SUSTAINABLE TRANSPORTATION SYSTEMS AND SUSTAINABILITY AS AN ORGANIZING PRINCIPLE FOR TRANSPORTATION AGENCIES

INTERIM REPORT # 1
Prepared for the
NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP)
TRANSPORTATION RESEARCH BOARD
OF
THE NATIONAL ACADEMIES

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES
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Submitted by:

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McLean, Virginia
March 6, 2012
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1. EXECUTIVE SUMMARY

The purpose of this Interim Report is to convey results to date of the National Cooperative Highway Research Program (NCHRP) Project No. 20-83 (07), “Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies.” Specifically, this report is the first of two Interim Reports to be produced under this project; a final report will follow. This report:

- Provides the background for the report, including an overview of the NCHRP 20-83 projects;
- Describes the objectives and scope of the project;
- Defines sustainability and organizing principles and assesses the current progress and ability of transportation agencies to support a sustainable society;
- Presents literature research and thought-leader interview findings on current sustainability-related practices and initiatives;
- Postulates and assesses the key gaps between present day agency functions and those that would most likely be needed in a future sustainable society setting;
- Presents multiple plausible future scenarios and identifies future opportunities and challenges that transportation agencies would encounter in a sustainable society setting under each of the scenarios;
- Outlines strategies and principles to address the gaps, challenges, and opportunities in the near term and as potential scenarios develop; and
- Identifies tools and methods to be developed (to be developed further in Interim Report #2).

It is important to note that this research is not to advocate or to predict that sustainability will become a viable overarching organizing principle for transportation. Rather, the work is to consider how transportation might best support a sustainable society in the future—and to examine what the implications for the transportation community might be if sustainability is adopted as an organizing principle for transportation agencies. The time-horizon for this research is between 2012 and 2050.

The scope of the research objective is unprecedented—and actual experience with the managed achievement of a Triple Bottom Line (TBL) sustainable society is nonexistent. Additional challenges include the following:

- **Predicting a distant future**: This is of course impossible to do with precision and detail. To cover the possibilities, the research team developed a set of plausible futures using
logical projections of the key drivers that are likely to affect social, economic, and environmental conditions. But we cannot foresee the “expected unexpected,” and the details of each projection are somewhat speculative and debatable.

- **Defining sustainability in programs and literature:** The term “sustainability” is overused and misapplied and refers frequently to initiatives that focus on operational or project-level sustainability, or on a single bottom line—usually environment or greening. This report uses “TBL” when “Triple Bottom Line” sustainability is intended.

- **Applying economic and social theories to long-term demographic effects:** With much of the infrastructure and jurisdictions fixed, significant demographic shifts (even gradual ones) can present governance, management, resource, and TBL policy challenges to agencies at all levels.

An overview of the research approach is shown in Figure 1 below.

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**Figure 1: Research Overview**

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**Defining “Organizing Principle” and “Policy System”**

“Organizing principle,” means a core assumption from which everything else can derive a classification or value. That is, an organizing principle is a central reference point or organizing framework that allows all other concepts or values to be located in a single conceptual map. In terms of the design of organizations and decisionmaking structures, organizing principles sit above statements of specific goals or objectives, decisionmaking tools, and policies. Organizing
principles represent a paradigm through which all aspects of a delivery system for a public good are considered.\(^1\)

With a slightly broadened definition, “organizing principle” is commonly understood as “policy system.” A policy system encompasses the same policymaking and high-level functional components as does an organizing principle. A policy system includes a more explicit overarching priority at the top level, along with measurement systems and feedback to enable and inform policy. The overarching priority and measurement concept resonate very well with the past and present experience with evolution of organizing principles, or policy systems.

An evolving policy system:

- Starts with a strong, widely held belief in an overarching priority, concern, or concept;
- Builds on policy and measurement approaches that can support and inform policy and regulation; and
- Engages high-level functions to deliver on the priority and concept.

Policy systems have evolved in this way for generations. Early in U.S. history, transportation played an important role in opening up the country’s resources and fueling the industrial revolution. Mobility then became a policy system as it drove major transportation infrastructure development. As the infrastructure fueled growth, the U.S. policy system gradually evolved to respond to safety and environmental concerns that had generally been absent earlier. Those concerns were then met with the development of extensive regulation, further transforming the policy system focus to regulatory compliance. Today, a new policy system is evolving that seems to be focusing on non-renewable resources and climate change concerns, though all levels of government have not yet embraced this system.

Policy systems exist singly or in parallel in society, depending on the sector focus of the priority or the concept driving it. Policy systems evolve and decline as priorities strengthen and abate.

For this research, the team developed and characterized the past, present, and future evolution of policy systems for transportation. Section 4 lays out system models for the five identified policy systems. The evolution identified begins with the early policy system of the 1950s and

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\(^1\) Public goods (and services) in this sense generally refer to the goods and services provided by a government to its citizens. A government provides public goods and services directly (through the public sector); by financing private provision of services; or by implementing policies that encourage individuals, the private sector, and other groups to provide those goods and services. Even where public goods and services are neither publicly provided nor financed, for social and political reasons they are usually subject to regulation.
1960s (Transportation Only), evolves though another distinct phase (Compliant Transportation) into the current decade (“Green” Transportation), and then evolves through another phase (Sustainable Transportation) to the future (TBL-Sustainable Society) policy system. These are depicted and generally characterized in Figure 4.

The policy systems depicted are thematic and apply to transportation as a whole. Not all transportation agencies and sectors adapt to aspects of these policy systems in the same way or during the same timeframe. Section 4 illuminates this point further. It describes the policy systems, as well as where various levels of U.S. government agencies and international governments appear on this spectrum. The research team focused the gap analysis by contrasting Level 4, TBL Sustainability, with Level 2, “Green” Transportation. Level 2 is the best overall characterization of the policy system in effect today for transportation as a whole.

**High-Level Functional Framework for a Policy System**

To frame and structure an analysis of a future policy system based on sustainability, the research team determined to focus initially on the high-level functions of governance, policymaking and decisionmaking, and enterprise management. These high-level functions are
common to federal, state, and local transportation policy systems. The functional framework involves three broad categories, as shown in Table 1.

**Table 1: Functional Framework for Assessment of a Future TBL Policy System**

<table>
<thead>
<tr>
<th>High-Level Functions</th>
<th>Functional Category</th>
<th>Enterprise Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governance and Policy-making</td>
<td>Decision-making</td>
<td>Service and Product Delivery</td>
</tr>
<tr>
<td>Consensus on Needs and Goals</td>
<td>Planning and Programming</td>
<td></td>
</tr>
<tr>
<td>Regulation and Rulemaking</td>
<td>Budgeting and Resource Allocation</td>
<td></td>
</tr>
<tr>
<td>Outreach and Communications</td>
<td>Compliance and Dispute Resolution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Education, Training, and Culture Change</td>
<td></td>
</tr>
</tbody>
</table>

These functions do not form a strict hierarchy—rather, they are the core functional components that work to establish a policy system and deliver transportation products and services. The core functions are used in this report to enable systematic assessment of sustainability as an organizing principle—or policy system—for transportation.

The core functions do not necessarily imply specific activities vested in specific entities. Under any policy system, they are core functions that one, some, many, or all entities engaged in the business of transportation could execute. Today, numerous entities structure and execute these functions to follow various policy systems (e.g., mobility, safety, economic development, environmental stewardship). The body of this report further describes and assesses the core functions.

The research team notes here that the future “lines and boxes” aspects of a policy system can follow many structural schema. The practical considerations of authorities, nature of tradeoffs and decisions, information to be processed, geography, and cross-sector and multimodal issues and strategies will ultimately drive the basic institutional, commercial, and government structures and relationships that make best sense at the time.

**Defining Sustainability and Key Assumptions**

There are many popular definitions of sustainability in use today. The research team has based its working definition on the report of the Brundtland Commission, *Our Common Future*, which provides a now well-accepted definition of sustainable development: “Sustainable development is development that meets the needs of the present without compromising the ability of future
generations to meet their own needs” (World Commission on Environment and Development, 1987).

NCHRP Project No. 08-74: A Guidebook for Sustainability Performance Measurement for Transportation Agencies has developed guidance for state departments of transportation (DOT) and other transportation agencies to understand and apply measures and concepts of sustainability. This guidance also contrasts sustainable development and the larger concept of sustainability. Nevertheless, the basic thrust of the Brundtland definition is generational equity, it and serves as a reasonable definition to apply to sustainable society. Sustainability calls for consideration of three dimensions: economic, social, and environmental—the elements of the TBL. The research team used TBL as an appropriate descriptor in the research and also adopted some additional key assumptions:

- **TBL focuses on the long rather than the short term**: The key requirement of sustainability is to allow fulfillment of present as well as future needs; present and future needs fulfillment must occur for development to be sustainable.

- **TBL is an integrated rather than a “standalone” concept**: TBL is not exclusive to any one policy area or system. Specifically, given the integrated nature of transportation with the rest of human activity, it is difficult to view the transportation system in isolation. Sustainable transportation requires considering a broad definition of sustainability that considers how transportation affects overall social sustainability and how other policy areas need to be coordinated to achieve sustainability.

- **TBL is multidimensional**: The three TBL dimensions do not represent clearly distinct compartments; rather, they provide ways to systematically view the interlinked character of societal development as it draws on environmental, economic, and social resources and mechanisms. Development along the TBL dimensions does not take place in a governance vacuum; it presupposes institutional arrangements and institutional reforms.

**Sustainable TBL**: Society can work toward this concept with specific environmental, social, or economic improvement initiatives, but to reach the goal of sustainable TBL, programs need to—

- Provide for generational equity in society’s well-being overall, per Brundtland;
- Stand up to TBL challenges under a range of plausible future scenarios, and at the same time; and
- Be based on long-range logic and TBL decisions that yield discernible return on investment (ROI) to ensure support.

The long-range, broad risk/reward decisions and planning needed to address generational equity on a TBL scale are foreign to the shorter and mid-range perspectives of most decisionmakers in both the public and private sectors. The necessary extent of multiparty
engagement in decisionmaking is also unprecedented. Our society can be easily distracted from sustainable TBL by pressing near-term issues or by the need for a narrow focus on a singular long-term challenge (albeit important). The latter is perhaps why our policy system has been tilting for the last few years toward emphasis on reduction of greenhouse gas (GHG) emissions. This is not to say GHG reduction is not a very big concern nor that it does not go hand in hand with the need to reduce fossil fuel consumption. But by the policy system definition above, GHG abatement has passed through the “widely held belief” stage, and many agencies and interest groups are now working energetically on the second stage (policy and measurement) in the United States and overseas. The research team has taken some perspectives from the GHG case to inform our research on how a future sustainable TBL policy system will likely evolve.

In practice, the term “sustainability” is used very loosely. It is used most often in reference to objectives connected primarily to one of the three bottom lines or to specific assets or processes, such as “sustainable business,” or “sustainable hotels.” This has complicated the dialogue and the assessment of best practices that can apply to sustainable TBL.

Transportation asserts an enormous impact on all three elements of the established view of TBL sustainability — with both benefits and impact:

- **The economy** is highly dependent on the readily accessible and efficient movement of people and commerce, but it is also very sensitive to availability and cost of resources — and transportation consumes about a quarter of all the energy we use.

- **Social** well-being depends heavily on accessible and efficient transportation services; however, extensive fixed infrastructure and operations that intrude on quality of community life strongly affect social well-being. Effective transportation planning and development practices can mitigate or resolve many of these issues.

- **The environment** does not benefit in many ways from transportation; at the same time, transportation agencies focus deeply on compliance with environmental regulations and on initiatives to mitigate negative impacts on and enhance the environment.

### Table 2: Dependency and Sensitivity in the TBL Elements

<table>
<thead>
<tr>
<th>Sustainable TBL “Bottom Lines”</th>
<th>Sensitivity to Risk Decisions and Tradeoffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Cyclical, resource-sensitive, otherwise fairly independent, resilient, and driven by market supply/demand</td>
</tr>
<tr>
<td>Social</td>
<td>More dependent and sensitive to economy and environment than vice versa</td>
</tr>
<tr>
<td>Environmental</td>
<td>Air and water have been resilient, but physical destruction of natural features and exhaustion of non-renewable resources are virtually unrecoverable</td>
</tr>
</tbody>
</table>
RESEARCH FINDINGS

For this report, the team interviewed 54 subject matter experts, thought leaders, and senior agency officials were interviewed; many of them twice. In addition, extensive literature research was performed. Some of the key take-aways from the interview process are shown in Table 3 below. These reflect some divergence of opinion, but these points were shared by multiple interviewees.
Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies
Interim Report #1

Table 3: Key Interview Take-Aways

| **Sustainability is a complex, challenging idea:** |
| Definitions are complex and ambiguous. |
| Some are hostile to the concept and uncomfortable with its connotations. |

| **Understanding of and support for sustainability is increasing:** |
| The current trend is toward acceptance of the need for sustainability. |
| Transportation policy is increasingly integrating the concept of sustainability. |

| **TBL is fine, but it needs a fiscal element:** |
| TBL needs to address sustainable fiscal capacity. |
| Long-term funding and support commitments are needed. |

| **Social indicators are difficult to develop:** |
| Developing credible social indicators is challenging. |
| Cost is prohibitive and measures are difficult to apply. |

| **Waiting for demand versus developing demand:** |
| Tendency exists to wait for strong leadership from the state or local leaders or the public as a whole. |
| Small modifications in the planning process can build constituency. |
| Waiting for public policy is not necessarily the best solution. |

| **Sustainability can’t be an add-on, it must inform culture and process:** |
| Sustainability needs a total process and culture change. |
| TBL is outside the context of traditional transportation planning and engineering. |
| Performance standards should be used to influence change. |
| New internal processes and organization schemes are needed. |

| **Once size will not fit all:** |
| Case conditions vary so much that tailored different solutions are needed. |
| Need for a range of tools and accepted performance standards. |
| Methods are needed to normalize different measures and indicators. |
| Scenario planning could be useful in planning for sustainability. |

| **Need to Build the Business Case for Sustainability and Show ROI:** |
| Need a comprehensive business case for sustainability. |
| Appropriate ROI tools for sustainability do not exist in the U.S. |

| **Sustainability requires public involvement and stakeholder buy-in:** |
| Substantial stakeholder buy-in and constant public involvement needed. |
| Concept is too far reaching for the traditional technocratic public involvement process. |

| **Localities are the leaders in sustainability:** |
| Localities influence land use, transit, user charging, voters. |
| States more limited to management of highway systems and other facilities. |
| Need for coordination of programs with modal agencies and localities. |

The literature research confirmed the interview findings overall and added considerable best practice information. It also added perspective that informs the work throughout report. Information on specific subject areas and transportation agencies is organized in Chapter 3 as follows:

- Sustainability Programs in State DOTs;
- Funding and Needs Assessment;
- Sustainability, Resource Allocation, and Intergenerational Equity;
- Coordination and Planning;
• Data and Performance Measures;
• Culture Change, Outreach and Communication;
• Local Government and City Sustainability Programs;
• Trends in Local Government Sustainable Transportation Programs;
• Federal Sustainability Programs; and
• Sustainability and Sustainable Transportation Programs and Policies in Other Countries.

**Gap Analysis**

The research team compared the high-level functional characteristics of the current predominant transportation policy systems to the functional characteristics needed for the sustainable TBL policy system. The principal gaps to fill in those functional characteristics are—

• Credible and widely applied performance measurement framework for TBL;
• Application of life-cycle cost analysis (LCCA), total cost accounting (TCA), and sustainability accounting based on TBL;
• Broad consensus on performance assessment processes to address TBL and the contribution of transportation to TBL;
• Increased incorporation of TBL impact assessments in planning and programming;
• Direct public and private sector engagement in needs development;
• Market and business incentives for private industry to share and engage in TBL goal-setting and decisionmaking;
• Integration of sustainability tools in decisionmaking;
• Established multimodal, multiagency, multisector, and multijurisdiction planning and decisionmaking to address evolving regional needs and consensus on TBL issues; and
• Multimodal, multiagency, multisector, and multijurisdiction programming with clear mandates and authorities (as for megaregions for example) to better leverage resources.

**Scenario Development**

The policy system for sustainable TBL will represent large and gradual societal culture changes evolving over a long period. Because that system would evolve in future conditions, the research team used a scenario planning approach to help frame the plausible conditions for transportation in a sustainable TBL society. The team synthesized five plausible future scenarios, each with variations in some basic assumptions and scenario drivers. The team then evaluated these scenarios to determine key future challenges and opportunities for transportation. The five scenarios are briefly described as follows:
• **Crisis World** is the most pessimistic scenario the research team developed and is a world undergoing persistent, recurrent, multidimensional crises. Under this scenario, environmental crises and resource depletion are occurring much sooner and more quickly than currently anticipated, while the economy is trapped in an ongoing economic recession with slow growth.

• **Mega World** is one of two “as-expected” scenarios. The future is viewed as a general continuation of current trends. Economic and population growth are concentrated in growing megaregions, technology is anticipated to develop along all anticipated paths, and there is a slow adoption of new transportation funding mechanisms.

• **Suburban World** is also an “as-expected” scenario. The future is viewed as a general continuation of current trends. Technology is anticipated to develop along all anticipated paths and enables people to disperse to suburbs, small towns, and second-tier cities. There is slower adoption of new transportation funding mechanisms.

• **Wonder World** is one of two “positive” scenarios. In this scenario, there is better-than-currently-expected economic growth, and technology development is more rapid than currently anticipated. Environmental challenges remain manageable and population grows rapidly. The dynamic economy, personal wealth, and technology lead to a more dispersed population.

• **Green World** is a mostly positive scenario. In this scenario, there is rapid economic growth, technology development, and population growth. There is also broad social and political consensus to strive to manage a “greener” sustainable society. As a result, there is substantial investment in green technologies and infrastructure, with substantial regulation and greater social and economic control.

**Future Challenges and Opportunities for Agencies**

Table 4 and Table 5 list key expected challenges and opportunities that would plausibly arise under each of the scenarios developed. Please note that these are presented in the present tense, as from a future point of view, just as the scenario “stories” are described with a future-looking-backward perspective.
### Table 4: Challenges under Different Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Challenges</th>
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| Crisis World   | • Recurrent environmental crises that have dramatic negative impacts on transportation infrastructure; greater demands to maintain basic services  
                        • Gradual, persistent, long-term economic decline and slow growth mean less resources available to achieve goals  
                        • Reduced Federal Government spending and transfers to state and local government mean greater inequality between regions  
                        • Lack of technological progress reduces the likelihood of technological solutions  
                        • Difficult to maintain all transportation facilities with constrained resources — need to prioritize crucial assets  
                        • The best assets that can be maintained and operated with user fees are privatized; agencies must make decisions to maintain or decommission the less popular bus routes and low-demand bridges and roadways  
                        • Limited resources to enforce traffic rules and user safety  
                        • Difficulty maintaining funding (worsening economic growth)  
                        • State government shrinks in response to declining revenues, resulting in fewer staff at transportation agencies  
                        • Mishandled, poor, or missing information leads to bad decisions about funding priorities  
                        • Fewer amenities (e.g., goods, health care, parks) available  
                        • Different entities have different priorities, forcing the agency to make tradeoffs in deciding where to allocate limited funds  
                        • Need for a process for decommissioning unsustainable infrastructure  |
| Mega World     | • Gradual centralization to megaregions and megacities requires changing funding mechanisms and increasing spending on infrastructure  
                        • Need to address social and economic equity impacts on the “left-behinds” outside megaregions (i.e., regions that are trapped in long-term decay and economic decline)  |
| Suburban World | • Gradual decentralization from megaregions and megacities requires changing funding mechanisms  
                        • Need to address social and economic equity impacts of the “left-behinds” in the cities (i.e., regions that are trapped in long-term decay and economic decline)  |
| Wonder World   | • Recurrent disruptive technologies cause dramatic change to society and the economy  
                        • Increasing population growth and greater diversity of population (more diverse ethnic population and aging population)  
                        • Increasing economic and technological growth, leading to greater demand for mobility of goods and people  
                        • Rapid technology innovations, leading to one region implementing a technology that quickly becomes outdated; technologies may not link across regions  
                        • Some technologies may require new infrastructure (e.g., new right of way for smaller, lighter vehicles; “air train” rapid transit; multijurisdictional management systems)  
                        • Agency staff unable to keep up with technologies and needed changes  
                        • New technologies require new standards and safety considerations  
                        • Need for new transportation revenue sources as new sources of fuel and propulsion are used  |
### Scenario | Challenges
--- | ---
**Green World** | • Increasing population growth and greater diversity of population (more diverse ethnic population and aging population)  
• Demand that all sectors of society become substantially “greener”  
• Greater concentration of population in green urban areas results in need to address social and economic equity impacts on the “left-bet...  
• Major decrease in personal vehicle travel, requiring agencies to provide sufficient alternatives for intra- and inter-city travel  
• Move away from carbon-based fuels requires new vehicles and new infrastructure

### Table 5: Opportunities under Different Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Opportunities</th>
</tr>
</thead>
</table>
| **Crisis World** | • Crisis allows for local and regional response to problem  
• Withdrawal of Federal Government opens up new areas of regional, state, and local action; more flexibility  
• Austerity forces transportation toward “low-level” sustainability; that is, reduce the size of the network and focus on key sustainable elements |
| **Mega World** | • Gradual centralization to megaregions and megacities means cities and regions have the resources to address problems |
| **Suburban World** | • Gradual decentralization means cities and regions have the resources to address problems |
| **Wonder World** | • Resources are available to support expansion of sustainability-based transportation system  
• Technology facilitates new planning and participation mechanisms, real-time performance management, and controlled and flexible resource allocation |
| **Green World** | • Withdrawal of Federal Government opens up new areas of regional, state, and local action; more flexibility  
• Austerity forces transportation toward “low-level” sustainability; that is, reduce the size of the network and focus on key sustainable elements |

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**Addressing the Functional Gaps under the Scenarios**

The team then reviewed the functional gaps in the context of the scenarios and identified basic principles to prepare for change as the real future emerges. These principles are summarized briefly below and discussed in greater depth in the body of the report:

- **Adopting a precautionary approach to policymaking and decisionmaking:** A precautionary approach to decisionmaking means taking into account the level of risk, using existing knowledge, and accounting for uncertainties. The approach recognizes a social responsibility to minimize the community’s exposure to harm as much as possible when detailed situational analysis and investigation have found a plausible risk arising from a decision or policy choice.
• **Choosing flexible or adaptive management options**: Flexible or adaptive management strategies are based on the insight that knowledge and understanding of social, economic, and environmental conditions is inevitably partial, limited, held in different forms (e.g., data, tacit knowledge and understanding, experiential information), and widely distributed among different individuals, groups, and organizations. As such, one single entity can never develop an all-encompassing vision of the world that correctly models all factors and elements likely to affect the outcome of a decision or public policy.

