIA tools and methods into future scenario planning exercises.
- Update its project prioritization guidelines to reflect the six planning pillars in the 2040 plan better.
- Update its TDM to make it a mode-choice model with five travel choices (drive alone, carpool, take transit, bike, or walk) and improve land use analysis capabilities.
- Identify improved methods for creating population and employment projections.
- Continue to partner with the Champaign-Urbana Public Health District and other health agencies to collect health data, map changes over time, and incorporate health impacts into scenario planning using health-related performance measures.

- Develop an interactive website that will be used to educate members of the public and engage them in an ongoing conversation about local transportation priorities and their impact on neighborhoods.
- Continue discussions with policy and technical committees surrounding the appropriate number of performance measures to track to ensure that key priorities are still clear.
- Complete sidewalk and ramp inventory to identify coverage gaps and provide data to the cities.

Lessons Learned

- Strong and collaborative relationships between the MPO and the agency's member jurisdictions and other partners are extremely important; they improve the MPO's effectiveness and its ability to acquire funding to innovate. This, in turn, improves the quality of the scenario planning and scenario analyses the agency undertakes. Some examples of strong relationships from the C-U region that have improved the agency's capacity and ability to obtain funding include:
  - Informal lines of communication between the CUUATS and its various partners are always open. Many of these relationships date back to 1998, when the Campus Area Transportation Study (CATS) was formed to discuss transportation issues affecting the university area and to update the campus master plan.
  - CUUATS, CU-MTD, and other partners successfully worked together to obtain the only Federal Transportation Investment Generating Economic Recovery (TIGER) grant in the State of Illinois. The TIGER-funded Multimodal Corridor Enhancement Project will create a network of complete and transit-friendly streets throughout the downtown and core areas.
  - Illinois DOT has frequently provided CUUATS with funding for different initiatives. In some cases, the funding is contingent on CUUATS providing technical assistance to other MPOs in the State.
  - Among CUUATS' member agencies, there is a strong sense of the need to do what is best for the region, even when it means "taking turns" with respect to which jurisdiction receives limited funding resources first. Strong relationships have enabled this approach.
  - The member agencies have service area boundary agreements in place to minimize interjurisdictional competition for development and jobs.
  - CUUATS worked with the Champaign Urbana Public Health District to conduct health surveys in coordination with the 2040 plan outreach and engagement. This has been beneficial for the Health District, and has enabled CUUATS to consider public health more fully in its modeling and planning processes (e.g., by using HIA tools). CUUATS has worked with the Health District to obtain health-related grants for complete streets policies for two member communities. Because of strong

relationships and taking specific confidentiality trainings, CUUATS staff have access to health data that allows them to do health analyses on a level that is unparalleled throughout the country.

- Building in-house capacity has been critical to the agency's continued success. In some cases, it can be more cost-effective to have in-house staff complete analyses, and can also position the agency to manage future planning cycles more efficiently. Having a highly skilled team of staff allows CUUATS to function successfully as a consulting firm for the entire region; grants and individual projects (developing cities' bicycle plans, for example) account for about half of the agency's revenue.
- The presence of a university with strong planning and engineering departments can be a significant benefit, particularly for a smaller MPO. UIUC faculty have assisted CUUATS in various ways (e.g., providing expertise on high speed rail, developing modeling tools for the agency's use). Nearly all of CUUATS' staff members were educated at UIUC, which provides the agency a steady stream of planning and engineering graduates.

RESOURCES

- CUUATS 2025 LRTP: http://www.ccrpc.org/transportation/lrtp.php
- CUUATS Choices 2035 Plan: http://www.ccrpc.org/transportation/lrtp2/documents.html
- CUUATS Sustainable Choices 2040 Plan: http://cuuats.org/lrtp/documents/long range-transportation-plan-sustainable-choices-2040-final/lrtp-2040-executive-summary/view

Fresno Council of Governments

The Fresno Council of Governments (Fresno COG) is the MPO for the Fresno-Clovis, California area in the State's Central Valley (see Figure C-6). Fresno COG's territory covers Fresno County and its member agencies include the County of Fresno and the Cities of Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron, Kerman, Kingsburg, Mendota, Orange Cove, Parlier, Reedley, San Joaquin, Sanger, and Selma. Mayors for each city (or the elected officials they appoint) and the Chairman of the County Board of Supervisors are the members of the agency's Policy Board. The Board is assisted in its decisionmaking process by a Policy Advisory Committee (PAC), which includes all city managers and the county administrator, and the Transportation Technical Committee (TTC), which includes senior staff from each member agencies and technically inclined members of other location organizations (e.g., the bike coalition). Fresno COG has a "double-weighted" voting system, which provides for an urban/rural balance of all interests.[18]

Figure C-6: Fresno County, California

Fresno COG is part of the San Joaquin Valley Air Pollution Control District (SJVAPCD) and the San Joaquin Valley Regional Policy Council (SJVRPC). Both the District and Council cover the same eight-county San Joaquin Valley region of San Joaquin, Stanislaus, Merced, Madera, Fresno,

[18] To approve any action, a vote must pass two tests: Agencies representing over 40% of the population must be in favor of an action, and a majority (i.e. at least nine) of all the members must support the action. http://www.fresnocog.org/about-cog.

Kings, Tulare, and Kern counties. The San Joaquin Valley is home to over 4 million people, and the population is expected to grow to more than 7.5 million residents by 2050.The San Joaquin Valley, often referred to as California's heartland, is also the fastest-growing region in the State and the hardest hit by the economic downturn. Communities in the Valley struggle with poor air quality and rising levels of childhood asthma, obesity, and diabetes.

Fresno County has been growing steadily for decades. As of 2013, the estimated population of Fresno County was 955,272, an increase of 25,000 residents in just the three years since 2010. A little more than half of the County's residents live in the City of Fresno (2013 population 509,924), which is California's fifth largest city. More than 65 percent of the County's inhabitants are minorities, primarily Mexican Hispanics (over 50 percent of all residents) and Asians (over 10 percent of all residents); the Asian community includes a sizeable Hmong population.

Table C-2: 2013 Household Income Quartiles

	Fresno County	**California**
Under $25,000	28%	20%
$25,000 – $49,999	25%	21%
$50,000 – $74,999	17%	17%
Over $75,000	29%	41%

Source: US Census American Community Survey

Fresno County is the top agricultural-producing county in the US, yet the area suffers from relatively high unemployment (around 11percent in 2014) and low incomes (see Table C-2). County residents also have significantly lower levels of educational attainment than those in the rest of the State. Fresno Area Express (FAX), whose service area covers the City of Fresno and other urban areas in the county, is in the process of constructing high capacity bus corridors, which were considered in the agency's most recent scenario planning process.

PBPP EXPERIENCE

In 2014, Fresno COG's Board approved the agency's 2014 Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS). The 2014 Regional Transportation Plan, with a horizon year of 2040, was the eighteenth in a series of quadrennially updated plans that date back to 1975. It was the first RTP to incorporate a Sustainable Communities Strategy, in accordance with California Senate Bill 375 (SB 375). Enacted in 2008, SB 375 requires all California MPOs to develop an SCS that provides an integrated transportation and land use plan for meeting GHG emission reduction targets established by the California Air Resources Board (CARB).

As shown in Figure C-7, California law requires the Fresno COG region to achieve a five percent drop in per capita GHG emissions (compared to 2005 levels) by the year 2020, and to cut another five percent by 2035. Air quality analyses conducted for the 2014 plan development process predict

that implementation of the 22 goals laid out in the adopted RTP/SCS, shown below, will meet and even exceed the CARB targets.

Figure C-7: Fresno COG's GHG Reduction Targets in the 2014 RTP/SCS

Year	Per Capita GHG Reduction Targets	Fresno COG Per Capita GHG Reduction
2020	5%	9%
2035	10%	11%
2040	NA	12%

The adopted RTP/SCS includes six goals, each of which is supported by objectives as shown in the list below. Each objective is further supported by several policies, as illustrated in Figure C-8.