• **Using “no-or-low regrets” options**: No-or-low regrets options are built around the idea that good policy should bring benefits regardless of the reasonable future. Although this might reduce the potential for a policy to maximize benefits by “doubling down” on an attractive near-term policy option, caution may ultimately increase constituent value because it can help agencies deal with uncertainty.

• **Avoiding shift of burden**: This principle suggests that decisionmaking and policymaking should not resolve problems by shifting them to other areas, jurisdictions, modes, or other economic or social sectors. This principle is difficult to apply and often impeded by legislative mandates, but it is vitally important in a TBL policy system.

• **Dealing with “messy” futures, citizen cooperation, and government-as-enabler**: Social, environmental, and economic innovation can be messy and confusing. The future rarely comes as a unitary, easily understood event that everyone immediately comprehends and accepts. The future arrives at an uneven pace and is interpreted differently according to point of view, region affected, and many other factors.

• **Building internal adaptive capacity**: Organizations must develop the capabilities needed to operate in unforeseen circumstances and volatile environments. Organizations need to adapt to develop more flexible internal structures, a capacity to recognize and accept change, and the ability to move away from traditional bureaucratic, hierarchical structures. More open, responsive, and resilient structures that focus on outcomes rather than process and possess an expectation of change are needed, but this requires a culture change and a different organizational and institutional system.

• **Making public participation a positive force**: Technological, social, legal, institutional, political, and economic changes have created an environment where citizens, social groups, activists, and “super-empowered individuals” are a fact of life in public policymaking. Citizens are, in the terminology of current public administration literature, “co-producers”; that is, they are critically involved in the success of a policy because substantial behavioral change is required from them if the policy is to deliver its full benefits (Brandsen & Pestoff, 2006). As such, transportation agencies need to adopt an approach to public participation that designs policy around the assumption that the
public is involved in decisionmaking and will be critical to successful policy implementation. In particular, building and earning trust are crucial to being able to make necessary decisions in periods of uncertainty.

**Strategies for Transportation Agencies to Consider**

Transportation agencies are considering strategies to prepare for a future in which transportation could best support a sustainable TBL policy system. Those strategies depend on understanding the challenges and opportunities to be found in the envisioned TBL policy system and the gaps—that is, where do agencies need to go from here? The research team addressed the key issues for evolution to a new TBL policy system, followed by what agencies can reasonably do to assess, prepare for, and participate effectively in that evolution.

In referring to “transportation agencies,” the report addresses a large audience of government agencies at all levels in the transportation community, so all of the research results will not necessarily interest or resonate with the entire audience in the same way. However, it is clear that a viable TBL policy system will place great importance on close collaboration and strategic consensus all levels of government— as well as private and institutional sectors.

Although the research shows that significant activity and momentum have been building around green transportation and context-sensitive development, there is no experience with sustainable TBL to conclusively show that it is practicable. Assessments on sustainability need to provide a continuous barometer to use in decisions on priorities, level of commitment, and potential ROI.

Some general strategy development actions for agency consideration (in addition to tracking relevant legislation and rulemaking) include:

- Establish and/or participate in a national dialogue on evolution of a TBL policy system, including all levels of government and the private sector;
- Monitor and assess development and spread of sustainability rating systems and measures, particularly those sponsored by independent rating bodies;
- Monitor and assess measurement and certification standards development and adoption, particularly those that deal with two or more elements of the TBL; and

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2 Here the team is not referring to what is known as “strong” TBL, which treats the environment as fixed capital and in which tradeoff choices are made at the expense of economy and social values. Strong TBL is not far from the policy system today, wherein such tradeoffs are frequently made. Rather, the team is referring to the “weak” TBL concept, in which all three bottom lines are traded off, balanced, and optimized.
• Monitor and assess deployment of sustainability tools and methods, particularly those adopted by several peer agencies, focusing on those involving two or more elements of the TBL.

• Conduct periodic discussions with stakeholders and constituents of the agency to take stock of the outlook for sustainable TBL (significant events, rulemaking, or trend changes in the factors monitored could trigger the timing of these discussions).

General-purpose tools and methods that agencies can adapt, develop, and use broadly to support a number of high-level agency functions include—

• Self-assessment tools to continuously gauge the “TBL maturity” and capability of the agency to be prepared for the next phase in sustainability policy system development; these will help prioritize near-term actions to improve or strengthen focus, if needed;

• Adoption and adaptation of appropriate sustainability-related ROI assessment tools that could support communication and decisionmaking for many agency functions; and

• Surveys and scans to follow up on previous sustainability initiatives and decisions; these could confirm or calibrate logic and assumptions.

Transportation agencies today could implement the actions and tools suggested above at a relatively low expense. They are easily reversible “no-or-low regrets” actions that would produce strategic information, including insight into future demands and benefits. The following are summaries of function-by-function strategies to prepare for and operate under a sustainable TBL policy system:

**Developing Consensus on Future Vision, Goals, Objectives, and Needs:**

• Agreeing with stakeholders and partners on a definition of sustainability that is built on the TBL and accounts for the needs and priorities of the state and region;

• Mapping agency goals to the proposed definition on sustainability;

• Developing associated measurable objectives to track agencies’ progress in addressing needs and achieving progress in meeting goals; and

• Developing performance measures tied to the proposed objectives and each focus area.

**Planning and Programming:**

• Expanding existing modeling and planning tools to account for multimodal options and impacts, as well as regional quality of life;

• Coordinating data collection activities with engaged partners, including state and local agencies, as well as system operators and the private sector; and

• Connecting the prioritization process to proposed goals, measures, and objectives (e.g., ROI estimators, Economic Assessment of Sustainability Policies of Transport [ESCORT] model, Assessment of Transportation Strategies [ASTRA] model).
Budgeting and Resource Allocation:
- Increasing flexibility in budgeting, which may be needed to support risk sharing within and between agencies over multiple budget cycles. Agencies should consider long-term budget accounting and management and control of reserve accounts;
- Considering the institution of TCA; and
- Considering integrating life-cycle cost analysis (LCCA) tools in the planning and budgeting processes.

Rulemaking and Regulation:
- Building capability to “stay ahead” of TBL-related rulemaking;
- Obtaining a common understanding of the shared concerns, issues, and opportunities connected with TBL;
- Determining overall ROI for the participants in the collaborative effort (e.g., What is the benefit for each party and for all parties? What is the potential cost and risk of not acting?);
- Monetizing the impacts of potential regulatory requirements;
- Connecting impacts to jobs, commerce, and state/local revenues;
- Developing high-level TBL-related planning and decisionmaking concepts;
- Obtaining TBL-related viewpoints, standards, expectations;
- Crafting TBL-related measures;
- Determining measures of success and rating; and
- Assessing acceptance and adoption issues.

Service and Project Delivery:
- Adopting standards and approaches to identify sustainable options and ensure selected materials or systems purchased meet sustainable requirements (as defined in the development of goals, objectives, and associated performance measures); and
- Considering embedding sustainability/TBL-related ratings and standards into all business processes (e.g., project development, vetting and selection, quality management).

Education and Cultural Development:
- Considering the development of a sustainability code of ethics for the agency that focuses on supporting a sustainable society;
- Developing and conducting training activities with internal staff on incorporating sustainability principles in transportation decisionmaking processes;
- Setting employee initiative and performance incentives associated with sustainability;
• Setting up and maintaining an internal news forum and discussion on sustainable TBL; and
• Supporting the development of sustainability-related coursework in regional education institutions, and encouraging/supporting study by agency personnel.

Outreach and Communications (to public and stakeholders):
• Establishing interagency and intra-agency coordination on TBL issues;
• Conducting regular communication and information exchange activities with trade/professional groups, the private sector, and the public;
• Ensuring outreach and communication activities stay ahead of the evolution of the transportation policy system; and
• Supporting overall outreach activities with relevant facts and figures as sustainable TBL initiatives progress.

The research has shown that the principle gaps between today’s policy systems and sustainable TBL are found in the needs development, policymaking, and planning functions of transportation agencies. These functions will need to engage shared objectives and shared risk-taking among many stakeholder agencies in a region, as well as private sector actors. The institutional structures needed will form slowly, as stakeholders grasp the commonality of mission needs and benefits under the TBL system. Tools and methods to inform, assist, test the TBL concept, and assess needed risk-sharing between stakeholders – are the most useful path for agencies to follow in the near term, pending what these tools and methods reveal about the practicality of wide-spread management of the TBL. It can be seen that many of our near term action recommendations address tools, methods, and TBL assessment framework development.

Some focus on situational assessment, and self-assessment to match real trends with the right agency capabilities to anticipate incremental changes and respond to them. The third category of recommendations deals with outreach, training, and educational programs to build professional capacity, and share knowledge for the future.
2. INTRODUCTION

The purpose of Interim Report #1 is to describe the results of phases I through IV of the National Cooperative Highway Research Program (NCHRP) project 20-83 (07) Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies. The report includes the following chapters:

- The remainder of Chapter 2 provides the background of the report, including an overview and description of the NCHRP 20-83 projects, the objective of this project, and a statement of the scope and limitations of the current research.
- Chapter 3 discusses the current literature on sustainability and the results of the series of interviews with transportation agencies, key stakeholders, academics, and other interested parties on the ability of transportation agencies to support a sustainable society and the challenges and opportunities that specific agencies have faced. A selection of the key insights made during this portion of the research concludes this chapter.
- Chapter 4 provides a gap analysis for the major functional areas relevant to both transportation and sustainability. It introduces the application of the Systems Analysis Model to the challenges generally facing sustainability initiatives. It concludes with a brief generalized discussion of the state of sustainability in various transportation agencies.
- Chapter 5 describes our scenario development methodology, including a background of scenario building, an overview of our development approach, detailed descriptions of the drivers (factors or determinants of change) used in this project, and how the drivers were integrated with the scenarios.
- Chapter 6 provides detailed descriptions of the five scenarios used in this project: Crisis World, Mega World, Suburban World, Wonder World, and Green World.
- Chapter 7 describes the pressures and demands on transportation agencies under different scenarios, and identifies challenges and opportunities they may encounter.
- Chapter 8 begins to tie together the thoughts from efforts. It combines the challenges and opportunities identified for each scenario in Chapter 7, and the gap analysis from Section 4 to create a list of key principles for sustainability transitioning applicable across all future scenarios. It also applies the lessons learned in Chapter 3’s literature review and stakeholder interviews to create a roadmap of probable organizational end-states for transportation agencies in sustainable societies under each scenario.
- Chapter 9 concludes the report with a description of organizational, policy, and management implications for DOTs and a brief discussion on near-term tools and strategies.
2.1 OVERVIEW OF RESEARCH INITIATIVES

In 2009, the American Association of State Highway and Transportation Officials (AASHTO) allocated $7 million of the available NCHRP budget to examine long-range strategic issues, both global and domestic, that will likely affect state departments of transportation (DOT). Each project received $1 million, and was selected based on the NCHRP’s 2008 report, *Long Range Strategic Issues Facing the Transportation Industry*. The goals of these projects were to:

- Explore the impact of major trends affecting the future of our nation’s transportation priorities and needs;
- Provide guidance to state DOTs that will prepare them for possible futures so they can act, rather than react.

This memorandum was generated from one of these projects. The NCHRP contracted with Booz Allen Hamilton (hereafter referred to as “the research team”) to develop a framework for transportation agencies to use in identifying and understanding the future trends and external forces that will increasingly strain their ability to meet society’s evolving demand for transportation services and to operate on a more sustainable basis.

This research was motivated by the increasing awareness that the transportation system must adapt to support a more sustainable society — specifically, transportation agencies face challenges in building consensus around balancing short-term cost-effectiveness and long-term sustainability. Thus, although the roles and responsibilities of transportation agencies differ from state to state, there are common organizational attributes and characteristics that transportation agencies need for their transportation systems to support the environment, the economy, and social well-being.

Against this backdrop, the traditional functions of many transportation agencies are changing. As they evolve, transportation agencies will have to be resilient in the face of continuing and new demands by society and may need to fundamentally rethink the mission(s) and organizing principle(s) that drive them today. An analytical framework and supporting tools are needed to assist transportation agencies in evaluating their current and future capacity to support sustainability, while delivering transportation solutions in a rapidly changing social, economic, and environmental context. This project helps respond to these needs.

2.2 OBJECTIVE

The objective of this research is to provide a framework for transportation agencies’ use in identifying and understanding the future trends and external forces that will increasingly put pressure on their ability to carry out their responsibilities to:

- Meet society’s evolving demand for transportation services;
• Meet society’s emerging need to operate on a more sustainable basis.

The framework will also provide a means for agencies to assess their future capacity to meet society’s demands and provide or identify tools and approaches that agencies may use to assist them in making changes they deem appropriate and necessary to meet rapidly changing needs and conditions.

The thrust of this research is to take the perspective of a transportation agency and interpret the considerable amount of information that portends various future social, economic, and environmental demands from its transportation system. This project will:

• Identify likely alternative future scenarios in which transportation agencies will be asked to achieve sustainability goals in providing for economic vitality, social well-being, and environmental integrity that reflect conditions 30 to 50 years in the future;
• Analyze how transportation agencies’ existing fiscal, legal, and institutional structure(s) and decisionmaking processes encourage or inhibit them from optimizing their contributions to a sustainable society;
• Examine the variety of roles and the nature of their related primary activities that transportation agencies may be expected to perform in the future;
• Explore linkages and expectations between transportation agencies and stakeholders and the need to form new alliances and partnerships with other transportation providers and system users; and
• Provide or identify tools that individual agencies can use in designing their particular approach to adapting to the challenges and opportunities of the future and in describing, in broad terms, how sustainable transportation agencies might be organized.

Specifically, this project consists of the following five phases:

• **Phase I**: Describe future scenarios and the difficulties, challenges, and opportunities that will likely require transportation agencies to make fundamental changes in how they deliver transportation services in a manner that contributes to a more sustainable society.

• **Phase II**: Assess the current and future ability of transportation agencies to support a sustainable society. Describe and assess the necessary evolution of linkages and relationships between transportation agencies and their partners and stakeholders. Identify barriers that may prevent transportation agencies from delivering transportation services in support of a sustainable society. Provide examples of transportation agencies that are well positioned to meet these future challenges or take advantage of future opportunities, focusing on practices or approaches that are transferrable to other agencies.
- **Phase III**: Determine inventory benefits achieved from business models, best practices, and lessons learned from other organizations, industries, or sectors (not limited to domestic transportation agencies) that have successfully adapted to rapidly changing external conditions.

- **Phase IV**: Describe plausible future roles and responsibilities of transportation agencies that deliver transportation services supporting a sustainable society. At a minimum, describe the organizational schemes, legal authorities, governance structures, and funding elements needed, as they relate to a broad vision of a transportation agency’s mission.

- **Phase V**: Develop analytical tools and processes for agencies to use to track relevant trends and evaluate their current ability to meet future challenges or take advantage of pending opportunities in a manner that supports a sustainable society. Provide tools and approaches that transportation agencies can use to implement the framework.

### 2.3 Description of Other Research Initiatives

As described above, this project is one of seven funded by AASHTO to address long-range strategic issues facing the transportation industry. The seven projects are:

- **NCHRP 20-83 (01)**: Economic Changes Driving Future Freight Transportation;
- **NCHRP 20-83 (02)**: Expediting Future Technologies for Enhancing Transportation System Performance;
- **NCHRP 20-83 (03)**: Long-Range Strategic Issues Affecting Preservation, Maintenance, and Renewal of Highway Infrastructure;
- **NCHRP 20-83 (04)**: Effects of Changing Transportation Energy Supplies and Alternative Fuel Sources on Transportation;
- **NCHRP 20-83 (05)**: Climate Change and the Highway System: Impacts and Adaptation Approaches;
- **NCHRP 20-83 (06)**: Effects of Socio-Demographics on Travel Demand; and
- **NCHRP 20-83 (07)**: Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies (this project).

In December 2010, principal investigators of these projects met with the AASHTO Standing Committee on Research and with Transportation Research Board (TRB) staff at the Workshop on Long-Term Strategic Issues Facing the Transportation Industry.

This project considers how freight transportation, technologies, infrastructure renewal, energy supplies and fuel sources, climate change, and socio-demographics affect sustainable transportation systems, and sustainability itself as an organizing principle for transportation agencies. The research team has begun conversations with the other project teams and hopes to
share lessons learned and documents as the project moves forward. The lessons learned in the other projects may also have some bearing here, because this report uses many of the topics from the other projects, including emerging technologies, energy, and climate change, as drivers for scenario analysis and comparison. These other projects may provide more details on these specific topics.

2.4 **Scope and Limitations of the Current Research**

This report is intended to provide the results of Phase I through Phase IV of NCHRP Project 20-83 (07), *Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies*. Key limitations on the scope of this report are as follows:

- This report is not intended to address the issue of sustainable transportation—it focuses on how transportation agencies can support a sustainable society.

- This report is not intended to discuss specific policies, programs, or guidelines that can be followed to deliver a more sustainable society or sustainable transportation—it focuses on the factors affecting the capabilities of transportation agencies to support a sustainable society and how this capability can be improved given certain scenarios.

- This report does not provide specific tools that can be used to increase the capability of transportation agencies to support a sustainable society. These will be provided in Phase V.

- This report focuses primarily on state transportation agencies; however, it does address how regional, local, and federal transportation agencies may be involved in future sustainability-related programs.

One of the key limitations on scope referenced above is that this is *not* intended to be an analysis of best policies for transportation agencies to follow to better support a sustainable society. There are a large number of potential policies that transportation agencies could undertake to increase societal sustainability. The applicability and effectiveness of these policies depend on numerous factors. Transportation agencies must select the mix of policies that best fit the challenges and opportunities they face. Furthermore, even though this project is future orientated, the team do not know whether current policies deemed unrealistic will become practical or appropriate in the future (e.g., local or state carbon taxes). As such, this project is “policy agnostic;” it does not recommend policies or take any positions. Instead, it focuses on how transportation agencies can change their organizational structures and functions to improve development, selection, and implementation of policies that are most applicable to the conditions they face.

This project is not about what transportation agencies can do to support more sustainable transportation, but what they can do to support a more sustainable society. As Figure 3 shows,
this is a multifaceted problem. It includes not only the issue of how to create a more sustainable transportation system (presumably supporting a more sustainable society), but also the whole gamut of changes necessary to improve policy development, decisionmaking, and implementation. One of these challenges will be re-defining some of the traditional roles of the stakeholders involved in transportation planning, including representatives of other agencies or social groups affected by transportation decisions (e.g., departments of the environment). Building consensus and sharing both resources and risks among these groups may prove to be some of the most critical aspects of moving toward a sustainable society. As such, the team has emphasized the full range of transportation agencies’ actions in the greater framework of the policy process, from the initiation and interpretation of citizen demands to tracking performance and communicating achievements.

Figure 3: The Relationship between Transportation Agencies and Other Stakeholders in Supporting a More Sustainable Society

Finally, while this project focuses on state transportation agencies primarily, it also addresses the broader institutional and political environments in which they operate (e.g., the relationship between state executives, legislatures, interest groups, business interests) and other types of transportation agencies (e.g., regional transportation agencies, metropolitan planning organizations (MPOs), localities, transit authorities, system operators). Thus, while these findings are of most interest to states, they may be useful to other transportation agencies facing similar challenges and opportunities.
2.5 DEFINING “SUSTAINABILITY”

A key concept for this project is the idea of “sustainability.” The Brundtland Commission, formally the World Commission on Environment and Development (WCED), supplied the classic definition of sustainability. The commission was created to address growing concern “about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development.” In establishing the commission, the United Nations (UN) General Assembly recognized that environmental problems were global in nature and determined that it was in the common interest of all nations to establish policies for sustainable development. The final report of the Brundtland Commission, Our Common Future, defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” (World Commission on Environment and Development, 1987) This definition, however, has been interpreted widely.

NCHRP Project 08-74 [A Guidebook for Sustainability Performance Measurement for Transportation Agencies] developed guidance for state DOTs and other transportation agencies to understand and apply concepts of sustainability. That project developed detailed definitions of sustainability and sustainable transportation. NCHRP 08-74 concluded that:

- There is no agreement on the terms sustainability and sustainable development. All definitions will be contested and are open to question;
- Typically, sustainability is considered to be a combination of three dimensions: economic, social, and environmental (the so-called “Triple Bottom Line”);
- The issues of future needs (i.e., intergenerational equity) and governance are also relevant;
- Growth in well-being, rather than pure economic growth, is desirable, and is related to the concepts of a strong versus weak approach to sustainability; and
- There is a need to better understand the implications and tradeoffs if all aspects of sustainability are treated as fully tradable concerns from the economic paradigm.

This project adopted NCHRP Project 08-74’s definitions of sustainability, sustainable development, and sustainable transportation:

“Sustainability” - Sustainability emphasizes the need to balance human needs with consideration of the natural environment and equity issues, in both a present (intra-generational) and future (inter-generational) context. Sustainability is generally discussed in terms of three dimensions: economic, environmental, and social (equity). The distinction between sustainability and sustainable
development is usually made by considering sustainability to be an idealized end state and sustainable development as the process of moving toward it.

**Sustainable Development** – Sustainable development can be viewed as a process of working toward achievement of sustainability, with a particular focus on human needs. Traditionally, it is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Critical to the definition of sustainability has been an emergence of the **“Triple Bottom Line”** (abbreviated as "TBL" or "3BL" and referred to as "people, planet, profit" or "the three pillars") (Bader, 2008). TBL is intended to capture the full range of goals that a sustainable organization should consider—specifically, economic, environmental, and social goals. The concept of the triple bottom line goes back to 1994, when John Elkington argued that companies should prepare three bottom lines: (1) the traditional account of profit and loss; (2) a “people account” (i.e., a measure of an organization’s social responsibility); and (3) a “planet” account (i.e., a measure of environmental responsibility) (The Economist, 2009).

Since then, the commitment to TBL has spread through the corporate world. According to the “Management Barometer,” a survey of 14 advanced economies, 68 percent of large corporations in Western Europe and 41 percent in the United States reported on their TBL (Robins, 2006). In the United States, this resulted in more widespread commitments to TBL and sustainability spending. Pruitt’s 2010 survey of 1,833 U.S. companies with at least $1 billion in annual revenue (from every major industry) estimated that funding for sustainability and TBL-related activities will increase from $28 billion in 2010 to approximately $60 billion in 2014. It estimated that the firms’ sustainability spending increased 11 percent between 2009 and 2010, and predicted that the sustainable business growth rate would increase 24 percent in 2012 (Pruitt, 2010).

In the United States, the concept of TBL has appeared at the state level as a greater commitment to developing business performance measures and tracking. For example, in 1989, the Oregon State Legislature created the Oregon Progress Board (OPB) as a state agency to track quantitative indicators for the State of Oregon. The OPB was charged further with keeping the public up to date on the implementation of the state’s strategic plan for sustainable development. The plan had three key goals: (1) quality jobs for all Oregonians; (2) safe, caring,

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3 Project No. 08-74, “Sustainability Performance Measures For State DOTS and Other Transportation Agencies, Final Report Prepared for National Cooperative Highway Research Program Transportation Research Board of the National Academies.” Josias Zietsman and Tara Ramani, Texas Transportation Institute, The Texas A&M University System College Station, Texas, July 2011
and engaged communities; and (3) healthy, sustainable surroundings. In 2000, an executive order from Governor John Kitzhaber established a set of sustainability-based goals:

- Increase the economic viability of all Oregon communities and citizens;
- Increase the efficiency with which energy, water, material resources, and land are used;
- Reduce releases to air, water, and land of substances harmful to human health and the environment; and
- Reduce adverse impacts on natural habitats and species.

In response, the OPB created a series of benchmarks grouped into seven principle categories: economy, education, civic engagement, social support, public safety, community development, and environment (Schlossberg & Zimmerman, 2003). Table 6 illustrates some of these indicators. As can be seen, efforts to track TBL performance on a macro-statewide scale can include a large number of diverse indicators. Integrating all of these indicators and communicating a credible overall scorecard presents very complex and difficult weighting and normalization challenges. Developing criteria and reliable measures of change or quality for each indicator is an additional challenge.

### Table 6: Illustrative Sample of TBL Indicators - State of Oregon

<table>
<thead>
<tr>
<th>Environment</th>
<th>Community</th>
<th>Economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream Water Quality</td>
<td>Child Abuse or Neglect</td>
<td>Drinking Water</td>
</tr>
<tr>
<td>Native Plant Species</td>
<td>Teen Pregnancy</td>
<td>Research and Development</td>
</tr>
<tr>
<td>Forest Land</td>
<td>Homelessness</td>
<td>Eighth-Grade Skill Levels</td>
</tr>
<tr>
<td>Air Quality</td>
<td>Health Insurance Coverage</td>
<td>New Companies</td>
</tr>
<tr>
<td>Agricultural Land</td>
<td>Overall Crime</td>
<td>College Completion</td>
</tr>
<tr>
<td>Marine Species at Risk</td>
<td>Teen Alcohol Abuse</td>
<td>Living Wage</td>
</tr>
<tr>
<td>Native Fish and Wildlife</td>
<td>Juvenile Arrests</td>
<td>Poverty</td>
</tr>
<tr>
<td>Carbon Dioxide Emissions</td>
<td>Commuting</td>
<td>Per Capita Income</td>
</tr>
<tr>
<td>State Park Acreage</td>
<td>Vehicle Miles Traveled</td>
<td>Economic Diversification</td>
</tr>
<tr>
<td>Municipal Waste Disposal</td>
<td>Volunteerism</td>
<td>High School Dropout Rate</td>
</tr>
<tr>
<td>Nuisance Species</td>
<td></td>
<td>Employment Dispersion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Affordable Housing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Timber Harvest</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Income Disparity</td>
</tr>
</tbody>
</table>

In the transportation community, the research indicated broad agreement for the concept of TBL. As discussed below, many state DOTs, metropolitan planning organizations (MPO), local governments, and other agencies involved in transportation have bought into the concept of TBL and are actively developing policy, guidance, or performance-based indicators (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010). In fact, compliance with the TBL is seen generally as the principal way in which sustainability has been incorporated into government business at the state level. Other concepts associated with sustainability, including intergenerational equity, the precautionary principle, and integrated decisionmaking, have received substantially less attention (Dembach, 2002).
Internationally, several countries have progressed significantly in implementing TBL accounting and reporting. For example, Australia’s Federal Department of Family and Community Services (FaCS) began to produce an annual TBL report as early as 2002, and the government of the state of Western Australia has developed a detailed sustainability plan with explicit TBL targets (Barrett, 2004) (Government of Western Australia, 2003). Similarly, in the United Kingdom (UK), many government agencies and semipublic organizations have developed detailed TBL scorecards and performance tracking measures. For example, the UK’s National Health Service (NHS), the largest employer in Western Europe, has developed detailed TBL sustainability guidance for its operating units, including processes for conducting sustainability assessments. NHS developed TBL performance indicators and scorecards, and recommended actions needed to support achieving TBL goals (Lockie & Bourke, 2009).

Based on the research, this report uses the following working assumptions to help clarify the sustainability concept for the purpose of this report:

- **TBL is fundamental to the emergence of sustainability in the public and private sectors:** Pursuit of the TBL has become fundamental to the concept of sustainability. Both public and private sector organizations have developed their sustainability programs around the concept of the TBL.

- **Sustainability focuses on the long term, rather than the short term:** The key requirement of sustainability is to accommodate both present and future development needs.

- **Sustainability is an integrated, rather than a “stand-alone” concept:** Sustainability is not exclusive to any one policy area. Specifically, given the integrated nature of transportation with the rest of human activity, it is difficult to view the transportation system in isolation. Sustainable transportation requires that the team consider a broad definition of sustainability that considers how transportation affects overall social sustainability, and how other policy areas need to be coordinated to achieve sustainability.

- **Sustainability is multidimensional:** Sustainability is multidimensional. It is not simply about “greening.” Sustainability has economic, social/cultural, and environmental dimensions—the TBL. These dimensions do not represent clearly distinct compartments; rather, they provide ways to systematically view the interlinked character of societal development as it draws on environmental, economic, and social resources and mechanisms. Development along the TBL dimensions does not take place in a governance vacuum; it presupposes institutional arrangements and reforms.
3. RESEARCH AND DATA COLLECTION

This chapter describes the data collection and analysis approach the research team took to characterize the current literature and stakeholder perceptions on sustainability and transportation agencies. As Figure 4 illustrates, it consisted of two major activities. First, the team conducted a detailed literature review and state-of-the-practice scan on how transportation agencies in the United States and other countries deal with sustainability. The team also reviewed the literature on how the Federal Government (including specific Federal Government agencies) and the private sector deal with sustainability. Second, the team conducted 54 stakeholder interviews to obtain their views on how transportation agencies are dealing with sustainability issues and the challenges of implementing sustainable policies. Appendix 4 provides a listing of the stakeholders interviewed. The team synthesized and integrated this information while identifying key insights, findings, and issues.

Figure 4: Approach to Research and Interviews
3.1 FINDINGS

3.1.1 State Governments and State DOTs

Understanding of Sustainability and the Role of Sustainability in State DOTs

Awareness and understanding of sustainability have been increasing at all levels of government in the United States. For example, according to the Federal Highway Administration (FHWA), a little more than half of state DOTs include sustainability principles in their mission statements, as shown in Table 7. While only two use the word “sustainable,” the remainder mentions the need to balance economy, environment, and quality of life; however, despite this activity, no state has a legislatively authorized sustainable transportation program.

Table 7: State DOTs with Sustainability Mission Statements

<table>
<thead>
<tr>
<th>DOT</th>
<th>Mission Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>To provide a safe, efficient, environmentally sound intermodal transportation system for all users, especially the taxpayers of Alabama. To also facilitate economic and social development and prosperity through the efficient movement of people and goods and to facilitate intermodal connections within Alabama. ALDOT must also demand excellence in transportation and be involved in promoting adequate funding to promote and maintain Alabama’s transportation infrastructure.</td>
</tr>
<tr>
<td>Arkansas</td>
<td>It is our mission to provide and maintain a safe, effective, and environmentally sound transportation system for the state.</td>
</tr>
<tr>
<td>Connecticut</td>
<td>To provide a safe and efficient intermodal transportation network that improves the quality of life and promotes economic vitality for the state and the region.</td>
</tr>
<tr>
<td>Delaware</td>
<td>To provide a safe, efficient, and environmentally sensitive transportation network that offers a variety of convenient and cost-effective choices for the movement of people and goods.</td>
</tr>
<tr>
<td>Florida</td>
<td>Provide a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities.</td>
</tr>
<tr>
<td>Georgia</td>
<td>Provide a safe, seamless, and sustainable transportation system that supports Georgia’s economy and is sensitive to its citizens and environment.</td>
</tr>
<tr>
<td>Hawaii</td>
<td>To provide a safe, efficient, accessible, and inter-modal transportation system that ensures the mobility of people and goods, and enhances and/or preserves economic prosperity and the quality of life.</td>
</tr>
<tr>
<td>Iowa</td>
<td>Advocates and delivers transportation services that support the economic, environmental, and social vitality of Iowa.</td>
</tr>
<tr>
<td>Illinois</td>
<td>To provide safe, cost-effective transportation for Illinois in ways that enhance quality of life, promote economic prosperity, and demonstrate respect for our environment.</td>
</tr>
<tr>
<td>Indiana</td>
<td>INDOT will plan, build, maintain, and operate a superior transportation system enhancing safety, mobility, and economic growth.</td>
</tr>
<tr>
<td>Kentucky</td>
<td>To provide a safe, efficient, environmentally sound and fiscally responsible transportation system that delivers economic opportunity and enhances the quality of life in Kentucky.</td>
</tr>
<tr>
<td>DOT</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Louisiana</td>
<td>To deliver transportation and public works systems that enhances quality of life and facilitates economic growth and recovery.</td>
</tr>
<tr>
<td>Maine</td>
<td>To responsibly provide a safe, efficient, and reliable transportation system that supports economic opportunity and quality of life.</td>
</tr>
<tr>
<td>Maryland</td>
<td>Efficiently provide mobility for our customers through a safe, well-maintained and attractive highway system that enhances Maryland’s communities, economy, and environment.</td>
</tr>
<tr>
<td>Michigan</td>
<td>Provide the highest quality integrated transportation services for economic benefit and improved quality of life.</td>
</tr>
<tr>
<td>Mississippi</td>
<td>To provide a safe intermodal transportation network that is planned, designed, constructed, and maintained in an effective, cost-efficient, and environmentally sensitive manner.</td>
</tr>
<tr>
<td>Montana</td>
<td>To serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality, and sensitivity to the environment.</td>
</tr>
<tr>
<td>Nebraska</td>
<td>We provide and maintain, in cooperation with public and private organizations, a safe, efficient, affordable, environmentally compatible and coordinated statewide transportation system for the movement of people and goods.</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>Transportation excellence in New Hampshire is fundamental to the state’s sustainable economic development and land use, enhancing the environment, and preserving the unique character and quality of life.</td>
</tr>
<tr>
<td>New Mexico</td>
<td>The primary responsibility of the agency is to plan, build, and maintain a quality statewide transportation network that will serve the social and economic interests of our citizens in a productive, cost-effective, innovative manner.</td>
</tr>
<tr>
<td>New York</td>
<td>It is the mission of the New York State Department of Transportation to ensure our customers – those who live, work and travel in New York State – have a safe, efficient, balanced, and environmentally sound transportation system.</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Connecting people and places in North Carolina—safely and efficiently, with accountability and environmental sensitivity.</td>
</tr>
<tr>
<td>Ohio</td>
<td>Moving Ohio into a Prosperous New World. Its meaning encompasses the multimodal, safe, efficient and reliable character identified in our last business plan mission statement. At the same time, it incorporates the realization that safety, economic development, green, innovative and accessible characteristics are additional drivers needed to achieve the prosperity that will assure Ohio’s future competitiveness.</td>
</tr>
<tr>
<td>Oregon</td>
<td>To provide a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians.</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>To maintain and provide a safe, efficient, environmentally, aesthetically and culturally sensitive intermodal transportation network that offers a variety of convenient, cost-effective mobility opportunities for people and the movement of goods supporting economic development and improved quality of life.</td>
</tr>
<tr>
<td>South Dakota</td>
<td>We provide a quality transportation system to satisfy diverse mobility needs in a cost-effective manner, while retaining concern for safety and the environment.</td>
</tr>
<tr>
<td>Tennessee</td>
<td>To plan, implement, maintain, and manage an integrated transportation system for the movement of people and products, with emphasis on quality, safety, efficiency, and the environment.</td>
</tr>
<tr>
<td>Vermont</td>
<td>To provide for the movement of people and commerce in a safe, reliable, cost-effective and environmentally responsible manner.</td>
</tr>
</tbody>
</table>
To date, few states have an active sustainability plan or program. For example, as of 2010, five state DOTs had a formal sustainability plan or program, as shown in Table 8.

Table 8: State Sustainability Transportation Plans

<table>
<thead>
<tr>
<th>DOT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Pilot project with Environmental Protection Agency (EPA) to create a sustainability assessment framework for transportation policy, planning, and programming; currently being tested for corridor analyses, but will be used to assess regional and state efforts, as well.</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>Statewide sustainable development principles adopted to guide policies, programs, and infrastructure investment decisions; partnering to coordinate transportation service planning and delivery.</td>
</tr>
<tr>
<td>New York</td>
<td>Sustainability is pursued through a statewide program (Smart Planning Program) integrating land-use and transportation planning, including the provision of training, educational materials and hands-on planning assistance. In addition the State DOT is implementing the Green Leadership In Transportation Environmental Sustainability (GreenLITES), a transportation environmental sustainability rating program.</td>
</tr>
<tr>
<td>Oregon</td>
<td>Three-volume plan that will outline goals, actions, and performance measures for internal actions and external system management to achieve a sustainable transportation system; Volume 1 (defining sustainability) released in January 2009, and Volume 2 (internal operations) released in Fall 2010; Volume 3 (managing statewide transportation network) under review.</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Partnering with other agencies, states, and local communities to make financially, environmentally, and socially sustainable decisions; includes a public education campaign and a handbook co-authored by New Jersey DOT.</td>
</tr>
<tr>
<td>Washington</td>
<td>Annual plan update and progress report on sustainability targets and emerging issues.</td>
</tr>
</tbody>
</table>

The data therefore suggests that at the state level, there is a growing adoption of sustainability terminology but limited implementation of TBL programs. Our stakeholder interviews support this observation. For example, many stakeholders supported the general principles of...
sustainability, but some were reluctant to use the term as they felt it polarizing and controversial, especially in the current climate, where resources are stretched thin and state governments are focusing on economic growth and job creation. Furthermore, the ideology of free-market economics and limited government that often infuses public discourse today would make the concept of government-enforced sustainability (deemed as government control of economic activity and freedom of choice) a difficult sell to state decisionmakers and the public. In addition, the complexity of the term and the challenge of developing consensus around an actionable definition hinder support for the concept. Many stakeholders suggested that rather than emphasize the TBL, it is better to sell sustainability as “stewardship,” which embodies responsible planning for and management of resources over an intergenerational period (e.g., “we must pass the world on to our children”).

Another insight was that sustainability was frequently interpreted as support for “green” or environmental programs. Data from FHWA’s recent survey of state sustainability programs seem to support this insight. Table 9 shows some examples of these programs. These initiatives encompass a wide variety of issues, including purchasing a more energy-efficient vehicle fleet to developing greenhouse gas (GHG) emissions budgets and climate action plans.

In particular, the growing emphasis on climate change has been a leading driver of state involvement in developing sustainability-related programs. For example, almost one-third of the state DOTs has some involvement with a climate change initiative. By 2011, more than 35 states had climate action plans and more than 10 had adaptation plans; state and regional transportation agencies contribute to those plans typically (Georgia Tech Research Corporation, 2011) From a sustainability point of view, these plans are important, because they inject new concepts into the intersection of transportation-environment planning and require a coordinated, multiagency, multijurisdictional approach to planning.