- General Transportation
  - An efficient, safe, integrated, multimodal transportation system
  - Improved mobility and accessibility for all regardless of race, income, national origin, age, or disability
  - Planning outcomes that are consistent with various planning efforts
  - A regional transportation network consistent with the intent of SB 375
  - Support cooperative efforts between Federal, State, and local agencies and the public to plan, develop and manage our transportation system
  - Attainment and maintenance of Federal and State ambient air quality standards (criteria pollutants) as set by US EPA and CARB.
- Highways, Streets, and Roads
  - An integrated and efficient highways, streets and roads network
  - Efficient use of available transportation funding
  - Acceptable level-of-service for the highways, streets and roads network
- Mass Transportation
  - An efficient and fiscally responsible public transportation mobility system
  - A safe and reliable public transportation service
  - An effective public transportation system
  - Public transit services with a positive public image in communities served
  - An integrated multimodal transportation system which facilitates the movement of people

- A coordinated policy for public transportation that complements land use and air quality policies

- Aviation
  - A fully functional and integrated air service and airport system that is complementary to the regional transportation system
- Non-Motorized
  - Maximize bicycling and walking through their recognition and integration as valid and healthy transportation modes in transportation planning activities
  - Safe, convenient, and continuous routes for bicyclists and pedestrians of all types which interface with and complement a multimodal transportation system
  - Improved bicycle and pedestrian safety through education and enforcement
  - Increased development of the regional bikeways system, related facilities, and pedestrian facilities by maximizing funding opportunities
- Rail
  - A safe, efficient and convenient rail system which serves the passenger and freight needs of the region and which is integrated with and complementary to the total transportation system
  - A transportation system that efficiently and effectively transports goods throughout Fresno County

Figure C-8: Example of Fresno's Goal, Objectives, and Policies Organization

Goal : An efficient, safe, integrated, multimodal transportation system.	
Objective: Maintain and improve existing facilities as the basic system which will address existing and future travel demands.	**Objective:** Manage the financial resources which are available from government, the private sector, and users of the transportation system in a cost-effective manner to meet regional needs.
Policies:	**Policies:**
Manage the transportation system in a manner designed to increase operational efficiency, conserve energy and space, reduce air pollution and noise, and provide for effective goods movement, safety, personal mobility and accessibility.	Procure and leverage federal, state and local transportation funding to the maximum degree possible, in order to develop a regional transportation network which serves the residents of the region in the most economical, effective and efficient manner possible.
Continue support for the preservation of existing transportation facilities and, where practical, addressing transportation needs by using existing transportation modes efficiently.	Encourage new or reconstructed facilities to incorporate design standards which extend the life cycle and reduce maintenance costs.
Maintain stringent safety requirements for all transportation modes, and identify problem (hazardous) locations and implement counter measures for anticipated problems wherever possible.	Pursue additional funding sources for development of major transportation programs and projects. Work with all interest groups to reach consensus and initiate an active public information program regarding transportation funds needed.
Identify those transportation problems where transportation systems management can be effective.	

The plan's objectives or policies do not correlate directly to specific performance measures or targets, except for those related to GHG emissions, although the agency did consider broadly the relationships between goals, objectives, and performance measures. The agency developed an array of performance measures for its scenario analysis process, and for an environmental justice analysis.

SCENARIO PLANNING EXPERIENCE

The 2014 RTP/SCS was built in part upon policies adopted through a broader regional scenario planning process. In 2006, the eight regions that comprise the San Joaquin Valley Councils of Governments/ Regional Policy Council (SJVRPC) came together to establish the San Joaquin Valley Regional Blueprint, a regional vision for land use and transportation intended to guide local and regional plans for Valley area growth over the next 50 years (a period in which the population is expected to more than double). Fresno COG's participation in this larger planning process influenced its approach to scenario planning and its development of the 2014 RTP/SCS land use and transportation policies.

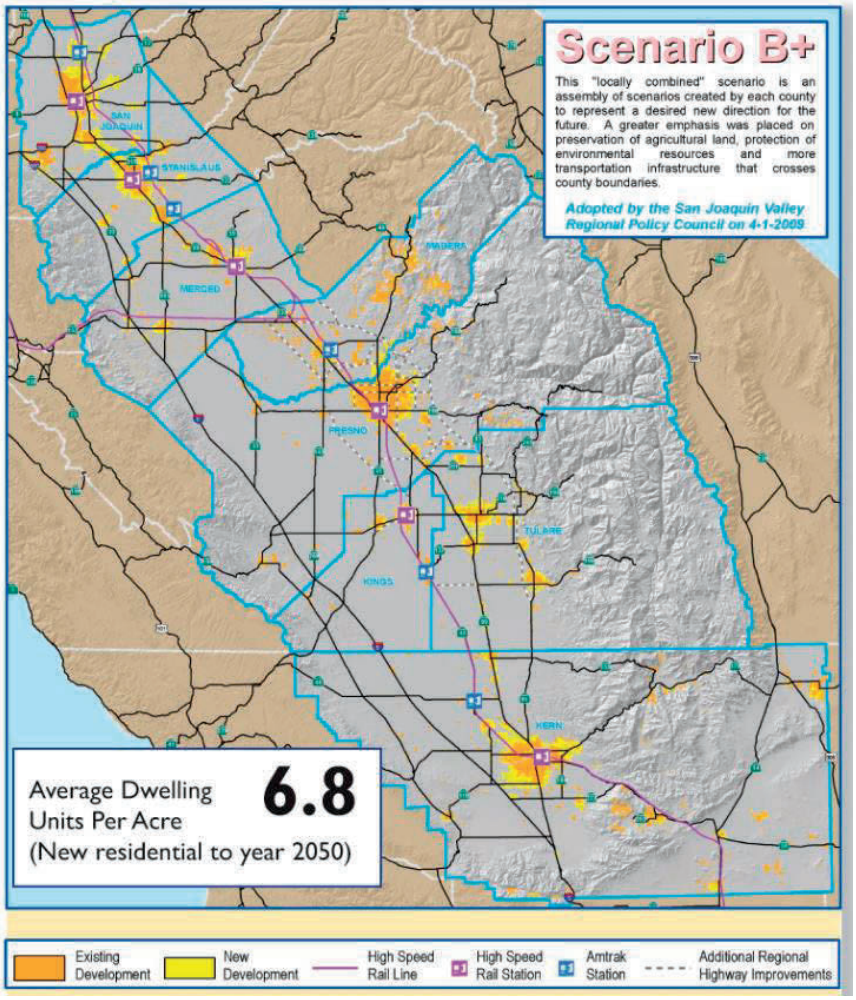
The Regional Blueprint process involved three major phases: Values and Vision; Goals, Objectives, and Performance Measures; and Evaluation of Alternative Growth Scenarios. With funding from the State's Regional Blueprint Planning Program, each of the eight agencies developed its own countywide Blueprint, which was then woven into the single Valleywide Blueprint. UC-Davis

faculty and students and local planners worked together to develop alternative growth scenarios for each county using the UPlan analysis tool.

SJVRPC used the Vision California Rapid Fire model, a comprehensive modeling tool, to evaluate the impacts of varying land use scenarios on environmental performance. The model used a hybrid scenario developed by aggregating the compact development options from the Blueprint Plans developed by Fresno COG and the other MPOs in the San Joaquin Valley. The scenarios were evaluated based on VMT projections and the amount of farmland expected to be developed under each scenario. The results of the scenario analysis provided a regional context and useful data to inform the subsequent development of the Fresno COG 2014 SCS.

In 2009, the Policy Council endorsed Scenario B+ (illustrated in Figure C-9), along with 12 supporting smart growth principles. Under the preferred scenario, compared to historic patterns, less land is consumed for development, more resources are preserved for future generations, distinctive communities are enhanced, and more travel choices are available. Additional information about the performance measures used to evaluate the four Blueprint scenarios, and how scenarios were selected, is available from the Valley Blueprint website links listed in the footnotes. Following the Regional Blueprint process, Fresno COG's large cities, Clovis and Fresno, both updated their General (comprehensive) Plans to increase their focus on inward growth and development.

Figure C-9: Scenario B+ from the San Joaquin Valley Regional Blueprint Process



Following the planning process, SJVRPC developed a two-pronged approach for implementing the Blueprint strategy. The Blueprint Integration Project (BIP) was established to work with rural and agricultural communities to implement the Blueprint's goals and objectives. The Smart Valley Places (SVP) program was developed to support implementation in urbanized metropolitan areas. Though the grants that funded the BIP and SVP ended in 2014, the impact of these programs continues through the ongoing collaboration among local agencies, elected officials, the public and non-governmental organizations to address the region's problems.

Due to timing, the Blueprint process fed right into the SB 375-required GHG reduction target setting. Because the Blueprint process had occurred, the ideas and lessons from scenario planning in that process were relatively fresh, and because of the discussions that had taken place in the Blueprint process, the cities were more comfortable with the smart growth principles and had a better understanding of the value, for example, of active transportation. To set GHG targets, Fresno COG developed three scenarios and came up with draft GHG reduction targets. Although CARB

ultimately did not adopt the agency's recommendations, the exercise led to numerous data and tool improvements that Fresno COG employed in developing scenarios for its 2014 process. It also led to strengthened relationships between the COG and its member agencies, as they increasingly understood the purpose and vision of regional planning. During the target-setting process, three Fresno COG staff members went to Sacramento to meet with CARB and help them understand that both agencies share the same goals; this was ultimately a very valuable use of time and resources. CARB assisted Fresno COG with developing and refining its models.

To develop the 2014 RTP/SCS, Fresno COG established a 35-member RTP Roundtable that included 16 staff from member agencies, 16 representatives of stakeholder groups, and 3 "at large" representatives. The Roundtable, which advised the Fresno COG Board, participated in 12 meetings between August 2012 and November 2013. Inspired by a similar Roundtable established for the SJVRPC Blueprint process, the Fresno group was, according to MPO staff and agency representatives, an invaluable resource for fostering the level of regional collaboration upon which the plan's success depends.

The planning process was supported by a robust, intensive public engagement effort, featuring dozens of workshops, focus groups, community meetings, briefings, surveys, and small group discussions. The COG supplemented its small staff by establishing an innovative mini-grant program to recruit, train, and support a variety of community organizations to facilitate outreach with their constituents. Many of the grant recipient organizations went door-to-door to solicit input. Each mini-grant was worth about $3,000. The entire program cost approximately $25,000 and resulted in high turnout at workshops. The grant recipients had to attend training sessions, which helped ensure their staff understood what MPOs, RTPs, and SCS's are, so they would be adequately prepared to explain the process and answer residents' questions. One challenge with the mini-grant program was ensuring that grantees were not biased in their presentation of the issues to constituents—in the future, impartiality will be emphasized in trainings. The mini-grant program resulted in strong relationships between Fresno COG and the recipients, and has set a high bar with respect to engagement—community groups in the region are now asking other COGs to implement similar programs.

Fresno COG brought in translators to help facilitate community meetings and to convert published documents into as many as five different languages (in many cases with help from the mini-grant recipient organizations). COG staff also sought coverage by local news media, conducted a "transportation needs and values survey," worked with the library (a mini-grant recipients) to make sure computer users would see information about the plan, and used online social media tool to share information. To reduce the barriers to attending meetings, Fresno COG provided food and daycare and offered free transit service to meetings. In addition, the agency used web conferencing to enable remote participation in meetings. To ensure that all interested parties were able to have their voices heard, the agency extended the engagement period multiple times to allow for more inputs and comments and heighten satisfaction with the process. To reduce potential points of contention, the agency responded to all comments individually. In the future, the agency plans to develop a social media policy to guide interactions on Facebook and other sites.

Relationship-building and education was critical; the agency's significant investments of time, money, and in-kind resources for public engagement (including 19 meetings and a 150-attendee public meeting) yielded a high level or return—both in terms of improving the quality of the process and in achieving buy-in and support, among the community and decisionmakers, for the final plan. This was especially important given that the agency's member cities initially feared that Fresno COG's planning would infringe in some way upon their land use authority. Over time, through tireless engagement, they came to understand that the COG was trying to help them understand the implications of their land use decisions, and that they could take advantage of Fresno COG's technical skills to improve the quality of their own planning.

The COG, recognizing the need for agreed-upon indicators to evaluate scenarios, developed a list of 38 potential indicators that could be used.[19] The agency only considered indicators for which staff knew data were available and that had already been used in the past. To select the top ten indicators for developing and evaluating the RTP/SCS scenarios, Fresno COG solicited input from the Roundtable and from participants in six focus group meetings, each with a specific topic focus, conducted in September 2012. Based on the input received, the agency decided to evaluate each scenario based on the following ten criteria and associated performance measures:

- **Greenhouse gas emissions reduction**: Percentage of per person GHG reduction against 2005
- **Housing by types**: Percent of housing by types
- **Residential density**: Average housing units per acre of new growth
- **Compact development**: Average number of people per acre
- **Transit oriented development**: Share of the region's growth in households and employment within half-mile of Bus Rapid Transit (BRT)/high capacity bus service
- **Land consumption**: Acres of land consumed due to new development
- **Important farmland**: Total acres of important farmland (prime, unique and statewide importance) consumed due to new growth
- **Vehicle miles traveled**: Total Vehicle Miles Traveled (VMT) on a typical day in 2035
- **Criteria pollutant emissions:** Tons of pollutants released per a typical day in 2035 (CO, Reactive organic gases, NOx, PM_{10}, $PM_{2.5}$)
- **Active transportation and public transit**: Weekday person trips by transit, walk and bike modes

Some participants of the focus groups, and RTP Roundtable and TTC members proposed other indicators that the agency should consider using in the future, as data and tools become available. The agency found that establishing the indicators for scenario evaluation up-front allowed the

[19] This list is available in Appendix J, Item 8: http://www.fresnocog.org/sites/default/files/publications/RTP/Final_RTP/Fresno_COG_2014_RTP-SCS_Appendix_Final.pdf.

agency to keep the discussion steered toward the indicators, and gave the agency the ability to deny mid-process requests to consider other factors.

After identifying the performance measures to be used in evaluating scenarios, Fresno COG developed and analyzed four scenarios, each of which featured alternative patterns of land development, density, and design. Implications of each scenario, in terms of the ten indicators listed above, were compared to each other and to a status quo scenario. Three of the scenarios (A, B, and C) were circulated broadly for public discussion in the late summer of 2013. Shortly after this public engagement period, a local coalition of community-based organizations proposed a fourth scenario (D), which COG staff analyzed (under significant time pressure) at the direction of the agency's TTC and PAC. The fourth scenario was included in the planning process and documents, but was not circulated for public review along with the other three, due to the timing of its introduction.

Key elements of the four Draft SCS Scenarios are listed below and summarized in Figure C-10. Expected performance outcomes under each scenario are summarized in Table C-3.[20]

Figure C-11, selected from a presentation given by Fresno COG to the TTC and PAC, provides graphic depictions of the scenario evaluation results.

- **Scenario A** – This scenario is based upon public input collected at a community workshop in November 2012. The ratio of metro vs. non-metro growth is controlled, with more growth allocated to some rural communities than has occurred historically.
- **Scenario B: "Current Planning Assumptions"** – This scenario was developed in consultation with planners and representatives of COG member governments and agencies. Growth occurs according to historical patterns in each city and community, with some modifications based on current general plans, proposed land uses, and the latest planning assumptions. Unique among the four scenarios, this scenario includes actively proposed development projects in Millerton New Town, Friant Ranch, and the proposed pharmacy school.
- **Scenario C: "Foothill Growth to City of Fresno"** – This scenario was developed by the RTP Roundtable, principally to test concepts that would require more aggressive urban development than assumed in current plans. It assumes four percent of additional growth (beyond what City of Fresno was projected to receive) being reallocated away from the foothills and into corridors and activity centers in the City of Fresno. Under this scenario, growth in unincorporated areas would be constrained to ten existing communities. It does not include Scenario B's developments in Millerton New Town, Friant Ranch, and the proposed pharmacy school.
- **Scenario D: "Foothill Growth to Existing Communities"** – This scenario was developed by a Coalition of Community Based Organizations. Using the same population and

[20] For a more legible version of this table, see: http://www.fresnocog.org/sites/default/files/publications/SCS/Performance_Measures_Matrix.pdf

employment forecasts as Scenarios A, B, and C, this scenario accommodates growth through redevelopment and higher densities within existing cities and communities, and allocates further growth to the unincorporated rural communities in the County areas. Like Scenarios A and C, this scenario does not include proposed developments in Millerton New Town, Friant Ranch, and the proposed pharmacy school.

Although none of the measures used to evaluate scenarios directly addressed social equity, the topic was part of discussions throughout the scenario planning process. Questions regarding where development would occur, who would benefit, etc. were regularly raised, which was unsurprising given the economic hardship faced by many of the County's residents. In November 2013, the Fresno COG Policy Board unanimously selected Scenario B as the Preferred Scenario to guide the RTP/SCS. Scenario B did not perform as strongly as the other three scenarios in terms of the ten priority indicators, but it was still a significant improvement over the trend line projection (status quo scenario). As with the other three scenarios, the preferred Scenario B exceeded the GHG reduction targets established by CARB. Perhaps the most compelling element of Scenario B is that it was the most politically feasible: it reflected adopted local land use plans and current development projects, which in turn reflect, to varying extents, the smart growth principles developed through the SJVRPC Blueprint process. Implementing Scenario B required only modest modifications, if any, to local land use policies and plans. Key "next steps" needed to implement the preferred scenario will focus upon supporting implementation of local general plans, especially the City of Fresno's, which calls for aggressive land use changes, as well as pursuing funding to implement the RTP/SCS transportation strategies.