<table>
<thead>
<tr>
<th>DOT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Active climate change mitigation and adaptation measures in response to state legislation; includes GHG reduction strategies, sea-level rise assessment, and habitat-connectivity study.</td>
</tr>
<tr>
<td>Delaware and Tennessee</td>
<td>Statewide geographic information system (GIS) data used to identify environmental issues during the planning process; requires GIS data from multiple state, regional, and local agencies.</td>
</tr>
<tr>
<td>Florida</td>
<td>Process to anticipate environmental problems early on through partnership with resource agencies, public involvement, and GIS-based environmental assessment.</td>
</tr>
<tr>
<td>Illinois</td>
<td>Initiatives to improve agency’s internal sustainability (energy efficiency, emissions reduction, recycling) and be a model for local governments.</td>
</tr>
</tbody>
</table>
In terms of the economic element of the TBL, state attention is focused mainly on developing mechanisms that analyze the ability to fund transportation infrastructure, rather than the broader health of the economy. As a result, a number of states are developing tools to help assess the long-term financial sustainability of transportation assets, as shown in Table 10.

### Table 10: Sample Economic and Financial Sustainability Tools and Initiatives

<table>
<thead>
<tr>
<th>DOT</th>
<th>Practice</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>Program Menu</td>
<td>Develops funding packages based on different emphases (e.g., system preservation or capacity for economic development) and uses iterative process to allocate all available funding and meet statewide transportation needs.</td>
</tr>
<tr>
<td>Illinois</td>
<td>Life-Cycle Costing (LCC)</td>
<td>Process to assess present and future roadway condition and prioritize improvement projects; based on a facility’s cost over its lifetime rather than just the upfront capital costs.</td>
</tr>
<tr>
<td>Montana</td>
<td>Performance Programming Process (P3)</td>
<td>Decision process for funding allocations based on asset management principles, scenario planning, and strategic goals.</td>
</tr>
<tr>
<td>Montana</td>
<td>Highway Economic Assessment Tool (HEAT)</td>
<td>Enhanced benefit-cost analysis tool for projects that accounts for system impacts at state, corridor, and project level; considers traditional mobility measures in addition to economic and resource impacts; tool is customizable to each state’s goals and data availability.</td>
</tr>
<tr>
<td>Oregon</td>
<td>Investment Scenarios</td>
<td>Oregon Transportation Plan assesses seven policy scenarios and three investment scenarios to determine system performance outcomes of different levels/types of investment.</td>
</tr>
</tbody>
</table>

There has been much less progress in incorporating the social element of the TBL into sustainability initiatives. In large part, this is due to the difficulty in defining social...
sustainability or to a lack of appropriate data. Most DOTs have addressed this issue via Environmental Justice (EJ) and Context Sensitive Solutions (CSS) policies, although some states are attempting to move beyond this.

In our interviews, many stakeholders felt that the TBL framework was inadequate and needed to be expanded to consider a broader definition of sustainability. In particular, the idea of fitting technology and technology impact assessment into the TBL was deemed important. Many stakeholders saw technology as a critical driver that needed to be better understood and managed if true sustainability was to be achieved.

Other issues that emerged in terms of the definition of sustainability were the issues of financial or fiscal sustainability and the importance of system preservation. Under this concept, a budget proposal must consider additional dimensions:

- **Solvency**: The ability of the proposed project or investment to contribute to the overall ability of the government to meet long-term financial obligations
- **Growth**: The ability of the proposed project or investment to help sustain economic growth
- **Stability**: The capacity of the proposed project or investment to improve governments’ ability to meet future obligations within existing or projected tax burdens
- **Intergenerational Equity**: The capacity of government to pay current obligations without shifting the cost to future generations.

Some stakeholders suggested that fiscal sustainability may be a way to sell the whole concept of sustainability to the wider state leadership and general public. Fiscal sustainability requires a much broader understanding of the total costs and benefits of any public project. For example, if a road project generates additional costs on other parts of the infrastructure or forces the state to incur additional costs (e.g., additional expenditures associated with nonattainment of clean air standards), then those costs would be included in the overall cost-benefit analysis of the project. The project would then have to demonstrate sufficient benefits to the state to overcome the additional cost. Furthermore, techniques such as TCA would go a long way toward allowing state programs to consider long-term or intergenerational costs.
One of the current leaders in integrating sustainability into the DOT operations is the State of Oregon. Since 2000, Oregon’s governors and state legislature have mandated sustainability objectives for state agencies. In response, the Oregon Department of Transportation (ODOT) has developed one of the most extensive sustainability plans in the United States. It includes both short-term goals and longer-term goals to be achieved by 2030 (Fordham, 2008). In addition, Oregon DOT has gone far to institutionalize the concept of sustainability through the development of an integrated, strategic Sustainability Program. This program provides central oversight and coordination, and is a resource to staff incorporating sustainability goals into their work. The program crosses all divisions and addresses both internal support functions and the external transportation system.

Oregon DOT’s sustainability program manager is located in the director’s office and reports to Oregon DOT’s chief of staff. The manager has broad responsibility to analyze all aspects of the agency’s internal and external operations and to identify opportunities to integrate sustainability principles into agency decisionmaking, management and operations. The manager is responsible for development and implementation of the Sustainability Plan.

Best Practice Example: Oregon’s Sustainability Mandates

- **Executive Order 00-07**: Promoted sustainability in state government operations primarily through the adoption of certain practices by the Department of Administrative Services.
- **The Oregon Sustainability Act**: Provides state agencies with 10 objectives for conducting their internal operations and 10 objectives for carrying out their missions to support sustainable communities. Created the Oregon Sustainability Board to provide oversight to sustainability efforts in the state.
- **Executive Order 03-03**: Broadened the scope of state agency sustainability planning efforts. It supported the Oregon Sustainability Act and directed 20 of Oregon’s larger agencies (including ODOT) to designate a sustainability coordinator and write a sustainability plan.
- **Executive Order 06-02**: Reaffirmed agency sustainability planning process and created several interagency teams to address specific sustainability initiatives, such as GHGs, purchasing, electronic waste, and energy. This executive order also addressed sustainability in the private sector and in Oregon’s university system. It reauthorized the Oregon Sustainability Board and rescinded earlier sustainability executive orders.
The ODOT Sustainability Council, an internal group of managers appointed by ODOT’s director to represent a variety of functional areas and geographic locations, meets quarterly to provide oversight to the plan and the program. This group approves and monitors sustainability work items and recommends policy and practice changes to the director.

Conservation and Alternative Resource Teams (CARTs) act as office “green teams” for the agency, supporting the overall sustainability program by implementing on-the-ground initiatives in ODOT facilities. CARTs educate employees about work-related efficiency efforts and promote voluntary participation in those efforts to create a culture of resource conservation awareness.

Sustainability project teams are convened, as needed, to address specific sustainability projects and initiatives. These teams may be formal groups that meet regularly or informal collaborations of staff that meet only to address a particular need. Teams have worked on internal GHG emissions tracking, neighborhood electric vehicles, fleet use of biodiesel, vehicle emissions issues, and other initiatives.
In addition, the Oregon Sustainable Transportation Initiative (OSTI) is a coordinated effort by Oregon state agencies to explore ways that the state, MPOs, and local communities can significantly reduce GHG emissions from the transportation sector to help offset effects of global climate change and foster energy independence. OSTI is a partnership among ODOT, the Department of Land Conservation and Development (DLCD), Oregon Department of Energy (ODOE), and Oregon’s Department of Environmental Quality (DEQ), which grew out of two legislative directives: HB 2001 (2009)/The Jobs and Transportation Act and SB 1059 (2010)/Chapter 85 Oregon Laws.

California offers another example of successfully integrating sustainability into a DOT operation. The California Transportation Plan (CTP) is a statewide, long-range transportation plan for meeting future mobility needs. The CTP defines goals, policies, and strategies to achieve the collective vision for California’s future transportation system and emphasizes what the California Department of Transportation (Caltrans) calls the three “E’s of sustainability:” environment, economy, and equity. Caltrans served as a pilot program using EPA’s Smart Mobility Framework (SMF) to develop an approach to implement this plan. Specifically, SMF provides a tool to assess how well plans, programs, and projects meet smart mobility principles and objectives (Georgia Tech Research Corporation, 2011).

The SMF is organized around six principles:

- **Location Efficiency:** Integrate transportation and land use in order to achieve high levels of non-motorized travel and transit use, reduced vehicle trip making, and shorter average trip length, while providing a high level of accessibility.
- **Reliable Mobility:** Manage, reduce, and avoid congestion by emphasizing multimodal options and network management through operational improvements and other strategies.
- **Health and Safety:** Design, operate, and manage the transportation system to reduce serious injuries and fatalities, promote active living, and lessen exposure to pollution.
- **Environmental Stewardship:** Protect and enhance the transportation system’s emission of GHGs.
- **Social Equity:** Provide mobility for people who are economically, socially, or physically disadvantaged to support their full participation in society. Design and manage the transportation system to distribute its benefits and burdens equitably.
- **Robust Economy:** Invest in transportation improvements that support the economic health of the state and its local governments, the competitiveness of California’s businesses, and the welfare of California residents.

Adapted from: (Georgia Tech Research Corporation, 2011)
The Smart Mobility principles will be integrated into Caltrans’ day-to-day operations. The principles will be introduced into a wide range of DOT and partner activities, including planning and programming, standards and guidelines, transportation projects and programs, development and conservation projects and programs, decision support, and performance measures.

The SMF guidebook establishes priorities and provides tools for beginning to implement Smart Mobility at Caltrans and partner agencies. The Smart Mobility Action Plan identifies 10 implementation themes:

- Increase the impact and effectiveness of the SMF and the call to action by widely disseminating information;
- Support an expanded Interregional Blueprint Planning program;
- Integrate the SMF consistently into Caltrans policy and practice;
- Integrate the SMF policy and practice with activities of other agencies and departments, like the Strategic Growth Council and Senate Bill (SB) 375;
- Collect, develop, and use data and tools needed to implement the SMF, including performance measures;
- Revise planning and programming procedures to reflect the SMF;
- Revise design standards and procedures to reflect the SMF, starting with revision of the Caltrans Highway Design Manual (HDM) and implementation of the department’s complete streets policy;
- Undertake major cross-functional initiatives, like a comprehensive program to insure strong consideration of location efficiency factors in newly developing areas, and a funding initiative to identify adequate resources for transit and rail capital investment and operations;
- Integrate the SMF into local government land-use and transportation planning and implementation activities; and
- Encourage local government Smart Mobility implementation assessment and evaluation activities, like advancing the use of multimodal level of service (LOS).

The action plan is presented as a checklist of high-priority activities for implementation, and identifies the relevant level(s) for implementation (state, regional, local). Caltrans anticipates that several important outcomes will be achieved over the long term:

- Improved accessibility;
- Reduced average length and number of trips;
- Social equity;
- Reduced environmental impacts of travel;
- Improved public health;
• Reduced energy costs and vulnerability to price escalation; and
• Economic development.

Thus, the SMF provides a mechanism for integrating short-term actions into long-term sustainability.

One of the major concerns that stakeholders identified was the need to ensure that sustainability was customized to different settings. The SMF addresses this issue and identifies seven “place types” that represent generic development patterns throughout California: Urban Centers, Close-in Compact Communities, Compact Communities, Suburban Areas, Rural and Agricultural Lands, Protected Lands, and Special Use Areas. The SMF provides guidance for how Smart Mobility may be implemented in each place type, offering resource documents and example guidelines for each, and grouped into Planning, Transportation Projects and Programs, and Development and Conservation Projects and Programs (Georgia Tech Research Corporation, 2011).

**FUNDING AND NEEDS ASSESSMENT**

Funding and sustainability were major issues emerging from our stakeholder interviews. Most agreed that new funding sources were needed if sustainability was to become a reality. Furthermore, there was a general acceptance that as resources became less plentiful, there should be a move toward more user fees and a greater emphasis on prioritization and self-funding. For example, if an individual decides to live in a remote rural area, he or she should not expect the state or local government to provide roads to his or her home and should be required to self-fund his or her own roads. Some interviewees even suggested that in the future, remote communities or property owners should establish and operate a nonprofit or cooperative to support remote rural roads.

In terms of funding for sustainability, there are a large number of successful international examples. For example, in 1997, Denmark replaced its fixed annual vehicle ownership tax with a variable vehicle tax based on fuel efficiency. This policy, known as the “Green Owner” fee, required that owners pay €200 ($266.70) for a gasoline car with a specific fuel consumption of 6.5 L/100 km (36 mpg), with the rate increasing by €100 ($133.35) for every additional liter of consumption per 100 km. This meant, an average 8.5 L/100 km (27.7 mpg) car would be assessed €400 annually ($533.40) (Whitelegg, 2003).

Internationally, perhaps Singapore has gone farthest in the area of sustainability-based user fees and funding. It first implemented an area-based road pricing system in the 1970s. By 1998, the system was fully automated through the use of prepaid smart cards. Initially, the goal of this policy was congestion relief only; however, it has since moved to full externality pricing. The basic price for the road fare is proportional to the target-speed that has been estimated to
optimize traffic flow. If the average speed drops, the fees increase and vice versa. The fees are revised every third month, specified on electronic billboards at every gate, and communicated to drivers directly via smart phones and other electronic means. These fees are then modified based on the type of vehicle and estimated emissions. For example, electric vehicles pay a 20 percent lower road fee and hybrid vehicles pay a 10 percent lower fee. Revenues from this system produce approximately $50M to $70M per year (Gordon, 2005). Singapore has a population of approximately 5 million and an land area of 270 square miles.

There is a broad consensus within the transportation community that the current system of transportation funding is broken and that some form of user fees is needed to fund the future development of federal, state, and local transportation systems (Transportation Research Board, 2005). Technology, shrinking government budgets, and public hostility to across-the-board tax increases all make some form of user fees potentially appealing; however, schemes like those adopted in Singapore, Denmark, or other foreign countries are difficult to implement in the U.S. Attempts at implementing congestion zones and similar concepts are highly controversial and complex. Implementing advanced user-fee revenue generation systems, such as Vehicle Mile Traveled (VMT) charges may be decades away, and states are only beginning to test public reaction. For example, Minnesota’s Department of Transportation (MDOT) tested mileage-based user fees. In the Minnesota Road Use Test, it will ask 500 people from two counties to test technology that could someday be used to collect a mileage-based user fee. Thus, while there are many promising ideas for future funding of the road system, agreement on new funding mechanisms is still very unclear. This work builds on earlier work completed by Oregon. In 2006, ODOT launched a 12-month pilot program designed to test the technological and administrative feasibility of this concept. The program included 285 volunteer vehicles, 299 motorists, and two service stations in Portland. The pilot program showed that, using existing technology in new ways, a mileage fee could be implemented to replace the gas tax as the principal revenue source for road funding. At the conclusion of the pilot program, 91 percent of pilot program participants said that they would agree to continue paying the mileage fee in lieu of the gas tax if the program were extended statewide (Whitty, 2007). There is also broad consensus on the need to develop guidelines to assist transportation agencies in making the case for new funding structures and to institute revenue collection sources.

Any move towards greater sustainability would require major changes in how states account and budget for transportation programs; specifically: (1) the development of a more integrative cooperative budgetary system; (2) accounting for full social costs; and (3) greater flexibility in resource allocation.

The first of these elements poses the biggest challenge to transportation budgeting systems. Budgetary reform has a long history in the U.S. (Tyler & Willand, 1997). Table 11 shows some of
these initiatives. In general, such initiatives have had limited success. Integrated, sustainable budgeting, in which budget developers estimate the long-term intergenerational impact of different investments on the TBL, in concert with spending’s impacts on other agencies, is likely to be of limited success given the performance of previous budgetary “fads” and the general competitive nature of United States budgeting processes. There are some tools that are better able to evaluate the impacts of specific spending, and are discussed below.

Table 11: Budget Reform Initiatives in the United States

<table>
<thead>
<tr>
<th>Period</th>
<th>Budget Idea</th>
<th>Emphasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early 1900s</td>
<td>Line-item budget</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td>Executive budget</td>
<td></td>
</tr>
<tr>
<td>1950s</td>
<td>Performance budget</td>
<td>Management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Economy and efficiency</td>
</tr>
<tr>
<td>1960s</td>
<td>Planning, Programming, Budgeting System</td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>(PPBS)</td>
<td>Evaluation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Effectiveness</td>
</tr>
<tr>
<td>1970s and 1980s</td>
<td>Zero-Base Budgeting (ZBB)</td>
<td>Planning</td>
</tr>
<tr>
<td></td>
<td>Target-Base Budgeting (TBB)</td>
<td>Prioritization</td>
</tr>
<tr>
<td></td>
<td>Balanced-Base Budgeting (BBB)</td>
<td>Budget Reduction</td>
</tr>
<tr>
<td>1990s</td>
<td>New Performance Budget</td>
<td>Accountability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Efficiency and Economy</td>
</tr>
</tbody>
</table>

Numerous techniques exist to better capture the full social, environmental, and economic cost of proposed investments (see Table 12).

Table 12: Project Accounting Approaches

<table>
<thead>
<tr>
<th>Project Costing Approaches</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost Accounting (TCA)</td>
<td>TCA was introduced in the late 1980s in response to pressures to reduce the impact of industry operations on the environment. It is a cost estimation method that focuses on in-company assessments of cleaner production investments. TCA can be described as a normal, long-term cost accounting method, which pays special attention to hidden, less tangible costs and liability. Liability costs include fines for future damage involving environmental cleanup, healthcare costs, and property damage. Less tangible costs involve reduced consumer acceptance, tarnished corporate images, and strained external relations. Specifically, the TCA method focuses on the risks and hidden costs associated with a product or activity.</td>
</tr>
<tr>
<td>Full Cost Accounting (FCA)</td>
<td>TCS is often distinguished from FCA. FCA includes an additional category of costs that should be accounted for, namely, the social external costs related to production, use, Operations and Maintenance (O&amp;M), and disposal, which are not accounted for by any of the life-cycle actors or participants.</td>
</tr>
<tr>
<td>Life-Cycle Costing (LCC)</td>
<td>LCC is a process for evaluating the total economic value of a project by specifically addressing initial and discounted futures costs, such as O&amp;M,</td>
</tr>
</tbody>
</table>

42
<table>
<thead>
<tr>
<th>Project Costing Approaches</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Costing Approaches</td>
<td>rehabilitation and reconstruction, restoration and resurfacing, and other costs that are likely to be incurred during the life of a project.</td>
</tr>
<tr>
<td>Life-Cycle Cost Environmental Accounting (LCEA)</td>
<td>LCEA attempts to assess the full life-cycle costs, including costs (and benefits) associated with the environmental impact of the project (both the direct and indirect costs of the environmental impacts caused by the project throughout its entire life-cycle).</td>
</tr>
<tr>
<td>Sustainability Life-Cycle Accounting (SLCA)</td>
<td>SLCA goes beyond the other forms of accounting for project costs by attempting to estimate the full sustainability (i.e., TBL net costs) of all potential project alternatives in addition to the conventional life-cycle costs. At the extreme, SLCA attempts to assess the full value added to society (including transportation and non-transportation impacts) as a whole. Additional SLCA goes beyond the full life-cycle window, and considers very long-term costs and what long-term options are foreclosed by the selection of a specific option.</td>
</tr>
</tbody>
</table>

These techniques can be arrayed in terms of a number of dimensions; specifically, the range of impacts included (e.g., project costs only, economic costs, environmental costs) and the degree to which long-term and/or full life-cycle cost (Figure 6).

**Figure 6: Project Cost Accounting Techniques Array According to Range and Inclusion of Future Costs**
In general, as agencies move toward a greater emphasis on sustainability they would move from the bottom left side of the quadrant toward to top right corner. These cost-benefit techniques can be combined together to move toward a sustainable budgeting or resource allocation system. Under this system, needs would be identified in the needs assessment process and converted into specific plans. These plans would be cost-estimated using SLCA and the results would be compared to identify the highest possible net TBL benefit to society over the long term.

Under this model, agencies should consider four complementary approaches for bolstering sustainability. One would be to construct long-term fiscal scenarios using cutting-edge socio-econometric techniques, such as generational accounting and present-value accounting. Second, agencies could extend baseline projections beyond the medium term using methods that have been applied in medium-term frameworks. Third, agencies could estimate the impact of current policy changes on the long-term fiscal outlook. Finally, agencies could reconfigure fiscal risks, so that a greater portion is shared by households and current generations. It has been proposed that sustainability work requires a greater degree of independence than conventional budget tasks, and should therefore be conducted outside of government (Schick, 2005).