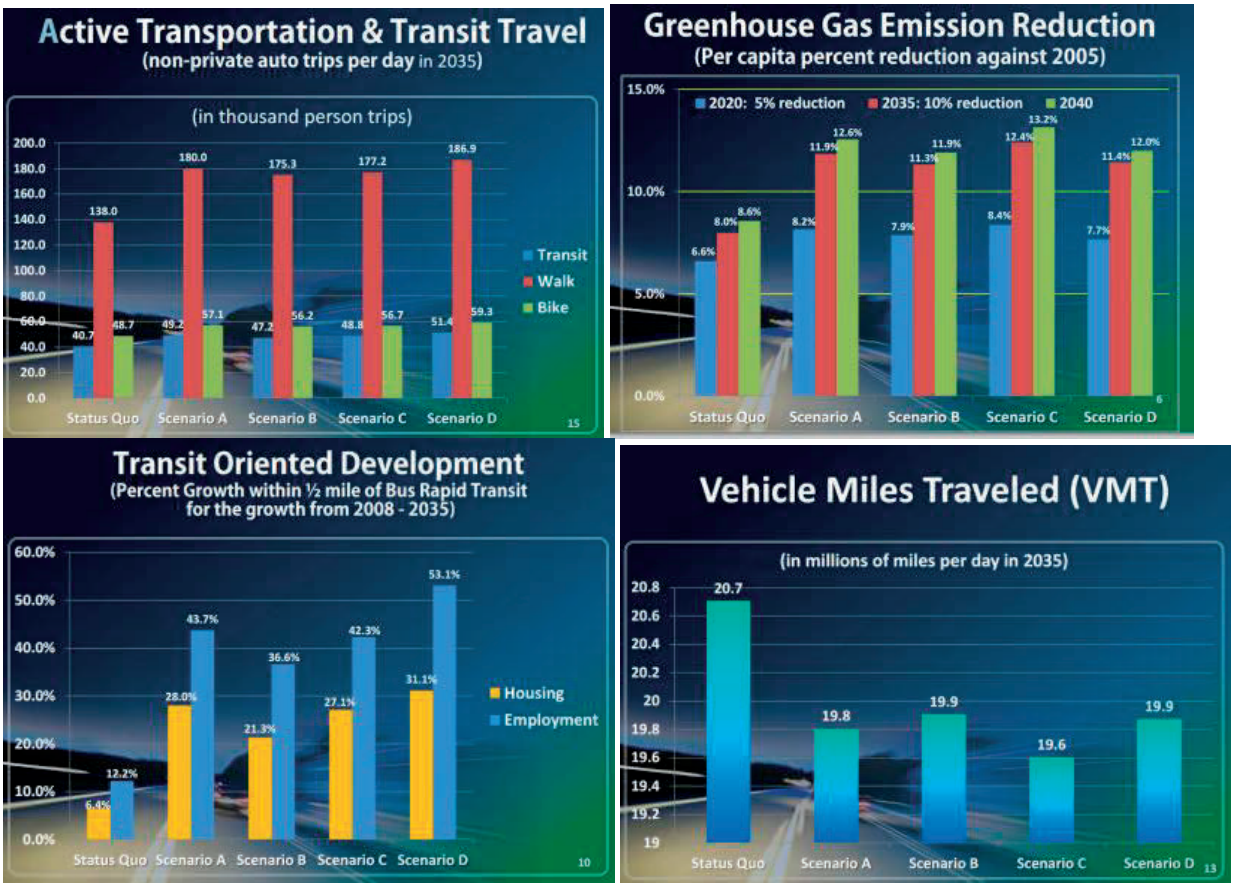
Figure C-10: The Four Fresno COG Scenarios

Scenario >	A	B	C	D
Central Theme	Public input from November 2012 workshop	Current planning assumptions	Foothill growth to City of Fresno	Foothill growth to existing communities
Proposed By...	Public	Member Agencies	RTP Round Table	Coalition of Community Organizations
Defining Characteristics	• Considers public input from November 2012 workshop • Growth in the metro area conforms to historical trend • Some rural communities receive much higher growth	• Follows current general and specific plan updates • Growth allocation follows historical trend • Includes development in Friant Ranch, Millerton, and the proposed pharmacy school	• Additional 4% of countywide growth allocated to City of Fresno along corridors and activity centers • Unincorporated growth constrained to 10 existing communities; little change in incorporated cities • Development in Friant Ranch, Millerton, and the proposed pharmacy school not included	• Developed by coalition of community organizations • Increased redevelopment and higher density for new growth • Growth reduced from the foothill communities and reallocated to existing cities and communities • Development in Friant Ranch, Millerton, and the proposed pharmacy school not included
Communities with Significant Changes in Growth Allocation*	**Less Growth** • Clovis, Coalinga, Parlier, Sanger • Auberry, Friant Ranch, Millerton, Shaver Lake **More Growth** • Firebaugh, Fresno, Huron, Kerman, Kingsburg, Orange Cove, San Joaquin • Caruthers, Easton, Lanare, Laton, Raisin City, Riverdale, Squaw Valley	Each city/community receives growth based on historical trend	**No Growth** • Auberry, Friant Ranch, Millerton, Raisin City, Squaw Valley **More Growth** • Fresno	**No Growth** • Friant Ranch, Millerton **Less Growth** • Auberry **More Growth** • Biola, Bowles, Caruthers, Del Rey, Easton, Lanare, Laton, Raisin City, Riverdale, Tranquillity

Table C-3: Fresno COG's Sustainable Communities Strategy Scenario Performance Indicator Comparisons

Performance Measure/Indicator	Definition	Scenario A	Scenario B	Scenario C	Scenario D	Status Quo
Greenhouse Gas emission reduction	Percentage of per person greenhouse gas reduction against 2005.	2020: -8.15% 2035: -11.85% 2040: -12.55%	2020: -7.86% 2035: -11.32% 2040: -11.91%	2020: -8.36% 2035: -12.40% 2040: -13.15%	2020: -7.7% 2035: -11.4% 2040: -12%	2020: -6.59% 2035: -7.97% 2040: -8.56%
Housing	Percent of housing by types	Single Family: 44.1% Town Homes: 9.0% Multi-Family: 46.9%	Single Family: 53.1% Town Homes: 9.1% Multi-Family: 37.8%	Single Family: 45.1% Town Homes: 8.3% Multi-Family: 46.6%	Single Family: 36.6% Town Homes: 14.6% Multi-Family: 48.8%	Single Family: 77.7% Town Homes: 7.3% Multi-Family: 15.1%
Residential density	Average housing units per acre of new growth	8.3 Housing Units per acre	7.4 Housing Units per acre	8.5 Housing Units per acre	10.2 Housing Units per acre	4.6 Housing Units per acre
Compact development	Average number of people per acre	27.6 people per acre	21.1 people per acre	24.7 people per acre	31.1 people per acre	13.9 people per acre
Transit-oriented development	Share of the region's growth in households and employment within half-mile of Bus Rapid Transit (BRT)	Housing Units: 27,475 (28.0%) Employment: 35,805 (43.7%)	Housing Units: 20,389 (21.3%) Employment: 29,958 (36.6%)	Housing Units: 26,416 (27.1%) Employment: 34,646 (42.3%)	Housing Units: 33,415 (31.1%) Employment: 43,518 (53.1%)	Housing Units: 5,787 (6.4%) Employment: 9,969 (12.2%)
Land consumption	Acres of land consumed due to new development	11,226 acres	14,675 acres	12,542 acres	9,961 acres	22,308 acres
Important farmland consumed	Total acres of important farmland (prime, unique and state-wide importance) consumed due to new growth	90.6 acres	37.6 acres	27.4 acres	21.3 acres	352 acres
Vehicle Miles Traveled (VMT)	Total Vehicle Miles Traveled (VMT) on a typical day in 2035	Total VMT: 19,789,601 miles Per capita VMT: 15.2 miles Per capita reduction: -11.1%	Total VMT: 19,924,347 miles Per capita VMT: 15.3 miles Per capita reduction: -10.5%	Total VMT: 19,638,153 miles Per capita VMT: 15.1 miles Per capita reduction: -11.8%	Total VMT: 19,878,208 miles Per capita VMT: 15.3 miles Per capita reduction: -10.7%	Total VMT: 20,743,263 miles Per capita VMT: 15.9 miles Per capita reduction: -6.8%
Criteria pollutants emissions	Tons of pollutants released per a typical day in 2035: Carbon Monoxide, Reactive Organic Gases, Nitrogen Oxide, Particulate Matter 10, Particulate Matter 2.5	Carbon Monoxide: 40 tons Reactive Organic Gases: 4.6 tons Nitrogen Oxide: 11.3 tons Particulate Matter 10: 7.9 tons Particulate Matter 2.5: 1.0 tons *(All Pass Conformity)*	Carbon Monoxide: 40 tons Reactive Organic Gases: 4.6 tons Nitrogen Oxide: 11.4 tons Particulate Matter 10: 7.9 tons Particulate Matter 2.5: 1.0 tons *(All Pass Conformity)*	Carbon Monoxide: 40 tons Reactive Organic Gases: 4.6 tons Nitrogen Oxide: 11.3 tons Particulate Matter 10: 7.8 tons Particulate Matter 2.5: 1.0 tons *(All Pass Conformity)*	Carbon Monoxide: 40 tons Reactive Organic Gases: 4.6 tons Nitrogen Oxide: 11.4 tons Particulate Matter 10: 7.9 tons Particulate Matter 2.5: 1.0 tons *(All Pass Conformity)*	Carbon Monoxide: 41 tons Reactive Organic Gases: 4.8 tons Nitrogen Oxide: 11.6 tons Particulate Matter 10: 8.2 tons Particulate Matter 2.5: 1.0 tons *(All Pass Conformity)*
Active Transportation and transit travel	Weekday person trips by transit, walk and bike modes	Transit: 49,155 trips Walk: 180,009 trips Bike: 57,065 trips	Transit: 47,202 trips Walk: 175,316 trips Bike: 56,213 trips	Transit: 48,765 trips Walk: 177,172 trips Bike: 56,743 trips	Transit: 51,448 trips Walk: 186,909 trips Bike: 59,302 trips	Transit: 40,650 trips Walk: 138,033 trips Bike: 48,715 trips
Central Theme of Scenario - Proposed by...		Public Input from November 2012 Public Workshop	Current planning assumptions - member agencies	Foothill growth to City of Fresno - RTP Roundtable	Foothill growth to existing communities - Coalition of Community Organizations	

Figure C-11: Expected Performance with Respect to Active Transportation, GHG Emissions Reductions,
Transit-Oriented Development, and Vehicle Miles Traveled (respectively) under Each Scenario



In addition to evaluating land use and transportation scenarios for the 2014 RTP/SCS, Fresno COG also analyzed four alternative combinations of revenue projections and priority projects. Each scenario assumed the same total future funding levels, but varied the types of allocations within three main "flexible" funding sources: RSTP, CMAQ, and TAP. The four revenue projection scenarios are described below and are shown in Table C-4.[21]

- **Traditional** – Continuation of modal allocations in the current Transportation Improvement Program (TIP).
- **Increased Active Transportation** – This analysis adjusted the percentages per mode within each of the three main funding sources to support moderate increases in bicycle, pedestrian, transit, and street capacity projects.

[21] Details on each are available in Appendix C of the RTP/SCS.

- **Emphasis on Active Transportation** – Under this projection, a significant commitment was made to increase the direct funds toward projects that would deliver complete streets, bike lanes, new sidewalks, etc.
- **Emphasis on Maintenance** – Developed at the request of the PAC, the fourth scenario redirects all flexible funds to support the "fix it first" emphasis on preserving the existing local street and road network, with correspondingly fewer funds allocated to bicycle, pedestrian, transit, and capacity expansion projects.

Table C-4: Spending by Transportation Mode by Revenue Scenario

Mode	Revenue Projection 1: *Traditional*	Revenue Projection 2: *Increased Active Transportation*	Revenue Projection 3: *Emphasis on Active Transportation*	Revenue Projection 4: *Emphasis on Maintenance*
Bicycle & Pedestrian	3.59%	4.89%	9.03%	3.26%
Streets & Roads Capacity Increasing	24.06%	24.00%	22.96%	22.96%
Streets & Roads Operations and Maintenance	24.91%	23.02%	17.54%	26.45%
Streets & Roads - Any Type	8.53%	8.53%	8.53%	8.53%
Transit	30.56%	31.56%	34.07%	30.45%
Other/Multiple Modes	8.34%	7.99%	7.87%	8.34%

To score projects submitted, Fresno COG uses Project Evaluation Criteria, which were developed by the Financial Element Technical Working Group and approved by the Board. The Criteria vary by mode and project type (bike and pedestrian, capacity increasing road projects, operations and maintenance road projects, and transit), so that only similar projects are evaluated against each other.

When the projects (by mode) were compared against the revenue projection scenarios (again, by mode), Projections 1 and 2 (Traditional and Increased Active Transportation) resulted in the same project list ("A"), due to the relatively low amount of eligible flexible funds. Revenue Projections 3 and 4 also produced the same project list ("List B"). The difference between Lists A and B was the inclusion in List B of five fiscally unconstrained, capacity-increasing projects (most of which bicycle and pedestrian components).

Based on this analysis, the Policy Board chose List A as the most inclusive, cost-effective and financially constrained. Taking into account the bicycle and pedestrian components of capacity-increasing projects in List A, Fresno COG developed an estimate of modal allocations for the preferred scenario, as shown in Table C-5.

Table C-5: Revenues Programmed by Transportation Mode[22]

	Total Dollars		Number of Projects	
Project Type	Dollar Amount	Percentage	Number	Percentage
Bicycle & Pedestrian	$112,708,000	2.52%	202	13.75%
Streets & Roads Capacity Increasing	$1,747,945,000	39.16%	297	20.22%
Streets & Roads Operations and Maintenance	$1,011,398,000	22.66%	894	60.86%
Transit	$1,591,878,000	35.66%	76	5.17%
TOTAL	$4,463,929,000	100%	1469	100%

It is important to note that a limitation to the effectiveness of project prioritization in California is the limited amount of flexibility allowed in spending projects funded by sales tax measures. All sales tax funding measures voted upon must identify which in advance which projects will be funded with the money generated from the tax.

DATA AND TOOLS

In 2012, the eight-MPO consortium that conducted the Blueprint process hired a consultant team, which used forecasting models to develop county-level Year 2050 population and employment projections for use in the scenario planning process. The projections determined total household population and employment numbers Countywide, and allowed for assessment of other metrics such as household sizes and vacancy rates.

In the 2006-07 Regional Blueprint scenario planning process, the tools used did not allow Fresno COG to do parcel-level modeling. Fresno COG used Envision Tomorrow to develop land use scenarios for its 2014 plan.[23] Throughout the 2014 process, the tools and capabilities were evolving; as needs for more analysis were identified, the agency's staff tried to see which could be met by increasing their analysis capabilities, given the tools and data available. COG staff are now (after completion of the 2014 process) considering various modifications and additions to the agency's suite of scenario modeling tools. One tool of particular interest is Urban Footprint, an open-source, online scenario modeling tool that bears similarity to Envision Tomorrow, but provides more flexibility and customization by the user. Perhaps most notably to Fresno COG, Urban Footprint users can allocate two or more different land use types within parcels, as opposed to allocating only one type to the entire parcel, which allows for a more accurate analysis of the impact of mixed use development. Since Urban Footprint is run from the cloud, users can access it with a basic internet browser and a high-speed data connection, which reduces the need to invest in a powerful desktop computer and staff training to support GIS modeling. The online feature makes Urban Footprint a

[22] As explained above, these figures represent estimates made after consideration of the spending on bicycle- and pedestrian-specific components of road projects.
[23] Appendix J Items 5 and 7 discuss the land use modeling conducted and the development of each scenario. http://www.fresnocog.org/sites/default/files/publications/RTP/Final_RTP/Fresno_COG_2014_RTP-SCS_Appendix_Final.pdf.

bit more time-consuming to use because of the need to upload and download data and/or to wait for runs to be completed. However, it could reduce the amount they agency needs to spend on software, training, and technical support fees, which may be particularly appealing to smaller MPOs with fewer staff and computing resources.

Fresno COG's Travel Demand Model (TDM) uses Cube software and is based on a traditional four-step process, with modifications to reflect mode splits and the multimodal implications of different assumptions about land use density, diversity, design, and location (destination). Fresno COG made a number of updates to its TDM to improve its ability to estimate GHG reductions under each scenario in the GHG target-setting process, including splitting TAZs into smaller zones in high-density areas to reflect smart growth policies.[24] The TDM does include transit. Staff hope to upgrade in the future to an activity-based model. COG also used the CARB's EMissions FACtors (EMFAC) model. Together, CARB and Fresno COG designed and ran five sensitivity tests to the model to estimate GHG reductions and verify that the region's reduction targets could be met.

Fresno COG also used a number of off-model tools to address issues not covered by the TDM such as ride-sharing, employer-based commute strategies, bicycle and walk facility enhancements, and ITS deployments.[25] Fresno COG is working with the State's public health department to develop an Integrated Transportation and Health Model (ITHIM) in-house. The ITHIM is from England and was adapted by the health department; the Metropolitan Transportation Commission (MTC) in the San Francisco Bay Area and the San Diego Association of Governments (SANDAG) have also developed ITHIMs for their own regions. The ITHIM estimates the health co-benefits and potential harms from active transport and low carbon driving in urban populations. It relates physical activity, air pollution, and travel behaviors to specific health outcomes based on established causal relationships reported in the scientific literature for: heart and respiratory disease; stroke; diabetes; cancers of the breast, colon and lung; dementia; and depression. This is particularly significant given the high incidence with which the County's population faces many of these health problems.

In addition to more effectively considering public health in its future scenario planning activities, Fresno COG also continues to seek ways to more meaningfully consider (and, ultimately, address) social equity. In addition, staff are currently working on the agency's Congestion Management Process and are using the Process as an opportunity to explore improved performance monitoring systems that could be implemented.

LESSONS LEARNED

- Identifying the performance measures that will be used to evaluation scenarios up early in the scenario planning process helps ensure a productive and effective process. Tying scenario planning to performance meaures allow for more effective communication about

[24] Appendix J of the plan describes these in more detail. http://www.fresnocog.org/sites/default/files/publications/RTP/Final_RTP/Fresno_COG_2014_RTP-SCS_Appendix_Final.pdf.
[25] Id.

why some scenarios are better performing than others and the extent to which goals can be achieved under each scenario.