One of the key concepts in sustainability budgeting is that resource allocation must be flexible and resources allocated to achieve the optimal sustainable state consistent with the agency’s project and mission. Thus, project funding should not be limited to specific funds or accounts. Rather, funding should be able to flow freely between accounts. Furthermore, sustainable resource allocation requires that budgeting and resource allocation not be limited to specific agencies, transportation modes, or geographic regions. Thus, transportation resource allocation and budgeting should be approached as a whole and resources allocated to achieve the optimal sustainable return (Cutcher-Gershenfeld, et al., Sustainability as an Organizing Design Principle for Large Scale Engineering Systems, 2004).

The interviews with stakeholders emphasized that budget and spending flexibility were critical for sustainability. Specifically, they cited the challenges federal transportation funding poses to sustainability. Stakeholders wanted more flexibility in using these funds, because oftentimes, government restrictions prevent them from being used where needed.

For instance, in the Netherlands, the Ministry of Infrastructure and the Environment was formed to maximize the potential for efficient resource allocation by merging the former Ministry of Transport, Public Works and Water Management and the Ministry of Housing, Spatial Planning and the Environment. Now the Dutch have one Ministry that has authority over regulation, management, and capital investments of Transportation of people and goods via roads, trains, boats, and airplanes. In theory, the new Ministry’s budgeting decisions are made without reference to individual modal organization biases and allocates funds based on overall transportation goals.
Similarly, the state of Victoria’s (Australia) system was remodeled by the Transportation Integration Act 2010 to create a new framework for the provision of an integrated and sustainable Transportation system in Victoria. Now, the Victoria Department of Transportation oversees and coordinates the activities of all state agencies that impact the Transportation system in Victoria, including heavy and light rail systems (including trains and trams), roads systems, all vehicles (including cars, trucks, bicycles), ports and waterways, and some air transportation systems. As with the Netherlands, the Victoria model is intended to promote integration between modes and drive transportation priorities towards shared sustainability goals.

The core of Victoria’s Transportation Integration Act is the high-level policy framework for making sustainability policy. The key features of the framework are the six transportation system objectives and seven decisionmaking principles. The policy framework applies the principles of sustainability to the transportation sector and recognizes that transportation is part of a broader policy goal of achieving sustainable development, both locally and globally.

Specifically, the Act sets the following goals for the transportation system:

- Facilitate social and economic inclusion;
- Encourage economic prosperity;
- Support environmental sustainability;
- Encourage the integration of transportation and land use;
- Support efficiency, coordination, and reliability of transportation assets; and
- Promote safety and health and well-being.

In terms of decisionmaking and resource allocation, the act identifies a number of key decisionmaking principles covering the following:

- Integrated decisionmaking;
- Regular TBL assessments;
- Specific inclusion of equity conditions;
- Consideration of transportation system user perspectives;
- Consideration of the precautionary principle;
- Ongoing stakeholder engagement and community participation; and
- Decisionmaking transparency.

Transportation agencies and interface agencies can use these principles in the formation of their own objectives when exercising their powers and performing their functions. In addition, the
Act establishes requirements for need identification, plan development, and budget management that specifically address each of the six objectives.

The potential of implementing these examples in the United States may be limited. Differences in political ideology, geography, and institutional systems make it difficult to see how these innovations might be easily adopted here. Over time, the Federal Government might reduce the strings attached to federal transportation money or withdraw from the transportation funding system might convince states and local governments to develop new sources of funding from user fees or innovations, such as infrastructure banks.

**SUSTAINABILITY, RESOURCE ALLOCATION, AND INTERGENERATIONAL EQUITY**

A major issue in accounting for the cost of projects in the context of sustainability is the inclusion and evaluation of inter-generational equity or environmental justice. The origin of the concept in modern debate goes back to the 1970s with the work of John Rawls. Rawls developed a complex thought game based on social contract theory where rational individuals were asked to determine the rules and structure for a society without knowing where they were located in that society in terms of wealth and social position or the resources that society had at its disposal (each participant had some random chance of being assigned a role as “wealthy,” “middle,” or “poor,” but they had no knowledge at the time they constructed rules) (Rawls, 1971). Through a series of logical arguments Rawls proposed a series of rules that participants would then generate to create a “fair” society. In this game, Rawls rejected the Benthamite approach (i.e., the greatest goods for the greatest number) and, using a social contract approach, argued that decisions concerning public goods should be at least partially evaluated in terms of the welfare impacts to the least well-off group.

In terms of inter-generational equity, Rawls put forward the “just saving principle” to help deal with the problem of looking after the least-well-off in future generations. According to this idea, saving (i.e., capital accumulation) should be encouraged via laws or cultural norms over current period consumption. This implies that consumption and economic well-being of the current generation should be limited, in order to save resources and raise “the standard of civilization and culture” to a certain level. This would ensure that future generations would benefit from that accumulated capital and also any social/environmental benefits of de-emphasizing consumption.

The rationale for this is that in Rawls’ thought game, all members of a society have equal claims on the aggregated resources of the group. The game also requires participants to include future members of the society as well as current members. Thus, if the participants chose to allow the current generation to consume all the non-renewable resources available and leave behind no net savings or accumulated capital, future generations have no opportunity to use or benefit from those resources. According to Rawls this would be an unjust taking of resources by one
group (i.e., the current generation) from another group that was not able to influence or participate in the decision to use these resources (i.e., future generations).

In terms of sustainability, discussions about the difficulties associated with fair inter-temporal resource allocation have given rise to a large body of literature in recent years (which builds in many ways on the economic literature on inter-temporal consumption). This literature has focused on budgeting, environmental protection, and economics. In general this literature has identified several approaches to intergenerational equity.

The first is the preservationist model, in which the present generation does not destroy or deplete resources or significantly alter anything; rather it saves resources for future generations and preserves the same level of quality in all aspects of the environment and society. At the extreme, this model requires an unchanging status quo where future generations benefit at the expense of current generations (i.e., current generations do not use their resources to improve their current well-being). Furthermore, considering that natural changes are inevitable, a growing level of resources would be needed to maintain the world in its current state. This requirement for capital replenishing would actually harm the wellbeing of the current generation as a greater and greater volume of their consumption would have to be diverted into investment to maintain the current state. Ultimately this could lead to a society where a majority of its resources are channeled into a preserving a static condition in a world that constantly changes.

While this model seems unrealistic, its underlying principles can be found in a number of public programs. For example, numerous state parks programs, and the original “organic act” for the National Park Service, call for parks to be maintained in their current state in “perpetuity.” In addition, a number of historic prevention programs calls for specific historical or culturally valuable sites to be maintained in their current states in perpetuity for future generations to enjoy. This has led to numerous challenges for natural conservation organizations faced with the dual mission of encouraging access and use (by the current generation) and over saving the resource for future generations.

Variations of the preservation model that emphasize stewardship or conservation are more common. However, as with preservationist models, these approaches frequently lack the tools

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4 For examples of literature on budgeting, see (Strow & Strow, 2010)
5 There are many texts on the integration of environmental concerns with intergenerational fairness, but for a starting point, see (Portney & Weyant, 1999)
6 For examples of economics literature on sustainability, see (Beder, 2000)
7 A good discussion of this topic can be found in (Passmore, 1974), (Norton, 1986)
8 See “The NPS Split Personality” at [http://www.gcroa.org/Pages/nationalpark.htm](http://www.gcroa.org/Pages/nationalpark.htm)
and heuristics to be able to identify trade-offs between current and future use. Furthermore, the enshrinement of conservation or stewardship in legislation as a necessary decision factor (e.g., in NEPA analysis) means that well-meaning decisionmakers are faced with incompatible requirements where they must simultaneously preserve one set of public goods (e.g., an endangered species) while attempting to provide for another such as the construction of necessary infrastructure.

An alternative position on intergenerational resource allocation is the so-called “opulence” or “technology model” in which the current generation consumes all the resources that it requires and uses them to generates as much wealth as it can, either because there is uncertainty that future generations will exist or because maximizing consumption today is the best way to maximize wealth for future generations. This model generally ignores long-term degradation of resources or argues that future technology and the growing wealth of society will enable future generations to address these issues with fewer burdens on their resources than current generations (it will be easier to fix this problem with future technology than it is with present technology). In many ways this is the default position for the U.S. today; most public policy is directed towards the increase of current income, wealth, and technology with the assumption that any resource problems created can be dealt with in the future by wealthier or more technologically advanced generations. For example, mountain top removal (MTR) allows current generations to benefit from the coal mined in a low cost manner. However, the Surface Mining Control and Reclamation Act of 1977 (SMCRA) mandates that sites must be reclaimed to the land’s pre-mining contour and use by the mine owner. Thus, the wealth generated by MTR is used to address environmental problem created by MTR. In the context of the global literature on sustainability, this is a position that many theorists dislike.

Finally, there are economic models that focus on total life-cycle cost minimization. By using proper accounting and discounting techniques, it should be possible to estimate the full cost of different alternative investment and spending opportunities and identify the option that has the lowest costs across all time periods. In the US, discounting is commonly used in regulatory or business case analysis in the Federal Government. For example Circular A-4 of the U.S. Office of Management and Budget (OMB) mandates that all executive agencies and establishments conduct a “regulatory analysis” for any new proposal, and more specifically, a cost-benefit analysis. The OMB circular A-4 explicitly refers to the importance of equity for future generations, and requires a “lower but positive” discount rate for projects with potential long term impacts. Beyond this there is little guidance.

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9 See (Barnett & Morse, 1963) or (Simons, 1981) for classic statements of this position.
One alternative is the use of a “social discount rate,” which calculates the net present value of a project’s social costs and benefits over time (in some case, inter-generationally). A positive net present value indicates the project increases efficiency or raises wealth in aggregate. It also means that the project produces sufficient benefits to fully compensate individuals for the forgone benefits of the resources it displaces from alternative uses. Debates on the use of the social discount rate for very-long duration investments are often highly technical, but center around several key issues:

- How the opportunity costs of public funds should be addressed;
- The degree to which the net benefits of government projects are reinvested or consumed;
- The social rate of time preference;
- The mechanism for compensating the generations which bear the costs of the project; and
- The role that risk and uncertainty should play in the analysis.

For example, scholarly objections over the conclusions and methodology of the famous “Stern Review on the Economics of Climate Change” largely revolved around the discounting technique used and whether the discount rates were appropriate.

It is generally clear in the sustainability literature that greater attention needs to be paid to considerations for intergenerational equity in sustainability resource allocation discussions. While the tools do exist to conduct this analysis, there is no consensus as to the how these tools should be used, the exact methodology to be followed, and the key assumptions that should be made. Until these issues are resolved, intergenerational accounting and resource allocation will remain controversial and difficult to incorporate into sustainability planning.

Another common lesson from the sustainability budgeting literature is that resource allocation is most effective when it is flexible; funding that is able to flow with minimal restrictions between accounts is easier to re-purpose if that project raises new sustainability concerns. Since the point of incorporating sustainability into planning is to allocate the available resources to achieve the optimal sustainable state consistent with the overall purposes of project and mission

10 See. (Baumol, 1968); (Harberger, 1968); (Arrow & Lind, Uncertainty and the Evaluation of Public Investment Decision, 1970); (Bradford, 1975); (Auerbach, 1982); (Lind, 1982); (Arrow, Cline, Maler, Munasinghe, Squitieri, & Stiglitz, 1996); (Fugui & Wilcox, 1999); (Portney & Weyant, 1999); (Tresch, 2002)

11 The Stern Review on the effect of global warming on the global economy was released by the British government on October 30, 2006. It has been a hotly debated topic amongst environmental economists since that time.
of the agency, funding for projects should be flexible enough to be applied to projects and circumstances as they arise.

Furthermore, best practices in sustainable resource allocation emphasize that budgeting and resource allocation are most efficient when they are not limited to specific agencies, transportation modes, programs, or geographic regions. For these reasons, transportation resource allocation and budgeting should be approached in a holistic manner, and resources should be allocated to achieve the optimal sustainable return (Cutcher-Gershenfeld, et al., Sustainability as an Organizing Design Principle for Large Scale Engineering Systems, 2004). For examples of budget and resource allocation flexibility, please see Section 3.1.4

**COORDINATION AND PLANNING**

Many stakeholders considered coordination as a major challenge, because it is multidirectional; that is, horizontally between different departments within the state government and vertically between different levels of government. It was noted that unless state DOTs improve coordination of land use issues with local governments, there was little hope of improving the sustainability of state transportation initiatives.

States recognize this challenge; however, they are limited in the extent to which they can manage land use issues. A number of states have attempted to develop programs that coordinate land use and sustainability. At least twenty-two state DOTs address land use coordination and one-third of them use access management as the primary tool. Each initiative involves coordination with other state-level agencies and/or local governments. Table 13 shows some of these initiatives

<table>
<thead>
<tr>
<th>DOT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Grant program for collaborative regional visioning and scenario planning that integrates transportation, land use, housing needs, resource protection, and other issues; communities shape their “Blueprints” process through selection of performance goals.</td>
</tr>
<tr>
<td>Montana</td>
<td>Transportation Impact Analysis tool and coordinated development review process for determining impacts and required mitigation.</td>
</tr>
<tr>
<td>New Jersey</td>
<td>Effort coordinated with NJ’s Office of Smart Growth to emphasize reinvestment and transformation of existing transportation infrastructure; produced nationally recognized programs, including transit villages and mobility and community form.</td>
</tr>
<tr>
<td>New York State</td>
<td>Smart Growth educational and training programs and planning assistance for local and regional transportation agencies; website to facilitate communication.</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Coordinate transportation and land use planning efforts among several state and federal agencies; initiatives include a statewide action plan and development of a comprehensive shared GIS database.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>DOT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvania</td>
<td>State and regional agencies coordinate efforts for land use, transportation, economic development, and conservation to make effective investment decisions; DOT's Sound Land Use Implementation Plan is updated annually.</td>
</tr>
</tbody>
</table>

From: (Georgia Tech Research Corporation, 2011)

In many states, there has been an increase in the use of collaborative approaches in planning and management as a means of coordinating the efforts of state and local governments in transportation planning. For example, in 1990, the Washington State legislature passed the Growth Management Act (GMA). The GMA established the Regional Transportation Planning Program to create associations of local governments into Regional Transportation Planning Organizations (RTPO). RTPOs are designed to create a formal mechanism for local governments and the state to use in ensuring consistency and coordination in transportation planning and project prioritization for regional transportation facilities. Washington’s regional transportation planning system is comprised of the Washington Department of Transportation (WSDOT), 14 RTPOs, and 10 MPOs (Brody & Margerum, 2009).

Key highlights of the Washington transportation system include the following:

- **Organizational integration of RTPOs and MPOs**: RTPOs and MPOs use the same policy board for decisionmaking;
- **Formal statewide meetings of regional planning organizations**: WSDOT holds quarterly meetings for all of the state’s regional planning organizations to coordinate activities and information;
- **The Tribal Transportation Planning Organization (TTPO)**: The TTPO was created to incorporate tribal participation into transportation planning and programming more fully; and
- **Dedicated funding for planning a cross-boundary project**: WSDOT offers dedicated funding to RTPOs for projects that cross multiple RTPO boundaries.

Similarly, Iowa’s transportation planning system is managed through a partnership involving the Iowa Department of Transportation (Iowa DOT), nine MPOs, and 18 Regional Planning Affiliations (RPA). In its initial regional transportation planning, Iowa delineated areas outside MPO boundaries into 16 rural transit regions, which were each represented by a Council of Government (COG), and later a new process based on the existing rural transit regions. The RPAs implement a relatively new method of collaboratively based regional transportation planning for Iowa by including local government in regional transportation planning, project prioritization, and funding.

Despite these initiatives, however, coordination between state and local governments remains one of the biggest challenges in developing a more sustainable state transportation system.
DATA AND PERFORMANCE MEASURES

Data and performance measurement are vital to proper sustainability management. Progress cannot be measured until a system exists to measure performance and track change. Approximately 60 percent of state DOTs use performance measures or indicators that are related in some way to sustainability (i.e., mention environment, economy, and/or quality of life), and approximately 20 percent of DOTs use indicators for project prioritization as shown in Table 14.

Table 14: Sample State DOT Transportation and Sustainability Measurement Frameworks

<table>
<thead>
<tr>
<th>DOT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>Reports on performance goals and measures at both the regional (Blueprint Planning reports) and state levels (annual reporting on nine performance outcomes from the California Transportation Plan).</td>
</tr>
<tr>
<td>Iowa</td>
<td>Annual report and online monitoring system that outlines performance goals and measures, and assesses which targets have been met; measures used to adjust allocation of resources and identify investments in priority corridors.</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Framework using clear policy priorities, performance trend data, and performance forecasting to guide investment decisions; measures cover both internal and external activities.</td>
</tr>
<tr>
<td>Missouri</td>
<td>Quarterly report of measures for eighteen outcome areas covering environmental responsibility and economic development since 2005; an additional goal added in 2009, to track impacts of stimulus funding.</td>
</tr>
<tr>
<td>Texas</td>
<td>Framework for sustainability measures that corresponds to goals in TxDOT’s strategic plan; current selection of measures was limited by data availability.</td>
</tr>
<tr>
<td>Washington</td>
<td>Quarterly report of goals and measures organized around WSDOT’s five legislative and strategic policy goals (i.e., safety, preservation, mobility/congestion relief, environment, and stewardship) and a “Performance Dashboard” of key indicators; transparency and organized presentation make it useful for internal tracking and external accountability.</td>
</tr>
</tbody>
</table>

From: (Georgia Tech Research Corporation, 2011)

As Table 15 shows, these efforts are part of a much larger effort to develop sustainability measures.

Table 15: Sustainable Performance Systems in the United States and Other Countries

<table>
<thead>
<tr>
<th>Source</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDOT (2003) Performance Report 2004 Performance Plan, Washington, DC</td>
<td>USDOT has defined five strategic goal areas covering safety, mobility, economic growth and trade, human and natural environment, and national security. For each goal, a set of strategic outcome goals and a number of more specific performance measures are defined for use in the annual performance planning.</td>
</tr>
<tr>
<td>EPA (1999) Indicators of the Environmental Impacts of Transportation, updated</td>
<td>The reports attempt to provide a comprehensive overview of the full range of environmental impacts (including impacts on air, water, climate, natural habitats, and other endpoints) from transportation.</td>
</tr>
<tr>
<td>Source</td>
<td>Overview</td>
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<tr>
<td>-----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Transport Canada (2001) Sustainable development strategy 2001–2003, Ottawa, Canada</td>
<td>The reports are structured around a set of seven challenges, broken down into 29 commitments, again broken down into targets and performance indicators. Three levels of indicators, reflecting different spheres of influence, include state-level indicators (describing the state of the transportation systems in terms of sustainability), behavioral indicators (describing the behavior or activities of the actors and stakeholders whose actions matter for the state of the system), and operational indicators (describing indicators for operations and actions of Transport Canada, itself).</td>
</tr>
<tr>
<td>Environment Canada (1991) and (2003) Canada’s Progress Towards a National Set of Environmental Indicators, State of the Environmental Rep. No. 91-1, Ottawa, Canada</td>
<td>This report presents 43 preliminary indicators in 18 issue areas with widespread stakeholder and media interest. This uses a modified “Pressure-State-Response” framework, and includes a fourth category related to the nature of human activity. The structure encompasses four sets of issues: ecological life support systems; natural resources sustainability; human health and well-being; and pervasive influencing factors.</td>
</tr>
<tr>
<td>NRTEE (2003) ESDI for Canada, Ottawa, Canada</td>
<td>The NRTEE has developed a draft set of sustainable transportation principles that concern access, equity, individual and community responsibility, health and safety, education and public participation, integrated planning, land and resource use, pollution prevention, and economic well-being.</td>
</tr>
<tr>
<td>ORTEE (1995). Sustainability Indicators: The Transportation Sector, Toronto, Canada</td>
<td>The report develops and assesses indicators for evaluating the impacts of possible actions or measures on the sustainability of the transportation system in Ontario. The framework adopted is based on a “criterion-influences-actions-measures” system. The conceptual model adopted is a computerized revised version of the “environment-economy linkages model.”</td>
</tr>
<tr>
<td>TAC (1999), Ottawa. Canada</td>
<td>TAC presents 13 principles pointing to sustainable transportation systems and related urban land use in Canada in 1993. A survey to monitor trends towards attainment of the principles can be considered as framing indicators or potential indicators to the extent that they provide appropriate quantitative responses.</td>
</tr>
<tr>
<td>Litman, Todd; VTPI (2003). “Sustainable Transportation Indicators,” Victoria, Canada</td>
<td>Victoria Transport Policy Institute (VTPI) presents a literature review on its approach and selection criteria for sustainable transportation indicators. They offer an alternative perspective on the selection of transportation indicators by focusing on access (the ability to reach goods, services, or destinations) rather than on the transportation system’s ability to “move vehicles” (by measuring traffic congestion, for example).</td>
</tr>
<tr>
<td>CST (2003). STPI, Toronto, Canada</td>
<td>The Centre for Sustainable Transportation, Canada developed an initial set of 14 STPI. They adopted four criteria to select the indicators: the indicators must (1) be relevant to the definition, (2) be relevant to a time series, (3) represent all of Canada, and (4) come from a reliable source. The direction of the graph representing time series numbers for each indicator shows whether or not progress has been made towards sustainable transportation.</td>
</tr>
<tr>
<td>OECD (1999a)</td>
<td>The document pertains to the integration of environmental concerns.</td>
</tr>
<tr>
<td>Source</td>
<td>Overview</td>
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<tr>
<td>Indicators for the Integration of Environmental Concerns into Transport Policies, Environment Directorate, Paris, France.</td>
<td>into transportation policies through the development and use of indicators. The indicators are structured according to three themes: sectorial trends of environmental significance; environmental impacts of the transportation sector; and economic linkages between transportation and the environment.</td>
</tr>
<tr>
<td>Environmental Performance Indicators (EPIs) (Second Edition), World Bank, Environmental Economics Series, Paper No. 71</td>
<td>The Bank’s Environment Department (ENV) Unit has prepared a manual on EPIs. This document discusses indicator frameworks, selection criteria for environmental project indicators, and issues to consider for various environmental areas.</td>
</tr>
<tr>
<td>PROSPECTS (2003). Developing Sustainable Urban Land Use and Transport Strategies: Methodological Guidebook: Procedures for Recommending Optimal Sustainable Planning of European City Transport Systems</td>
<td>The purpose of the report is as follows: (1) To present a coherent but flexible general approach to planning for a sustainable urban land use/transport system, building on the logical structure (2) To offer innovative methods of carrying out the steps of that logical structure, especially regarding appraisal of land use/transport strategies with respect to sustainability, and optimization with respect to sustainability (3) To provide detailed advice on a number of issues in the planning process.</td>
</tr>
<tr>
<td>European Environmental Agency (EEA) (2002) TERM (2002)—Paving the way for European Union (EU) enlargement: Indicators of transport and environment integration, Environmental Issues, Copenhagen, Denmark.</td>
<td>The report describes the progress the EU is making towards the integration of environmental concerns into its transport policies. The aim is to monitor progress in three areas: the degree of environmental integration in the EU transport sector, progress towards transport systems that are more compatible with sustainable development, and the effectiveness of the adopted policy measures.</td>
</tr>
<tr>
<td>Baltic 21 (2000) Series No 13/98: Indicators on Sustainable Development in the Baltic Sea Region (An Initial Set): Baltic 21 Transport Sector Report (No. 8/98). Annex 5: Indicators for Sustainable Transportation, Stockholm, Sweden</td>
<td>Baltic 21 selects indicators according to three different types of goals and measures: (1) Indicators with regard to primary goals for sustainable transport (2) Indicators with regard to institutions, instruments, and measures (3) Indicators with regard to the transport system and transportation activity.</td>
</tr>
<tr>
<td>DSD (2003) Achieving a Better Quality of Life, Review of Progress Towards Sustainable Development, United Kingdom,</td>
<td>The United Kingdom presents the 10 guiding principles: (1) Putting people at the center (2) Taking a long-term perspective (3) Taking account of costs and benefits (4) Creating an open and supportive economic system (5) Combatting poverty and social exclusion (6) Respecting environmental limits (7) The precautionary principle (8) Using scientific knowledge</td>
</tr>
</tbody>
</table>
Closely related to the issue of performance standards is the use of “Green” transportation standards for transportation investments. States have developed rating systems modeled after the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) rating system for buildings. Table 16 shows a sample of these standards under development.

**Table 16: Sample Green Transportation Standards**

<table>
<thead>
<tr>
<th>DOT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York State Department of Transportation (NYSDOT)</td>
<td>First completed rating system; applied internally to DOT projects to recognize sustainable practices, encourage innovation, measure performance, and identify areas for improvement; certifications and awards are announced annually on Earth Day.</td>
</tr>
<tr>
<td>U of Washington, CH2M Hill, WSDOT</td>
<td>Sustainability rating system for highways that includes 76 credits in seven categories, including 11 required credits; draft version being tested and calibrated; roadway developers will be able to apply for official certification or use the system for guidance.</td>
</tr>
<tr>
<td>Public-private initiative with support from EPA, FHWA, Maryland DOT (MDSHA)</td>
<td>Voluntary partnership to share information and provide guidance for developing more sustainable roadways.</td>
</tr>
<tr>
<td>Public/Private Team from Oregon and Washington</td>
<td>Rating system for transportation projects, plans, and employer programs that is under development.</td>
</tr>
<tr>
<td>University of Wisconsin with Wisconsin DOT</td>
<td>Approach based on TBL that uses qualitative measures to screen road projects and then rates a project with quantitative measures.</td>
</tr>
<tr>
<td>Lochner Engineering</td>
<td>Checklist for sustainable highway/roadway projects that should be applied during planning, environmental assessment, design, and construction phases; able to track how projects change.</td>
</tr>
</tbody>
</table>

While all stakeholders interviewed agreed that improved performance measures were needed, many opposed expanding or developing unnecessary new techniques, such as Sustainability Impact Assessments (SIA). In fact, many feared a data overload – there may be too much data to choose from and the agency may struggle with what is the most important or most meaningful data to track. In addition, many stakeholders were concerned about data availability. In general, there is substantial data available on environmental indicators (often required by law) and
economic indicators (commonly used in transportation and travel demand planning), but it is difficult for state DOTs to develop meaningful indicators of social sustainability. Some states have tried to develop these indicators (e.g., Arizona, Delaware, and California), but have experienced considerable difficulty in narrowing down the list of potential indicators to a meaningful number. Furthermore, they have found that many of these indicators require original data collection, which can be extremely expensive. As a result, they have found it necessary to prioritize more pressing needs over data collection (Georgia Tech Research Corporation, 2011).

Culture Change, Outreach and Communication

Stakeholders conveyed a broad consensus that sustainability will require substantial culture change, both within agencies and with public and state leaders. In addition, the current fiscal and economic climate means that many agencies lack state support to engage in new initiatives. In general, stakeholders felt that there was a need to sell sustainability as a way to save money and as a more efficient means of delivering service. In particular, there was a need to change the mindset of some transportation agency staff away from focusing on the traditional level of service (LOS) and transportation as an end in itself, toward how transportation will improve community life and meet community needs. As such, stakeholders felt there was a need for new return-on-investment (ROI) tools that could develop the business case for sustainability and communicate its value as a common-sense initiative.

One of the major challenges that stakeholders felt existed with sustainability was the need to create new planning and implementation processes or entities that would manage transportation across multiple jurisdictions. This would require huge changes and would be difficult to achieve unless the Federal Government offered some financial incentive to cooperate. In addition, many stakeholders doubted the benefits of relying on foreign models to build support for sustainability, believing that their political, economic, and institutional systems were too different, and that only strong leadership, targeted outreach to key communities and interest groups, and public support could bring about change.

Recently, several state DOTs have already begun to move away from the traditional LOS. For example, in response to a perceived lack of confidence from stakeholders, limited funding, employee turnover, and political pressure to outsource, the Louisiana Department of Transportation and Development (DOTD) began to change its culture and adopted a new five-pronged approach (Bridges, 2008). First, it developed tools to demonstrate the ROI of any proposed change and identified changes that would improve performance and service delivery. Second, it engaged the department head as the chief sponsor of the initiative. He communicated forcefully that this was a “change-or-die” situation requiring maximum commitment. Multiple communication initiatives were launched to demonstrate the need for change, explain the rationale and proposed changes, and how people could participate in the change. The program
focused on quick-wins, claiming low-hanging fruit and building momentum for change (Bridges, 2008).

Some governments have attempted institutional change through massive public participation programs. In western Australia, the City of Perth provides an example of this process in action. In 2003, it began a broadly based consultation process to create a vision of the city. This process coalesced citizens, business groups, and more than 42 government departments to create a vision of Perth in 2030. As part of this exercise, a household survey was conducted of more than 1,700 households and 1,000 citizens participated in a one-day planning forum. Forum participants were grouped in teams of 10 and given a particular transportation problem. Each team was tasked with finding solutions to problems city planners faced involving sustainability, mobility, and economic growth. The result was a consensus plan known as “Network City,” which was endorsed by all major interests involved. One of its major goals was to have 60 percent of all new construction be a part of a car-free, sustainable network of transportation (Schiller, Preston; Bruun, Eric C; Kenworthy, Jeffrey R, 2010).

Figure 7 shows two alternative models that the research team generalized from the literature review for building support for sustainability initiatives.
Figure 7: Policy System Development—Top-Down, Bottom-Up

Top-Down Executive Led Approach to Building Sustainability

State Leaders and key stakeholders begin sustainable initiatives

Demonstrate ROI, show benefits

Increase support, build coalitions in favor of change

New Legislation or Executive Orders

DOT changes policies, programs, and process

Program Implemented

Program produces benefits

Bottom-Up Locality Led Approach to Building Sustainability

Local transportation challenges create catalyst for change

City government leaders develop sustainability program in response to local challenges

Demonstrate ROI, show benefits

Increase support, build coalitions in favor of change

Success builds support

Local DOT changes policies, programs, and process

Program Implemented

Program produces benefits

New Legislation or Executive Orders

State Leaders and key stakeholders begin sustainable initiatives

Other localities adopt innovations

Increase support and coalitions in favor of change

Public
Stakeholders
Major interest groups
Economic interests
One option is to work with state leaders and key stakeholders to develop a consensus in favor of sustainability. This requires strong support from state leadership. These leaders build support for sustainability by presenting sustainability as making good economic sense and relieving major transportation and quality of life problems. Areas include: reducing congestion and travel time, improving transportation options, improving transportation safety and security, increasing property values by improving system connectivity/accessibility as well as quality of life, making the state more attractive to industry, creating new jobs, and generating more revenues to support statewide needs.

Once this support has been obtained, legislation or executive orders can be enacted and the DOT can begin to push internal culture change to convert front-line staff and revise policies, programs and processes to meet new sustainability mandates. These new programs focus on quick-wins and low-hanging fruit, demonstrate benefits and gradually build more support for sustainability.

An alternative approach is to build support from the ground up. Under this approach, cities and localities begin sustainable transportation initiatives. The literature on sustainability suggests that it is easier to build support for sustainability at a local level because transportation and quality-of-life related problems primarily manifest themselves at the local level (e.g., congestion, lack of travel options) and it is generally easier, given the closeness to voters and less diverse interests, to develop consensus behind sustainability initiatives. If these initiatives are successful they tend to generate attention from key state leaders and stakeholders. Localities then begin to adopt innovations to obtain the benefits they have seen from early adopters. Ultimately a consensus builds in the state that creating state-wide programs may be appropriate. At that point, state leaders develop state versions of the program modified to fit state purposes.

3.1.2 Local Government and City Sustainability Programs

Most of the sustainability literature concludes that cities and local governments are the leaders in government sustainability. There are many reasons for this. First, cities experience many problems and challenges, which often demand a close integration of economic, environmental, and social policies. Thus, sustainability is a natural outgrowth of these efforts. Second, the proximity of cities to the people and key stakeholders makes it comparatively easy to develop coalitions in favor of change. Third, the powers that cities have to control or influence land use decisions provides them with the tools needed to implement sustainability. Fourth, the close proximity of key stakeholders makes it easier for cities to develop new funding sources for sustainability initiatives, such as user fees, congestion charges, or bond issues to finance new transit. Fifth, cities are often the most economically dynamic and wealthy parts of a state or region. The concentrated wealth that cities generate gives them the material basis from which to embark on ambitious infrastructure projects. Finally, while cities may be ethnically and culturally diverse, the relative breadth of diversity in terms of economic or transportation
requirements is limited by the city’s physical size. Unlike states, where the geographic size tends to create competing interests (e.g., Northern Virginia and Southeastern Virginia required increased transportation spending on urban systems, whereas rural Southwestern Virginia opposed spending on urban transportation and favored expanding the state highways system to support economic development), cities find it easier to unite interests around a common desire to address local transportation challenges.

For all these reasons, local and city sustainability programs tend to be the leaders in sustainability. It should be noted that local and city sustainability programs are not limited to large, wealthy cities. Table 17 shows a sample of city and local government sustainability plans in the United States that include transportation for cities under 1 million people. As can be seen, these plans are not focused on transportation only.

**Table 17: Sample Local Government Sustainable Transportation Programs**

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Plan</th>
<th>Scope</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burlington, Vermont</td>
<td>30-year Sustainability Action Plan</td>
<td>Economy, neighborhoods, governance, youth, and environment</td>
<td>30-year plan; progress reports provide annual (short-term) success</td>
</tr>
<tr>
<td>Charleston, South Carolina</td>
<td>Action Plan</td>
<td>Energy, transportation, recycling and waste management, land use/planning</td>
<td>Unclear</td>
</tr>
<tr>
<td>Fayetteville, Arkansas</td>
<td>Comprehensive Land Use &quot;Strategy&quot; Plan</td>
<td>Land use planning-sprawl, infill, livable transportation growth, green network, traditional town form, attainable housing</td>
<td>2025</td>
</tr>
<tr>
<td>Fort Collins, Colorado</td>
<td>Action Plan</td>
<td>Provides management tools for sustainable purchasing, healthy productive employees, green buildings, healthy ecosystems, sustainable energy, pollution and waste reduction.</td>
<td>Not stated</td>
</tr>
<tr>
<td>Northampton, Massachusetts</td>
<td>Comprehensive Plan</td>
<td>Social equity and economic vitality and environmental security for its citizens, the community, and its built and natural resources. Energy savings, waste</td>
<td>10 years</td>
</tr>
</tbody>
</table>
Many large cities have developed comprehensive sustainability transportation programs, as well. For example:

**BOSTON, MASSACHUSETTS**

In fall 2009, Boston Mayor Thomas M. Menino established the city’s Complete Streets program. This initiative aims to create streets that integrate pedestrians, cyclists, and public transit with motorists. In pursuing this program, Boston has major advantages. As a dense, historic city built around a business core, it lends itself naturally to Smart Growth principles and transit-oriented development (TOD). The public transit system is extensive and used widely, embracing regional rail, subway, light-rail, electric trolley buses, motor buses, and ferries. Rail lines integrate the entire region, stretching to neighboring communities like Cambridge, and other metropolitan areas such as Providence, Rhode Island, allowing commutes between these centers without relying on highways (Barmeyer, Transportation / Boston, Massachusetts, 2011).

According to the Green Boston Climate Action Leadership Committee and Community’s April 2010 summary report, “Sparking Boston’s Climate Revolution,” by 2020, Boston should be able
to reduce vehicle miles traveled in the city by more than 7 percent through promoting the use of public transit, as well as by fostering TOD and encouraging ridesharing, walking, and biking. Transportation initiatives account for 31 percent of the city’s carbon reduction goals for 2020. These goals include both state and federal policies—such as a GHG standard to improve the fuel efficiency of vehicles—as well as many of Boston’s own programs, such as increasing enforcement and education on anti-idling (Green Boston Climate Action Leadership Committee and Community, 2010).

For the past couple of years, Boston has been increasing bike usage through a city initiative that, among other things, added 30 miles of new paths. In fact, from 2007 to 2009, the city saw a 43 percent increase in bicycle ridership—more than three times the national average increase. In July 2010, the city was awarded more than $3 million in federal funding to establish one of the country’s first bike-sharing systems. Often located near public transit stations, riders can borrow, use, and return a bike with just the swipe of a card (Barmeyer, Transportation / Boston, Massachusetts, 2011).

**CHICAGO, ILLINOIS**

The foundation of Chicago’s sustainable transportation efforts is Chicago’s GO TO 2040, which was established by the Chicago Metropolitan Agency for Planning (CMAP). The plan has a goal of moving the region to affordable and innovative ways to increase transit, fleet, and freight efficiency.

In the realm of transit, minor changes, such as the Bus Tracker and Train Tracker systems have provided benefits. These systems provide real-time arrival information that can be accessed online, on mobile devices, or via text. Local businesses have the option of running Bus Tracker on a screen display or message board for the convenience of their customers. With Bus Tracker information free and accessible to the public, business owners can develop their own applications to display the information, or they can download for free the Do-It-Yourself Bus Tracker Display, available on the Chicago Transit Authority (CTA) website. For now, Train Tracker is available for phone use only (How-to guide: CTA Train Tracker by Text).

A TRB report found several benefits to such systems including:

- Reduced average waiting times for customers and increased willingness to wait due to real-time bus arrival information;
- More frequent transit service use;
- Increased ridership and revenue; and
- Shifting behavior towards public transportation.

From: (Transportation Cooperative Research Program, 2003)
By 2012, Chicago is also endeavoring to be electric vehicle-ready with 280 electric vehicle charging stations, including in the suburbs. The stations are to be installed at the O'Hare and Midway airports, in downtown parking garages, grocery store parking lots, and toll plazas, and will be ready to fully charge electric vehicles in less than 30 minutes. The City will be among the first to use the new recharging stations with its fleet of heavy-duty electric vehicles, such as electric-powered garbage trucks, which are slated to come online soon.

The City has designated nearly 40 charging stations for I-GO Car Sharing, a local nonprofit that will add solar canopies to its stations to power I-GO vehicles with clean electricity. I-GO, which views itself as an extension of the public transit system, became the first car-sharing service in the nation to offer customers a seamless integration with the region’s public transportation system. In 2009, I-GO partnered with the CTA to give users access to I-GO cars and CTA bus and rail services with a single I-GO/CTA smart card.

The region has taken a number of steps to increase the efficiency of its fleet, as well, including purchasing hybrid vehicles and using biodiesel and ethanol, whenever possible.

Another approach has been to train taxi drivers in “eco-driving,” which involves driving and maintenance techniques that can increase gas mileage. These include starting and stopping slowly, checking tire pressure regularly, and unloading heavy and unnecessary cargo before driving. As of December 2010, all new taxi drivers are required to receive training and are tested before licensing.

Chicago is a key freight hub. For example, six of the country’s seven largest railroad carriers have terminals in the Chicago metro region, bringing nearly 500 freight trains through the area each day. The freight traffic creates economic and industrial growth for the region—as well as pockets of congestion, bottle-necked traffic at rail crossings, and increased air pollution. To increase the sustainability of these initiatives, as well as increase the efficiency of freight movement in Chicago, the Chicago Region Environmental and Transportation Efficiency Program (CREATE) was created. CREATE is a public-private partnership between the U.S. DOT, the State of Illinois, the City of Chicago, six private rail companies, Chicago’s commuter rail service Metra, and Amtrak. It has outlined a plan to strategically upgrade four widely used corridors, increasing capacity and improving rail network connections throughout the region. Of the 71 projects underway, 10 are complete. Fully implemented, the program is expected to create 172,000 jobs and prevent the equivalent of 1.61 million metric tons of carbon dioxide emissions each year.

Additionally, 42 municipalities in Chicago’s south suburbs were awarded $2.3 million in competitive federal funding through the Department of Housing and Urban Development’s Sustainable Community Challenge Grant program to implement a multijurisdictional, rail-focused revitalization strategy. The plan emphasizes development around transit, intermodal
freight industries, green manufacturing, and environmental stewardship, and aims to attract 13,000 jobs and $2.3 billion in new income to the area over the next 10 years.

**NEW YORK, NEW YORK**

The New York metropolitan region’s population density provides it with a clear advantage in developing sustainability plans. This density has positioned New York to be served broadly by mass transit, accessible easily on foot and by bike, and to develop naturally by the principles of Smart Growth. Furthermore, with 19 million people living and working in the region, 3.6 million people commuting to the city daily, and 50 million tourists visiting annually, efficient and effective mobility programs are supported widely by voters and city leaders (Barmeyer, Transportation / New York, New York, 2011).

With nearly 50 percent of commuters using public transportation daily, New York has the highest percentage of transit users in the nation. Between 2000 and 2009, transit commuters by 4 percent, the greatest increase in the nation according to the report state of Metropolitan America. It is also one of only two regions in the United States, alongside neighboring Jersey City, New Jersey, with an average automobile ownership of less than one vehicle per household. Getting from place to place is more affordable in New York—at an average annual cost of $5,289—than in any other large city in the country, and at an average of 9,920 miles per year, New York City residents travel fewer miles by car than residents in any U.S. city, besides Jersey City.