- In hindsight, the Fresno COG's staff found that evaluating scenarios that were not consistent with reality (e.g., those that did not take preapproved development plans into consideration) was not a particularly productive exercise. The lesson learned from this experience was that it is important to set ground rules regarding what changes will, and will not, be formally considered in developing scenarios. Any evaluating of expected impacts under unrealistic scenarios should be done simply to understand the likely impacts of future decisions.
- Engaging with partners early and often throughout the scenario planning process was key for ensuring unanimous consensus in selecting a scenario and assuaging local agencies' concerns about the (perceived) need to protect their land use authority.
- The mini-grant program for local community-based organizations to engage residents in the planning process was very successful and cost-effective. The relationships that were strengthened due to that program have enhanced the quality of planning in the region (e.g., through the engagement of non-English-speaking communities) and resulted in greater support in the community for the smart growth principles that date back to the Regional Blueprint process.
- Having highly skilled technical staff who are responsive is important for enhancing the ability to incorporate performance measures into scenario planning and conduct analyses that improve stakeholders' understanding about planning and investment options.
- Inclusion of groups whose interests are often not aligned with the agency's (e.g., Building Industry Association in this case) is valuable to improve understanding, identify opportunities for mutually agreeable solutions, and keep lines of communication open.

RESOURCES

- Fresno COG RTP/SCS website, http://www.fresnocog.org/sustainable-communities-strategy-development-and-outreach.
- San Joaquin Valley Blueprint Planning Process website, http://www.valleyblueprint.org/.

Hillsborough County MPO

The Hillsborough County MPO is responsible for transportation planning in Hillsborough County, Florida, which is located in the west-central portion of the State. Hillsborough County MPO's jurisdiction includes the cities of Tampa, Temple Terrace, and Plant City, and unincorporated Hillsborough County. The MPO Board is composed of elected officials from Hillsborough County, City of Tampa, City of Plant City, and City of Temple Terrace, as well as officials from the Hillsborough Area Regional Transit Authority (HART), Hillsborough County Aviation Authority, Tampa-Hillsborough Expressway Authority, Tampa Port Authority, and the Hillsborough County City-County Planning Commission.

Hillsborough County is home to about 1.2 million people and is the largest population and employment center within the Tampa Bay region, which is home to 2.8 million residents. The county is growing rapidly and is expected to add 600,000 people by 2040. The MPO boundary, as is typical in Florida, is concurrent with the county boundary, which means that the Hillsborough County MPO represents less than half of the metropolitan area's population of 2.8 million. Like Hillsborough County, the Tampa Bay region as a whole has been growing rapidly, which has led to severe traffic congestion. The region is the 12th most congested metropolitan area in the country, according to a report prepared jointly by the region's seven MPOs.

The region's land use and development pattern is an important aspect of the context for Hillsborough's transportation plans. Unlike Pinellas County, its neighbor to the west, Hillsborough County has an abundance of developable land. Therefore, it is likely to absorb much of the region's growth through 2040. A key question continuously facing the county and its transportation planners is where and how that growth will occur. The MPO's most recent scenario planning effort explored this question.

Table C-6: Hillsborough County MPO Population and Employment Growth

	2010	2040 Projection	Growth
Total Population	1,229,226	1,815,964	586,738
Total Employment	711,400	1,112,059	400,659

The MPO and the Hillsborough County City-County Planning Commission collaborated in 2013 and 2014 to update the MPO's long range transportation plan and the local governments' comprehensive plans concurrently. This effort was named Imagine 2040. The Hillsborough County City-County Planning Commission serves as the planning agency for all local governments in Hillsborough County. According to the Commission's website, "It performs consolidated planning services and makes independent recommendations to the Board of County Commissioners, Plant City Commission, Tampa City Council, Temple Terrace City Council and other appropriate public bodies concerning the orderly growth and development of Hillsborough County."[26] The MPO and

[26] The Planning Commission. Meeting the Planning Commissioners. Accessed February 19, 2015. http://www.planhillsborough.org/meet-your-planning-commissioners/.

the Planning Commission convened a working group of residents, students, business and civic leaders, retirees, and various professionals to guide development of the Plan.

The Imagine 2040 planning process is notable for its use of scenario planning at multiple points for different purposes. Hillsborough County MPO's process used scenario planning in the Direction, Analysis, and Programming phases of the process. The MPO used scenario planning to define a preferred future land use and transportation vision for the county. Later in the process to the agency used scenario planning to compare the performance of the transportation system under a trend investment scenario (in which funding followed recent trends) and in two investment scenarios with increased funding.

Figure C-12: Hillsborough County MPO's Imagine 2040 Planning Process

PBPP EXPERIENCE

The Imagine 2040 Plan includes six goals, each of which is divided into multiple objectives; each objective is then supported by a number of policies listed in the plan.

1. Enhance the safety and security of the transportation system for both motorized and non-motorized users.
2. Support economic vitality to foster the global competitiveness, productivity, and efficiency of local and regional businesses.

3. Improve the quality of life, promote energy conservation, and enhance the environment, while minimizing transportation-related fuel consumption, air pollution, and greenhouse gas emissions.
4. Promote accessibility and mobility by increasing and improving multi-modal transportation choices, and the connectivity across and between modes, for people and freight.
5. Assure that transportation improvements coordinate closely with comprehensive land use plans and support anticipated growth and development patterns.
6. Consider cost-effective solutions that preserve existing facilities and optimize the efficiency of Transportation System Management and operations.

The goals and objectives were informed by the first scenario planning exercise that the agency undertook to determine the preferred growth scenario that policy decisions should support. Although the goals consider the role of transportation in achieving societal benefits (e.g., improving economic vitality and global competitiveness, and reducing air pollution), the agency's specific performance areas and measures are more narrow in scope, including only measures that can be affected by the agency's policies and investments. The performance areas are:

- Preserve the System
- Reduce Crashes & Vulnerability
- Minimize Traffic for Drivers & Shippers
- Real Choices When Not Driving
- Major Investments for Economic Growth

Within each performance area, Hillsborough MPO identified relevant performance measures that it would use to evaluate performance. These are listed in Table C-7 below.

Table C-7: LRTP Performance Measures

Category	Measure
Preserve the System	Percentage of roads resurfaced annually (i.e., duration of resurfacing cycle in years)
Preserve the System	Number of transit road-calls (vehicle breakdowns) per day
Reduce Crashes and Vulnerability	Fatality rate per 100,000 residents
Reduce Crashes and Vulnerability	Pedestrian fatality rate per 100,000 residents (and/or Pedestrian Death Index)
Reduce Crashes and Vulnerability	Bicycle and pedestrian crashes per 100,000 residents
Reduce Crashes and Vulnerability	Injury crashes per 100 million Vehicle Miles Traveled (VMT)
Reduce Crashes and Vulnerability	Fatality crashes per 100 million VMT
Reduce Crashes and	Total crashes per 100,000 residents

Category	Measure
Vulnerability	
Reduce Crashes and Vulnerability	Total crashes per 100 million VMT
Reduce Crashes and Vulnerability	Travel time delay due to transportation network disruption (hurricane)
Reduce Crashes and Vulnerability	Lost trips due to transportation network disruption (hurricane)
Reduce Crashes and Vulnerability	Economic losses due to storm in 2014 dollars
Minimize Traffic for Drivers and Shippers	Reliability: Travel Time Index Planning Time Index (mean travel time/free flow travel time) *Segments with a ratio of over 0.8 identified as "needing improvement"*
Minimize Traffic for Drivers and Shippers	Arterial capacity (percentage increase)
Minimize Traffic for Drivers and Shippers	Incident frequency
Minimize Traffic for Drivers and Shippers	Incident duration
Minimize Traffic for Drivers and Shippers	Percent miles of congested freight routes
Minimize Traffic for Drivers and Shippers	Percent of freight hotspots mitigated
Minimize Traffic for Drivers and Shippers	Planning Time Index (freight travel time reliability measure)
Minimize Traffic for Drivers and Shippers	Buffer Index (amount of time that must be added for freight to travel through a corridor)
Minimize Traffic for Drivers and Shippers	Cost of freight delay
Real Choices When Not Driving	Transit Level of Service (Using Florida DOT's ARTPLAN methodology)
Real Choices When Not Driving	Percentage of 2040 population and jobs served by bus system
Real Choices When Not Driving	Percentage of the population served by fixed route transit
Real Choices When Not Driving	Pedestrian Level of Service (PLOS)
Real Choices When Not Driving	Bicycle Level of Service (BLOS)
Real Choices When Not Driving	Percentage of the population living near a "good" or "excellent" walk/bike facility
Real Choices When Not Driving	Percentage of jobs located near a "good" or "excellent" walk/bike facility
Major Investments	Portion of roadway facilities at least 30 percent over capacity in 2040

Category	Measure
for Economic Growth	(according to forecast)
Major Investments for Economic Growth	Delay reduction-to-Centerline Miles (constructed) Ratio
Major Investments for Economic Growth	2040 Jobs-to-Centerline Miles (constructed) Ratio

SCENARIO PLANNING EXPERIENCE

The Imagine2040 plan and process are particularly notable because Hillsborough County MPO used scenario planning for multiple purposes to support decisionmaking in all four key phases of the PBPP process, as detailed below.