The average New Yorker’s energy consumption and carbon emissions are about one quarter of that of the average American, and there is no question that the city’s impressive transportation network is crucial to these results. The power largely behind many of these impressive results is the Metropolitan Transit Authority (MTA), which oversees a 5,000-square-mile region, including downstate New York, Long Island, and southwestern Connecticut. According to the MTA’s 2008 sustainability plan, “Greening Mass Transit and Metro Regions,” MTA must reach at least two-thirds of New York’s projected population growth of 4 million by 2030, for the metropolitan region to maintain its vitality and strong economy.

The high public transit use means lower energy consumption for the average New Yorker, because with 8 million riders each day, it is as though each of these people is driving a car with a fuel efficiency of 100 miles per gallon. It also means fewer carbon emissions. In 2008, MTA joined the Climate Registry, a nonprofit, third-party verifier of GHG emissions, which determined that for every unit of carbon emitted by New York public transportation, more than 8 units of carbon are saved due to reduced driving by transit riders.
MTA is also expanding uses of renewable energy, partnering with various entities at the city and state levels on TOD, exploring new technologies for trains to recycle energy wasted during braking, and replacing overhead “necklace” lighting on bridges with LED bulbs.

Although MTA is responsible for public transit in the region, the City of New York has been a guiding force in the transportation future of the city with its PlaNYC for a “greener, greater New York.” Since 2007, the City has added 200 miles of dedicated bike lanes, and bicycle commuters increased 26 percent from 2008 to 2009. In three years, it has completed 19 rezonings that have directed development to areas with good transit access.

**San Francisco, California**

San Francisco is a major public transit city. More than half of the city and county population commute via public or alternative transportation (e.g., bike, ride-share) and 90 percent of city residents are within two blocks of a public transit stop. Almost a third of city residents get to work by train, bus, trolley, or cable car; 7 percent carpool, 10 percent walk, and 3 percent bike. A 2008 Commuter Benefits ordinance required employers to reward employees for carpooling or using public transit (Quinton, Transportation / San Francisco, California, 2011).

The achievement of this level of reduction in car use has been brought about by a close integration of city and transportation planners. City planners work alongside the San Francisco Metropolitan Transportation Authority (SFMTA) and regional partners to make sure transit services stay relevant as the city changes. The eastern neighborhoods are of particular concern, because unlike many parts of this densely populated city, they will likely see a huge population increase in the next few decades; current plans show an increase to 320,000 daily trips by 2035 — 50 percent more than in 2005. The plan ensures transit meets the needs of rapidly growing neighborhoods.

City and state GHG reduction targets have focused the region on improving transit networks, and getting single-occupancy vehicles off the road. In 2004, San Francisco pledged to reduce carbon emissions to 20 percent below 1990 levels by 2012; in 2006, California committed to reducing GHG emissions 25 percent by 2020, and set a 20 percent reduction goal specifically for the transportation sector. To meet such targets, San Francisco’s transit ridership needs “to be doubled,” the SFMTA noted in its 2008 Climate Action Plan.

SFMTA’s investment in clean fuels will help lower emissions citywide. The electric trolley buses, streetcars, and light rail trains that comprise roughly half of San Francisco’s transit fleet already produce almost zero emissions. Not only are they electric powered, they are also powered by the city’s hydroelectric plant, keeping fossil fuel use low. All SFMTA buses are either diesel or hybrid-electric models, and by 2020, SFMTA hopes to field an all-electric fleet.
Switching nonrevenue vehicles, such as parking enforcement cars to more fuel-efficient models will be SFMTA’s next big project.

At the regional level, the Bay Area Metropolitan Transit Commission (MTC) has committed to expand the regional bikeway network, increase funding for TOD projects, and integrate a Climate Action Program into regional transportation plans. The MTC has set aside money for a regional bike-share program already, which will involve six cities along the Bay Area peninsula transportation corridor. The proposed development of a California high-speed rail network and initiatives to expand charging base stations for electric vehicles could further improve regional transit dramatically.

SFMTA’s Livable Streets unit focuses on “improving quality of life for people on the streets who aren’t in cars” (Quinton, Transportation / San Francisco, California, 2011). Livable Streets pioneered the “sharrow,” a road marking that tells bicycles and cars to share a lane, and has timed traffic signals on a major thoroughfare so that bicyclists never have to stop at red signals. SFMTA’s Livable Streets plan, currently experiencing dramatic increases in demand, is complemented by the city’s Better Streets Plan, a 2006 initiative that aims to make streets pedestrian friendly and viable public spaces. Using plantings, open spaces, and other design features, city planners hope to improve air quality, decrease surface runoff, and encourage residents to explore the city by foot or bike.

**PORTLAND, OREGON**

Portland stands out because of its commitment to sustainability, TOD, environmental stewardship, and infrastructure investments. As a result, it has developed a popular and growing public transportation system. City-based transit ridership grew almost twice as fast as the population and three times faster than expansions in transit service between 1996 and 2006. Eighty-six percent of riders choose the region’s transit system, TriMet, over driving, and transit ridership remains high throughout the week—even on weekends (Quinton, Transportation / Portland, Oregon, 2011).

TriMet provides light-rail, bus, and commuter rail services to the tri-county Portland region and partners with the City of Portland to deliver streetcar services. Portland’s Metropolitan Planning Organization (Metro) oversees transit at the regional level. Both authorities collaborate closely with local developers and city planners.

Ever since the 1970s, Portland has embraced TOD and resisted urban sprawl. City planners have attempted to encourage dense development and prevent suburban sprawl within an urban growth boundary to preserve the green space and forestland that lies beyond. Metro also provides tax incentives for TOD.
Portland’s Downtown Transit Mall, established in 1978, keeps the city center pedestrian-friendly with one-way streets intended specifically for transit. Ever since 1975, passengers have been able to ride public transit for free—any day, any time—in downtown Portland. The free service began with certain downtown buses, the only form of transit available at the time, and is now limited to light-rail and streetcar services within downtown Portland, the Rose Quarter, and the Lloyd District.

Portland also has an aerial tram that links two campuses of the Oregon Health and Science University. The aerial link, owned by the City of Portland, carries 980 people per hour in each direction; by 2007 statistics, 86.4 percent of tram riders are either employees or students of the medical facility (Quinton, Transportation / Portland, Oregon, 2011).

Portland’s Pearl District revitalization has become a classic case study for urban planners. In the early 1990s the Pearl District was mostly old industrial warehouses and an abandoned rail yard. A small group of developers, along with city planners, envisioned a much denser urban neighborhood. The stakeholders worked with city government to create a comprehensive development program; the City would provide the area with a modern streetcar line, and the developers would invest in mixed-use development projects all over the neighborhoods. Collaboration between the City, private developers, TriMet, and the nonprofit Portland Streetcar paid off. Today, the Pearl District is one of Portland’s most attractive neighborhoods, boasting a mix of local and national retailers, residences, and parks.

Current projects look beyond downtown Portland, aiming to link the city with other high-density communities in the region. By 2015, TriMet hopes to link Portland directly with the City of Milwaukie, by extending rail and streetcar services across the Willamette River. Another light-rail extension, this time across the Columbia River, will connect Portland with Vancouver, Washington, by 2020. Perhaps the most comprehensive initiative, the Southwest Corridor Plan will lay out a framework for integrated transportation and land-use planning along the corridor between Portland, Tigard, and Sherwood.

From green construction practices to reducing GHG emissions, congestion, and waste, TriMet has embraced a holistic environmental vision. All TriMet buses run on a biodiesel fuel blend, and the newest buses use a NASCAR-inspired engine cooling system and computer monitoring to boost fuel economy. Older buses have been retrofitted with exhaust filters that make their diesel engines burn 90 percent cleaner. Driving policies also help: at transit centers, bus drivers turn off their engines, rather than idling.

Portland maintains a strong commitment to environmental stewardship, and both the City and State have published climate action plans. By 2020, Oregon hopes to achieve GHG levels 10 percent lower than 1990 levels, and by 2050, to achieve GHG levels 75 percent below 1990
levels. Currently, 38 percent of Oregon’s carbon emissions from fossil fuels come from the transportation sector.

**TRENDS IN LOCAL GOVERNMENT SUSTAINABLE TRANSPORTATION PROGRAMS**

When these initiatives are reviewed, a number of trends can be identified:

- **Integration of transportation planning with other services:** City or local government sustainability programs tend to focus on the whole range of city services, rather than just transportation. This is because cities, given the factors identified above (e.g., less diverse economic interests, physical size, and greater integration of authority) must develop more comprehensive plans and approaches. For example, if a local government initiates a Smart Growth program that requires changes in land use and zoning, it will inevitably require coordination from water and waste management authorities, school departments, and other agencies that need to be included in coordinated land use planning.

- **Use of an integrated systems perspective:** Local and city sustainability initiatives are based on an understanding of the interaction between transportation and other social and economic systems. Naturally, this leads to a more sustainable, comprehensive view of the transportation system itself. This can be seen in a number of trends. For example, sustainable transportation initiatives emphasize that individuals plan their daily activities. It seeks to understand and influence the full array of economic and psychological factors shaping mode choice and vehicle ownership decisions in the context of these activity patterns. Similarly, sustainable initiatives try to understand and manage the relationship between infrastructure and the public institutions that operate it. It seeks to reorganize government around managing public infrastructure as an important asset whose value is maximized if it is priced, enforced, and managed effectively. Finally, it aims to better integrate transportation planning with societal needs, including opportunities for recreation and social interaction, and accessibility for children and the poor.

- **New institutional requirement:** As has been noted previously, sustainability poses a significant challenge to the ways that transportation agencies define their missions and organize their work. The transformation of local transportation agencies from “transportation only” to “sustainability managers” requires a shift in organizational culture, structure, and operations. This has required the redesign of some agencies, the development of new integrated planning structures, and the development of comprehensive sustainability culture change programs.

- **Funding remains a challenge:** No matter what size the community, funding sustainable transportation is always an issue. Local and state governments have used a variety of
low-cost options to encourage people to use sustainable services (e.g., use of information technology to alert commuters to train times). Major transit programs require significant new taxes (e.g., Northern Virginia’s business metro tax), bond issues, or coordination with state and federal efforts. In many cases, new user fee programs have been introduced. The overriding message is that no one solution will fit all, but every program seems to need new funding initiatives.

One area that remains a challenge is the development of rural sustainability programs at the local level. Smaller, rural communities often find it cost-prohibitive to implement a full-time transit system and lack the population density to make them successful. In some cases, rideshare or local employer-led bus transit can be an option. For example, the RabbitTransit System in York County, Pennsylvania, works with area employers to offer special all-day routes that serve the community’s largest employer (a regional hospital) and shuttle services at specific times of the day to support smaller employers. Employers pick up the bulk of the costs for these routes, but the routes are also available to the general public. As a result, Rabbit Transit has a more diversified and sustainable revenue base.

Similarly, the public transportation system in Ottawa, Canada, OC Transpo, began offering service to rural communities in 2002, one year after 11 municipalities were amalgamated into the new City of Ottawa. Today, eight routes serve 12 smaller communities that have a total population of about 84,500. The routes operate in peak rush hour times, with some routes averaging only 35 riders per day, while others serve more than 230 riders daily. OC Transpo also partners with several local bus companies and other area municipalities to offer 17 “rural partner routes.” These routes connect passengers to regular OC Transpo routes or transport them to their destinations directly (e.g., the downtown area).

The low population density, along with the lack of a concentrated revenue base and the distances involved make sustainable transportation in rural areas a major challenge.

3.1.3 Federal Sustainability Programs

Federal sustainability programs are developing and expanding rapidly, and derive their authority from a series of executive orders (EOs) (FedCenter.gov, 2012):

- **Executive Order 13423**: “Strengthening Federal Environmental, Energy, and Transportation Management” of 2007 set policy and specific goals for federal agencies to “conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner.” (Executive Office of the President, 2007)
• **Executive Order 13514:** “Federal Leadership in Environmental, Energy, and Economic Performance” of 2009 enhances EO 13423 "to establish an integrated strategy towards sustainability in the Federal Government and to make reduction of greenhouse gas emissions (GHG) a priority for Federal agencies.” (Executive Office of the President, 2009)

In addition, EO 13423 and 13514 established the following processes and management tools to aid in the implementation of the sustainable practices detailed in the EOs:

• Identification of a federal environmental executive;
• Identification of an agency senior sustainability officer;
• Establishment of the interagency steering committee on federal sustainability, which consists of the federal environmental executive and the agency senior sustainability Officers; and
• Every federal agency is required to develop and submit to the Council on Environmental Quality (CEQ) chair and the Office of Management and Budget (OMB) director an agency-specific strategic sustainability performance plan on June 2, 2010. This plan is also required to be updated annually.

EO 13514, Section 19 provides the following definitions applicable to this program area:

• **Agency:** an executive agency as defined in section 105 of title 5, United States Code, excluding the Government Accountability Office (EO 13514, Section 19(b)) (Executive Office of the President, 2009).
• **Sustainability and Sustainable:** to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations of Americans (EO 13423, Section 9 and EO 13514, Section 19(l)) (Executive Office of the President, 2007). In terms of transportation, these EOs addresses vehicle fleet management which includes optimizing vehicle maintenance operations, biofuels, pollution prevention tools and techniques, and used oil. Both EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management, dated 24 January 2007 and EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance, dated October 5, 2009 include goals and objectives applicable to the transportation sector. Note that EO 13514 builds upon and, in some cases, adds or amends EO 13423. The goals, objectives, and sustainable practices outlined in both EOs must be met.

In EO 13423, Section 2(d), if the agency operates a fleet of at least 20 motor vehicles, the agency, relative to agency baselines for fiscal year 2005 is required to:
• Reduce the fleet’s total consumption of petroleum products by 2 percent annually through the end of fiscal year 2015/ (NOTE: EO 13514, Section 2(a)(iii)(C) changed this date to 2020);
• Increase the total fuel consumption that is nonpetroleum-based by 10 percent annually; and
• Use plugin hybrid (PIH) vehicles when PIH vehicles are commercially available at a cost reasonably comparable, on the basis of life-cycle cost, to non-PIH vehicles.

In relationship to Energy, EO 13423 Section 3(a) mandates that the heads of each agency implement within the agency sustainable practices for vehicle fleet management. EO 13514 Section 2(a)(iii) further requires a reduction of GHG emissions from a reduction in the use of fossil fuels by:

• Using low GHG emitting vehicles including alternative fuel vehicles; and
• Optimizing the number of vehicles in the agency fleet.

Section 12 of EO 13514 requires the Department of Energy (DOE), in coordination with General Service Administration (GSA) — to issue comprehensive guidance on federal fleet management. In April 2010, DOE’s Federal Energy Management Program (FEMP) issued the Guidance for Federal Agencies on EO 13514 Section 12 – Federal Fleet Management, which fulfills this section 12 requirement. This guidance, accompanied by the DOE *Comprehensive Federal Fleet Management Handbook*, helps federal fleet managers implement federal fleet requirements.

As can be seen, federal efforts are focused largely at increasing the sustainability of the operations of the Federal Government using a compliance-based approach. This is supported by a wide range of federal programs that attempt to assist communities, states, and the private sector in developing sustainability programs. Table 18 shows major sustainability assistance programs by agency; these programs cover a broad range of services and goals.
<table>
<thead>
<tr>
<th>Agency</th>
<th>Program Description</th>
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</thead>
</table>
| Housing and Urban Development (HUD) | Sustainable Communities Initiative: This program has four components:  
- Sustainable Communities Planning Grants  
- Sustainable Communities Challenge Grants  
- Creation of a Capacity Building Program and Tools Clearinghouse  
- Joint HUD-DOT-EPA Research Effort on Transportation and Housing Linkages  

Catalytic Investment Competition Grants: This program is a part of the Community Development Block Grant, but like the Sustainable Communities Initiatives, the funding is competitive and not formula-based. The funding is specifically designed to leverage other funds, including Choice Neighborhoods and Sustainable Communities grants. Four programmatic eligibilities were outlined: (1) reclaim vacant property and create green infrastructure; (2) remove property-related obstacles to recovery; (3) facilitate economic development and neighborhood vitality in targeted neighborhoods; and (4) support TOD.  

Choice Neighborhoods: The intention of the program is to create a grant program focused broadly on distressed neighborhoods with a “strong emphasis” on community planning for school and educational improvements as part of neighborhood revitalization.  

DOT | Livable Communities Program. This funding supports three separate initiatives that are each part of DOT’s role in the interagency Partnership for Sustainable Communities. Projects include: (1) $307 million in transit funding to increase the planning and project development capabilities of local communities. The program assists transit agencies in using the Job Access and Reverse Commute formula grants; Alternatives Analysis grants; and formula grants for state and metropolitan planning to support planning for and implementation of livable and place-based investments in transportation. (2) $200 million in highway funding for a competitive livability grant program to assist states and local governments in integrating planning processes within transportation, land use, and natural resource conservation. Grants could also be used to enhance the capacity to plan, implement, and assess transportation projects according to livability goals and investment performance objectives. The funds could be used to improve modeling and data collection. (3) Establishment of an Office of Livable Communities in the Office of the Secretary to coordinate multimodal and interagency livability efforts and lead DOT’s investment decisions that focus on livable communities.  

National Infrastructure Innovation and Finance Fund. This new program is a replacement for the multimodal Transportation Investment Generating Economic Recovery (TIGER) grants funded in American Recovery and Investment Act (ARRA). The new fund would be a new structure within DOT providing loans and grants (as well as supporting public-private partnerships) for “projects of regional or national significance.” Funding will also be available to support the planning and feasibility studies necessary to identify potential projects.  

EPA | Healthy Communities Initiative. EPA consolidated several new and existing programs into the Healthy Communities Initiative. All program areas are grant programs and managed by EPA’s Smart Growth office. |
Additional sustainability initiatives, programs and tools that have a more limited focus include (but are not limited to) (FedCenter.gov, 2012):

- **Building for Environmental and Economic Sustainability (BEES):** BEES 4.0 software is now available for downloading at no charge. BEES is a powerful technique for selecting cost-effective, environmentally preferable building products. BEES reduces complex, science-based technical content (e.g., more than 400 environmental flows from raw material acquisition through product disposal) to decision-enabling results and delivers them in a visually intuitive graphical format.

- **Chartered Institution of Building Service Engineers (CIBSE) Sustainability Tool:** This tool is a searchable, online database of best practice sustainability measures for building services engineers. The measures are a distillation of well-established sustainability guidance. The tool provides a shortlist of measures for specific sustainability topics and references to further guidance, including the section of the relevant document. The issues addressed include: water use, adapting buildings for climate change, sustainable drainage systems, site ecology and habitats, and energy recovery. This is not a comprehensive list of all issues addressed.

- **Earth 911 Reuse and Recycling Services:** This program helps users identify available recycling services in their state and city for items such as plastics (e.g., packaging peanuts, bags, containers); paper (e.g., books, newspaper, drink boxes, chipboard, cartons); paint products; organic material (e.g., brush, grass clippings, tree trimmings, weeds, soil); metal (e.g., aerosol cans, vehicles, appliances, cans, foil, hangers, propane tanks); glass; batteries (e.g., vehicle, NiCad, rechargeable); construction and demolition materials (e.g., asphalt, flooring, ceiling tiles, carpet padding, concrete, windows, stone, linoleum, porcelain products, brick); and miscellaneous items, such as mattresses, furniture, cooking oils/grease, fluorescent bulbs, and medical equipment.

- **EPA's Regional Vulnerability Assessment (ReVA) program:** The ReVA program focuses on regional scale integrated assessment with the aim of assisting decisionmakers in identifying and locating both environmental resources and the conditions that are stressing those resources.

- **GHG Impact Tools:** EPA and its partners have developed several tools to help individuals and organizations determine the GHG impact of their purchasing, manufacturing, and waste management actions. These tools include: Recycled Content (ReCon) Tool for estimating the life-cycle GHG and energy impacts of purchasing or manufacturing certain materials; Waste Reduction Model (WARM) assists solid waste managers in determining the GHG impacts of their waste management practices; Durable Goods Calculator (DGC) aids in making informed decisions regarding the GHG and energy impact caused by the disposal of durable household goods; and the GHG
Equivalencies Calculator, which expresses quantities of GHG emissions in terms of metrics, such as number of cars, gallons of gasoline, acres of forest, etc.