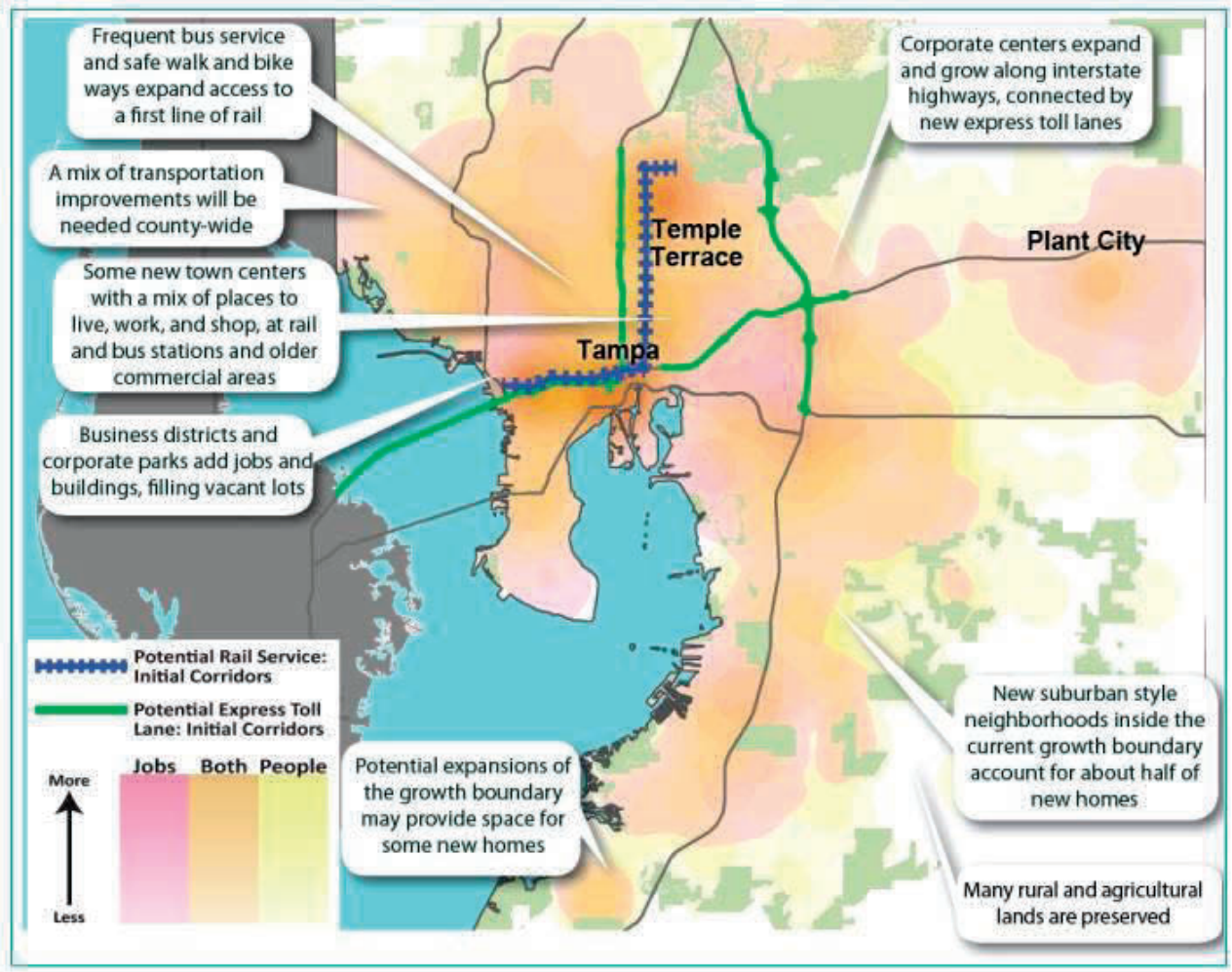
Scenario Planning to Support Direction Phase

The MPO and the Hillsborough County City-County Planning Commission convened the working group to develop the following three growth scenarios:

- **Suburban Dream:** This scenario "is primarily low-density residential growth with employment spread across the county. This vision, because it tends towards low-density residential development, will consume the most agricultural and rural land of the three."
- **Bustling Metro:** This scenario "is a much higher density approach to residential development, occurring closer to the urban centers. Employment occurs primarily in the existing economic centers. These factors result in little demand to expand the Urban Service Area boundary, and agricultural and rural lands are protected."
- **New Corporate Centers:** This scenario "envisions somewhat denser residential development, with most new jobs created in identified job centers. There may be a moderate need to expand the Urban Service Area boundary around the interstate highway and interchanges to accommodate these centers. Because much of the residential growth will continue in a suburban pattern, some agricultural and rural lands will consumed by development."

The Planning Commission and MPO took the scenarios to the public and solicited feedback through an online survey (3,500 responses), nearly 100 meetings, and interactive kiosks at 49 locations throughout the County. Based on the feedback received, the working group and MPO developed a fourth scenario called the Hybrid Scenario. This scenario is a combination of the Bustling Metro and New Corporate Centers scenarios. The Hybrid Scenario is depicted in Figure C-13, as it appears in the long range transportation plan.

Figure C-13: Imagine 2040 Preferred Scenario



The MPO used MetroQuest to obtain public input on the scenarios. The MPO states in the plan that "this online community engagement platform allowed the public to select future growth strategies as well as choose their preferred future transportation infrastructure program investment levels and major projects they want for Hillsborough County."[27] The MPO also used Facebook and Twitter to communicate with the public.

Using the regional travel demand model, the MPO evaluated the scenarios according to the performance measures listed in Table 8. These measures are broader than the measures listed in Table C-, which the MPO used to assess transportation needs and evaluate investment scenarios. The MPO intentionally selected measures that it thought would resonate with the public.

[27] Hillsborough MPO. *Imagine 2040: Part 2 Public Engagement Summary.* September 23, 2014. http://www.planhillsborough.org/imagine2040/.

Table C-8: Performance Measures Used to Evaluate Scenarios

Category	Measure
Impact on Agriculture	Potential impact on agricultural lands by increased residential development
Impact on Natural Resources	Potential for large wetlands (greater than 40 acres) and designated Significant Wildlife Habitats to be impacted by the increase in residential development
Efficient Energy Use	Energy consumption by vehicles (cars, trucks, buses, passenger rail), and by typical households living in single-family homes or apartments
Efficient Water Use	Water consumption by typical households living in single-family homes or apartments
Impact on Water Quality	Relative increase in impervious surfaces
Job Creation	Population to job ratio
Traffic Delay/Traffic Congestion	Vehicle hours of delay per person on a typical weekday
Shorter Commutes	Length of the average home-to-work trip
Air Pollution Rate	Total tons of emissions from vehicles, standardized per person
Cost to Expand Infrastructure	Relative cost of providing infrastructure to each new home or apartment
Potential for Redevelopment	Potential for previously developed office, retail or industrial land to attract a new use
Available Bus or Rail Service	Percentage of all people and jobs that are within walking distance to bus service
Access to Jobs from Underemployed Communities	A forecast of the length of the average home-to-work trip for communities protected under the Executive Order on Environmental Justice, and the percent of those communities with access to transit service running at least once every 30 minutes

The Imagine2040 Plan includes visualizations to help stakeholders and the public understand each scenario's expected impact on performance for each of the measures listed above. The MPO presented the results graphically rather than quantitatively. Figure C-14 shows an example of these visualizations.

Figure C-14: Visualization of Expected Performance for Each Scenario

Based on the community's input, the MPO ultimately settled on a new alternative scenario that combined aspects of the Bustling Metro and New Corporate Centers scenarios. This preferred scenario, also called the Hybrid Scenario, became the basis for the *Imagine 2040* Long range Transportation Plan. It allocates growth primarily to infill development, along with selected locations for future intense development around fixed guideway transit. It also calls for a modest expansion of the urban service boundary.

The MPO and the Hillsborough County City-County Planning Commission jointly prepared the scenarios. The MPO makes the following statements in the long range transportation plan about the *Imagine 2040* Scenario Planning project:

- The Long Range Transportation Plan's goals, objectives, and policies take into consideration input from the preferred growth scenario
- The MPO used the Hybrid Growth Scenario to identify the needed transportation projects.

Scenario Planning to Support Analysis and Programming

In addition to developing and evaluating growth scenarios, the MPO also followed a scenario planning approach to examine how low, medium, and high levels of financial investment would affect system performance (Investment Levels 1, 2, and 3 in the plan). Under Investment Level 1, the MPO would continue recent spending levels. Investment Levels 2 and 3 represent higher levels of funding allocated to the needs identified in the long range plan. The MPO found that this scenario planning process raised public awareness about what was possible under the trend level of funding and how the additional funding could improve system performance.

The agency evaluated expected performance with respect to each of the plan's performance measures for each Investment Level. In the example in Figure C-15, the plan identifies the expected benefits for each level of investment. In this example, the benefits are cumulative, with Investment Level 3 resulting in 117,000 daily truck trips flowing more smoothly through intersections, as well as a reduction of 10 hours per day of traffic stoppage.

Figure C-15: Expected Freight Performance under Investment Levels 1, 2, and 3

Figure 3-7: Freight Program Funding Tier Spending				
		Project Costs	Investment Level Costs	Investment Level Benefits
	Baseline (Total value of FDOT Freight Quick Fix projects in Hillsborough County funded in the current adopted five-year FDOT Work Program)	$3,105,333		
LEVEL 1	**72 operational and minor infrastructure projects** (continuation of FDOT Freight Quick Fix program)	$17,020,523	$17,020,523	117 thousand daily truck trips flow better through intersections
LEVEL 2	**Add one railroad grade separation**	$50,652,000	$67,672,523	Above, plus: removes traffic stoppage of about 5 hours per day
LEVEL 3	**Add second railroad grade separation**	$37,520,000	$105,192,523	Above, plus: removes another traffic stoppage of about 5 hours/ day
	Total Freight Needs (Includes additional grade separations)			$956,773,568
	Unfunded Freight Needs (Beyond Level 3 Investment)			$851,601,045

In addition to examining investment levels, the agency looked at eight different funding scenarios that could be employed to enable higher investment levels that were analyzed. The MPO took this

step in response to a failed referendum in 2010 that would have raised additional local funding for transportation. The MPO conducted surveys following the failed referendum that found people in the county wanted to know where their additional tax dollars would go and what the benefits would be. The funding scenarios listed below represent a different combination of potential changes to existing revenues and/or reallocation of revenues. The MPO adopted Scenario 8, which depends on a one-cent sales tax dedicated to transportation. This level of funding would allow all categories (Preserve the System, Reduce Crashes & Vulnerability, Minimize Traffic for Drivers & Shippers, Real Choices When Not Driving, and Major Investments for Economic Growth) to be funded at Investment Level 2 and most would be funded at Investment Level 3. They are:

- Scenario 1 (Baseline) - Existing revenues, existing spending
- Scenario 2 - Existing revenues, refocused on programs rather than road widening
- Scenario 3 - Enhanced revenues but no new tax referendum
- Scenario 4 - ½ Cent Sales Tax with Focus on Roads (local & State priority projects)
- Scenario 5 - ½ Cent Sales Tax with Focus on Alternatives & Preservation
- Scenario 6 - ½ Cent Sales Tax with Focus on Roads (high traffic-delay roads)
- Scenario 7 – 1 Cent Sales Tax and Roll Back HART Ad Val Tax S
- Scenario 8 – 1 Cent Sales Tax and Fully Fund most Programs

Scenario Planning Exercise to Support Analysis and Decisionmaking

During the Investment Level analysis, Hillsborough County MPO also conducted a Vulnerability Analysis, which was intended to explore the estimated impact of a Category 3 hurricane on the transportation system. . The region has three major bridges that are vulnerable to the storm surge from such as hurricane. The port is another key asset that is vulnerable. The purpose of this scenario planning exercise was to quantify the economic damage from flooding and then to study how different types and levels of investment could reduce the economic damage.

The agency evaluated each of the three investment level scenarios according to three performance measures:

- Travel Time Delay due to transportation network disruption;
- Lost Trips due to transportation network disruption; and
- Economic Losses due to storm in 2014 dollars.

The findings from this analysis are in Figure C-16 below.

Figure C-16: Vulnerability Analysis Results – Expected Impacts under Three Investment Levels

LEVEL 1

Investment Level 1:

- Cost over 20 years: Approximately $629 million;
- Funds only routine stormwater drainage improvements, and is based on current spending trend;
- 8 weeks of road network disruption due to representative Category 3 storm; and
- Economic loss to Hillsborough County: $266 million.

LEVEL 2

Investment Level 2:

- Cost over 20 years: Approximately $660 million;
- Funds Interstates only with drainage improvements, shoreline armoring and wave attenuation;
- 6 weeks of road network disruption due to representative Category 3 storm;
- Economic loss to Hillsborough County: $153 millior or 42% less than Investment level 1; and
- $31 million additional investment compared with Level 1 results in $113 million benefit in avoided losses.

LEVEL 3

Investment Level 3:

- Cost over 20 years: $772 million;
- Funds Interstates and arterials with drainage improvements, shoreline armoring and wave attenuation;
- 3 weeks of road network disruption due to representative Category 3 storm;
- Economic loss to Hillsborough County: $119 million or 55% less than level 1; and
- $112 million additional investment compared with Level 1 results in $147 million benefit in avoided losses.

The MPO assumed a sea level rise of 14 inches for this analysis. The MPO examined how long infrastructure would be disrupted by this hurricane under a "no build" (also called no adaptation) scenario. It also considered the economic impact of taking infrastructure off line. This scenario assumes no new risk management investments are built or implemented. The MPO compared this "no build" scenario with a medium- and high- risk management investment scenarios. The medium investment scenario assumed shoreline armoring, elevated coastal roadway profiles, and improved drainage on interstate highways. The high investment scenario assumed those improvements would be extended to arterials roadways. The hurricane would cause about $266 million in economic loss under the no build scenario, $153 million in the medium investment scenario, and $119 million in the high investment scenario.

The outcomes of this scenario planning have been useful in the MPOs coordination with the Florida Department of Transportation (FDOT). FDOT has been working to reduce vulnerability through design each time it rebuilds a highway or bridge that could be effected by rising sea levels and storm surges.

Scenario Planning Analysis Tools to Support Implementation

When the final plan was approved and Investment Levels (1, 2, or 3) for each of the expenditure programs was confirmed, Hillsborough County MPO conducted an analysis of the expected performance of the adopted plan with respect to vehicle hours of delay and transit ridership. The development of projected performance for the adopted plan and scenario will allow the agency to periodically track performance and identify whether outcomes are trending in the desired direction and whether improvements in performance are commensurate with the investments and policy changes that have been made.

DATA AND TOOLS

The Tampa Bay Regional Planning Model (the agency's TDM) is the primary tool used by the MPO to develop the long-term transportation needs assessment and to evaluate the effectiveness of specific project investments against a traditional set of transportation system performance goals. For some measures, such as reliability and crash reduction, the MPO took the travel demand model outputs and does post-processing using separate statistical analysis software.

The MPO also uses the REMI econometric modeling tool to estimate the economic impacts of storm surge related disruption (from a Category 3 hurricane in 2040). In addition, the MPO used basic GIS software for some measures, such as Transit Level of Service (TLOS).

CONNECTIONS BETWEEN SCENARIO PLANNING AND PBPP

The Hillsborough MPO incorporates scenario planning throughout its long range transportation planning and programming process. The MPO first used a normative approach to scenario planning to evaluate three alternative future growth patterns. The MPO developed a set of performance measures to evaluate the scenarios and ultimately settled on a hybrid scenario that is characterized by more compact development than recent trends. The preferred scenario influenced the MPO's goals and objectives.

The MPO used the preferred scenario to develop goals and objectives. Then, Hillsborough County MPO used scenario planning to evaluate the extent to which outcomes could be improved under three different investment scenarios for performance measures in five areas: preserving the transportation system, reducing crashes and vulnerability, minimizing traffic for drivers and shippers, enhancing non-driving travel choices, and making investments to support economic growth. These performance areas are closely aligned with the MPO's goals, expressed in the long range transportation plan, though they were narrower in scope to reflect the key areas in which the agency has the ability to improve performance directly.

The Planning Commission is currently (early 2015) updating the local governments' comprehensive plans to reflect the Imagine 2040 preferred scenario.

RESOURCES

- Long range Transportation Plan: http://www.planhillsborough.org/2040-lrtp/
- Transportation Improvement Program: http://www.planhillsborough.org/transportation-improvement-program-tip/
- Unified Planning Work Program: http://www.planhillsborough.org/unified-planning-work-program/

U.S. Department of Transportation
Federal Highway Administration

Office of Planning, Environment, & Realty (HEP)
1200 New Jersey Avenue SE
Washington, DC 20590
www.fhwa.dot.gov/planning/

June 2016

Publication No.: FHWA-HEP-16-068