- **GSA Sustainable Facilities Tool:** The Sustainable Facilities Tool is a one-stop online resource to support decisionmaking regarding sustainable building principles, materials, and systems. Targeted to help project personnel identify and prioritize cost-effective, sustainable strategies for small projects that do not normally engage workplace consultants or designers, this tool helps users understand and select environmentally preferable solutions for renovations, alterations, and leases.

- **Improving Air Quality in Your Community:** This website features activities for reducing both indoor and outdoor pollution, including diesel engine retrofit programs, improving air quality in local schools, and pollution prevention options for small businesses. These projects have a successful track record: they were put into action previously by state and local governments across the country. This site includes information about the costs to establish and maintain each project, and how local communities can apply for EPA grants to kick-start their activities.

- **Pharos Initiative:** Sponsored by the Healthy Building Network (HBN) and its partners, this tool seeks to define a consumer-driven vision of truly green building materials and how they should be evaluated in harmony with principles of environmental health and justice. Pharos evaluates materials across several impact categories, such as energy/water usage, air quality impact, and toxicity, but also introduces new categories, such as occupational safety, social justice, and habitat impact that to date, have not been included in any material rating system. Another of their tools is PharosWiki, which provides users a place to research materials, chemicals, and building products, as well as share their experience and knowledge.

- **READ-Database:** This tool provides GIS data and is available online to help renewable energy developers identify appropriate sites for renewable projects, such as utility-scale wind, solar, and geothermal energy facilities that are unlikely to interfere with military activities and training, and have the fewest environmental conflicts. This database was developed by the Natural Resources Defense Council (NRDC) in coordination with the U.S. Department of Defense (DoD) to help eliminate conflicts between renewable energy developments and DoD operations.

- **Smart Growth Policies Database:** The policies in this database represent a variety of approaches ranging from formal legislative or regulatory efforts to informal approaches, plans, and programs. These actions represent real and innovative ways for communities to realize Smart Growth.

- **Sustainable Management Approaches and Revitalization Tools - electronic (SMARTe):** SMARTe 2007 is a web-based, menu-driven decision analysis support system for developing and evaluating future reuse scenarios for potentially contaminated land. SMARTe contains guidance and analysis tools for addressing all
aspects of the revitalization process, including planning, environmental, economic, and social concerns. SMARTe is intended for all revitalization stakeholders. SMARTe is being developed by EPA’s Office of Brownfields Cleanup and Redevelopment and Office of Research and Development, with support from the Interstate Technology and Regulatory Council (ITRC).

- **Sustainable Water Infrastructure**: This website provides information about various initiatives to promote sustainable infrastructure. Specifically, it addresses the four pillars of sustainable infrastructure: better management, full-cost pricing, efficient water use, and watershed approaches to protection.

### 3.1.4 Sustainability and Sustainable Transportation Programs and Policies in Other Countries

A number of other countries have developed advanced sustainability, and sustainable transportation programs and policies. For example, New Zealand is widely thought to be a sustainable transportation leader, and is at the forefront in developing a coordinated national policy for sustainability. The 2008 New Zealand Transport Strategy (NZTS) integrated transportation and climate change into a single sustainability program. Sustainability is explicitly part of its future vision: “people and freight in New Zealand will have access to an affordable, integrated, safe, responsive and sustainable transport system.” The plan’s targets reflect the stated vision and include halving per capita GHG emissions from domestic transport by 2040, increasing rail’s share of freight to 25 percent of ton-kilometers by 2040, and using electric vehicles widely. While setting targets is not necessarily unique for transportation plans, NZTS 2008 is set apart because the targets are statutorily enforced through the Government Policy Statement on Land Transport Funding, which establishes short-term system goals that will be achieved by prioritizing funding over the next 6 to 10 years. In addition to the statutory funding statement, NZTS will also be evaluated through a Transport Monitoring Indicator Framework, which is being made available to the public via an online interactive version. The framework provides a procedure to monitor progress toward the objectives, sector outcomes, and targets in the Transport Strategy and Government Policy Statement. It provides a tool for evaluating the effectiveness of the current policy and for guiding future decisions. Last but not least, it also provides accountability (Georgia Tech Research Corporation, 2011).

New Zealand’s sustainable transportation program builds on a long history of increasing sustainability initiatives in government (Figure 6). In New Zealand, as it is with many state governments in the United States, successful sustainability programs take one to two decades to achieve and require substantial consensus building and careful development.

One of the striking elements of New Zealand’s sustainability efforts has been the emphasis on developing a business case for sustainability. This business case has focused on both formal ROI estimates and qualitative stories that convey clearly the benefits of sustainability. For example, the Auckland Regional Land Transport Strategy sets out seven objectives for transport in
Auckland for the period 2006-16. The first five objectives incorporate the national transport objectives, the remainder focuses on Auckland and include an economic efficiency dimension.

These are the seven objectives:

1. “Assisting economic development
2. Assisting safety and personal security
3. Improving access and mobility
4. Protecting and promoting public health
5. Ensuring environmental sustainability
6. Supporting the Auckland Regional Growth Strategy
7. Achieving economic efficiency “

From: (Auckland Regional Transport Authority, 2006)

The program established monetized targets for each goal, a methodology to estimate the benefits, and a series of indicators that could be used to track achievement of goals (and convert performance into monetized benefits). Collectively, this program creates a compelling business case for sustainability. Table 19 shows these targets.
Figure 8: Overview of New Zealand’s Sustainability Legislation and Programs

From: (Auckland Regional Transport Authority, 2006)
Table 19: Auckland Regional Land Transportation Monetized Benefit Targets

<table>
<thead>
<tr>
<th>Objective</th>
<th>Monetized Benefit</th>
<th>Relevance to TBL Element</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Environment</td>
</tr>
<tr>
<td>Assisting economic development</td>
<td>NZ$250M</td>
<td>X</td>
</tr>
<tr>
<td>Assisting safety and personal security</td>
<td>NZ$31M</td>
<td>X</td>
</tr>
<tr>
<td>Improving access and mobility *</td>
<td>NA</td>
<td>X</td>
</tr>
<tr>
<td>Protecting and promoting public health</td>
<td>NZ$5M</td>
<td>X</td>
</tr>
<tr>
<td>Ensuring environmental sustainability</td>
<td>NZ$4.4M</td>
<td>X</td>
</tr>
<tr>
<td>Supporting the Auckland Regional Growth Strategy*</td>
<td>NA</td>
<td>X</td>
</tr>
</tbody>
</table>

* Cannot be quantified

From: (Auckland Regional Transport Authority, 2006)

Using this approach, Auckland was able to develop a compelling business case for its sustainability plan. Specifically, Auckland was able to show that for an annual allocation of 4 percent of total transportation spending (around NZ$42 million), the sustainability plan was anticipated to yield an annual benefit of NZ$90 million.

The UK is another leader in sustainability planning and sustainable transportation. The most compelling points of its initiatives are the emphasis on prioritization in transportation and the integration of planning and implementation at all levels of government.

The prioritization emphasis resulted from the 2008 economic crash, which forced severe budget cuts and restrained spending. Critical to the development of this policy was the Eddington Transport Study. Led by Sir Rod Eddington, it was commissioned by the British government to document the impact of transport decisions on the economy and the environment. The Eddington study confirmed the link between transport and the economy, but focused on congested and growing cities, and inter-urban links and international gateways where congestion is a major threat to economic growth. Critically, Eddington emphasized the need to make choices and balance sustainability with economic growth. The basis of this approach was to state clearly the goal or purpose of a specific transportation policy and relate it to larger social goals. Building a road became not simply a way of transporting goods and people from point A to B, but part of a larger social, government mission coordinated with other missions. Figure 9 shows this logic.

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12 NZ$ = New Zealand Dollar
Figure 9: Integration of UK Government Transportation Goals Across Different Modes, Levels of Government and Goals

From: (Department for Transport (U.K.), 2007)
The Eddington study also concluded that transportation planning focused prematurely on developing and delivering a specific scheme or solution, when it should look at a wide range of possible actions, not just at investment in infrastructure. Critically, both the study and government policy require that national, regional, and local programs be aligned within a broader policy context to understand the goal and purpose of transportation investments. When these decisionmaking processes are aligned, it is possible to compare the merits of different road- and rail-based solutions to inter-urban congestion problems, and prioritize funding among the programs. This changes the way government engages with stakeholders and emphasizes the need to build consensus on future transportation needs. Putting proposals through this rigorous process enables more secure government funding for the projects. It contrasts with current programs, where individual projects are considered individually and subject to late adjustments in timing (or even cancellation) as better propositions emerge. This leads to inefficiency and disappointed expectations, which might have been avoided by a more coordinated approach (Department for Transport (U.K.), 2007).

From a state or regional point of view, the British approach shows how multiple transportation modes, agencies, and goals can be combined to create a plan that provides government leaders with a common tool to analyze project costs and benefits. Individual interests and stakeholder pressures still affect outcomes, but now decisionmakers can identify projects that meet major policy goals, understand their impact on policy areas, and identify tradeoffs.

3.1.5 Other Miscellaneous Tool-Related Findings From the Research

A few other tools and trends were identified in the course of the research that included the following:

**Citizen Engagement Tools**

Specific tools that have been used to involve citizens in decisionmaking include the following:

- The Service First Unit of the United Kingdom’s Cabinet Office commissioned the creation of a People’s Panel. The panel consists of 5,000 members of the public randomly selected from across the United Kingdom. It was designed to represent a cross-section of the population (age, background, region, etc.). Panel members are consulted on how public services are delivered and how that delivery can be improved from the user’s point of view. The panel provides a bank of individuals who can be used for a wide range of research and consultation. In addition, data is kept on past interactions so the Service First Unit can track change over time.

- The Netherlands has been experimenting with a number of participatory democracy innovations with the direct goal of reducing legal objections to development projects. For example, the municipality of Hoogeveen has implemented the “Forges” approach to
city planning (the metaphor being a forge is a workshop where new tools are made). This approach is a dramatic attempt to push control of planning and needs assessments to citizens. All citizens can participate in a Forge, where they come forward with direct ideas and recommendations for projects. Interactive citizen groups then debate and discuss priorities on various “Forge nights,” gradually developing budget priorities before voting on budgets on “budget nights.” So far, more than 18 Forges are operational, and they are generally seen as successful (van Hamersveld & Bina, 2008).

- The United Kingdom’s e-petition program allows citizens to create their own petition or join petition efforts online. Once a petition has reached 100,000 signatures, the issue is automatically debated in the national Parliament.

- The Brazilian city of Porto Alegre (a city of 1.5 million with an economic sphere of more than 4 million people) has been using a system of participatory budgeting since 1989. Under this system, every January a series of assemblies convene across the city and receive instruction from city specialists in technical and system aspects of city budgeting. Each assembly then discusses its goals and needs. When consensus is reached, neighborhood assemblies are rolled up into larger plenary assemblies in each of the city’s 16 districts. In addition, special assemblies deal with such areas as transportation, health, education, sports, and economic development. These large meetings—participation can reach more than 1,000—elect delegates to represent specific neighborhoods. The mayor and staff attend to respond to citizen concerns. In the following months, delegates meet weekly or biweekly in each district to review technical project criteria and district needs. City department staff may participate according to their area of expertise. At a second regional plenary, regional delegates prioritize the district’s demands and elect 42 councilors representing all districts and thematic areas to serve on the Municipal Council of the Budget. The main function of the Municipal Council of the Budget is to reconcile the demands of each district with available resources and propose and approve an overall municipal budget. The resulting budget is binding; the city council can suggest but not require changes. Only the mayor may veto the budget or remand it back to the Municipal Council of the Budget (a veto or remand scenario has never occurred). A 2003 World Bank paper suggested that participatory budgeting has led to direct improvements in facilities in Porto Alegre (Wagle & Shah, 2003). As a result of Porto Alegre’s experience, about 140 of Brazil’s cities (about 2.5 percent) have adopted participatory budgeting.

These and other examples cited throughout this report suggest that there are numerous ways to integrate greater public participation into decisionmaking without losing technical excellence or imposing excessive delay.
Another critical principle in preparing organizations for sustainability changes is the need to design all policy instruments with explicit feedback and communication mechanisms. A European-wide review of transportation policy identified eight different types of outputs and feedback from different countries’ transportation agencies at national, state/regional, and local levels. Table 20 shows the results of this analysis.

**Table 20: Anticipated and Unanticipated Transportation Policy Effects**

<table>
<thead>
<tr>
<th>Policy Effects</th>
<th>Case Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANTICIPATED INTENTIONAL EFFECTS</strong></td>
<td></td>
</tr>
<tr>
<td>“Bulls Eye”</td>
<td>The anticipated effect occurred and the magnitude and scope of the policy were correctly anticipated.</td>
</tr>
<tr>
<td>“Timely Warning”</td>
<td>Negative anticipated impacts were observed and mitigated as intended to prevent negative effects from overwhelming positive benefits.</td>
</tr>
<tr>
<td><strong>UNDERESTIMATED INTENTIONAL EFFECTS</strong></td>
<td></td>
</tr>
<tr>
<td>“Overdone”</td>
<td>Policy correctly anticipates changes but underestimates the influence of the policy on market or system behavior.</td>
</tr>
<tr>
<td>“Spill-Over”</td>
<td>Policy is intended to focus on a specific issue but “spills over” into another system or area with positive effects.</td>
</tr>
<tr>
<td><strong>UNANTICIPATED EFFECTS</strong></td>
<td></td>
</tr>
<tr>
<td>“Off-the-Mark”</td>
<td>Policy challenges and policy levers are generally understood, but assumed cause-effect models and estimates are flawed, worsening or reversing expected benefits.</td>
</tr>
<tr>
<td>“Not-in-My-System (NIMS)”</td>
<td>Policy applies valid cause-effect assumptions but omits a key part of the affected system or issue not within the policy jurisdiction.</td>
</tr>
<tr>
<td>“Blind Spot”</td>
<td>Policy ignores major variables and risks, leading to significantly reduced or moot benefits.</td>
</tr>
<tr>
<td>“Bulls Eye”</td>
<td>The anticipated effect occurred and the magnitude and scope of the policy were correctly anticipated.</td>
</tr>
</tbody>
</table>

Table 20 is based on European transportation policy research, but the examples may be applicable generally. This study also identified key factors that can enable transportation agencies to correctly identify cause-effect factors and probable policymaking effects. The factors include:

- Broad-based stakeholder participation throughout the policy development and implementation process but especially in the initial scoping and design of the policy intervention;
- Established mechanisms for interagency and intergovernmental (i.e., national-local, national-state/regional, state/regional-local, local-local, state/regional-state/regional) communication and coordination;
- A deep body of technical experts on all dimensions of the proposed policy and the involvement of these experts at all stages of the policy process;
- Experienced administrations that understood how the policy would be implemented present all stages of the policymaking and implementation process;
- Multiple feedback loops combined with an active performance/implementation metrics measurement program;
- Transparent processes and honest recognition of challenges and opportunities;
- Flexible implementation and management strategies; and
- Feedback and the reinforcing elements of measurement and communications.

These factors are the general principles that transportation agencies need to adopt to face an uncertain, rapidly changing future. Section 8.2 discusses specific actions and policies that agencies could undertake in detail under different scenarios. In analyzing these policies, the research team noted a general phenomenon: no matter what the scenario, certain policies, actions, programs, and concepts made sense. As a result, these generalizable optimal actions are preferable over actions of limited value.
3.2 **Key Insights**

The interviews conducted and the literature review revealed a number of key insights:

- **Sustainability is a complex, challenging idea:** There is growing understanding of the meaning of sustainability, but generally, the term is not well understood. Its inherent complexity and ambiguity deters decisionmakers, and key stakeholders and interest groups are often hostile to the concept and uncomfortable with its connotations.

- **Understanding of and support for sustainability is increasing:** Despite certain hostility toward sustainability, its acceptance is growing, as evidenced by more sustainability programs and greater integration of sustainability into transportation policy and all levels of government.

- **TBL is fine, but needs a fiscal element:** TBL is gaining acceptance, too, but many believe it requires a fourth element—fiscal sustainability. Economically struggling states are more focused on system preservation, rather than new capital programs. Now, programs must consider long-term funding and support. Innovations, such as FCA or LCC, should capture the full cost of transportation investments and demonstrate how they will be funded in the future.

- **Social indicators are difficult to develop:** Many states and localities are developing sustainability indicator programs. These programs tend to have relatively robust indicators of economic and environmental progress; however, it is difficult to develop social indicators. Most programs tend to use census data to develop environmental equity programs, but there is a need to develop more comprehensive social indicators. States that have attempted to do this have found costs prohibitive, measures difficult to develop, and data hard to obtain.

- **Waiting for demand versus developing demand:** A number of stakeholders stated that sustainability had to wait for strong leadership from the state or local leaders, or the public as a whole. Others said that support for sustainability could be generated slowly by small modifications to the planning process and indicator system, and by transportation agencies developing a constituency for sustainability. Both positions have their merits; however, cities like Portland, Oregon, show that small-scale efforts can generate public demand for sustainability, but waiting for public policy and state leaders to change could be futile.

- **Sustainability can’t be an add-on, it must inform organizational culture and internal process:** The literature and stakeholder interviews suggest that sustainability must be a complete process. Transportation agencies need to change their processes, culture, and operations to best support sustainability. This requires developing a new vocabulary and set of processes to understand sustainability and place it in the context of traditional transportation engineering. In addition, it requires recruiting new specialists with different expertise, changing individual performance standards to influence behavior,
encouraging culture change, and developing new internal processes (e.g., transportation modeling) and organizations.

- **Once size will not fit all**: The literature and stakeholder interviews both emphasize that “one-size-will-not-fit-all” when it comes to sustainability programs. The unique conditions of each state require unique solutions, and there are a range of tools and innovations to meet these needs. For example, most states have adopted similar performance standards and methods, so combining different indicators could prove useful, as would scenario planning.

- **Need to build the business case for sustainability and show ROI**: Stakeholders and the literature both conveyed the need for a comprehensive business case for sustainability that shows clearly the ROI for sustainability expressed in monetary terms. The ROI should include the full range of societal, economic, and environmental elements of sustainability. Currently, no such tool exists in the United States.

- **Localities are the leaders in sustainability**: Localities have the authority (e.g., control over land use), underlying resources (e.g., transit systems, concentrated populations), and financial resources (e.g., user fees) to develop sustainability programs. Frequently, states are limited to management of state highway systems and need to coordinate better with the local levels of government.

- **Sustainability requires public and stakeholder engagement**: The literature emphasizes that successful sustainability programs need to be based on substantial stakeholder buy-in and constant public involvement. The vast changes required by sustainability require planning and implementation to go beyond the old technocratic, limited public involvement process.

Instead of relying on traditional approaches, several sustainability initiatives have adopted a more direct and participatory form of public engagement to achieve a workable consensus on needs and goals. Several transportation agencies have successfully engaged the public and organized interests in forums where decisions on needs and goals are genuinely up for discussion rather than being pushed through with Q&A and minimal debate. Some transportation policy analysts have suggested that transportation planners should be better trained and effective as facilitators of stakeholder debates and discussions rather than simply as managers and collectors of citizen input (Forester, 1989), (Innes, 1995).

In this regard, Arnstien’s “ladder of citizen participation” is useful (Arnstein, 1969)). As Figure 10 shows, Arnstien visualized eight levels of citizen participation. The top three rungs represent real citizen participation and control, and the bottom five represent increasing control and management of citizens’ needs and goals. Planners have traditionally resisted citizen involvement on the grounds that citizens lack the expertise to participate in technical discussion. However, the perceived failure of central planning; the technocratic, growing expertise among citizen groups and organized interests; and the need to involve
the public in decisionmaking to attain support for future initiatives suggest transportation agencies must develop new mechanisms to bring the public into the process.

Figure 10: Levels of Public Participation

![Diagram showing levels of public participation ranging from manipulation at the bottom to public control at the top.]

Increasing public control of policymaking

- Public control
- Delegated power
- Partnership
- Placation
- Consultation
- Informing
- “Therapy”
- Manipulation
4. GAP ANALYSIS

4.1 THE SYSTEMS ANALYSIS MODEL

This chapter includes a gap analysis and identifies the challenges and opportunities that transportation agencies might face under different scenarios. A basic systems analysis model organizes and shapes this analysis. This model assumes that all public policy is made in discrete, semi-autonomous systems. These systems are connected to the wider political system, but largely autonomous and dominated by a set of interests, political and institutional actors and policy outputs unique to that system. Thus, while transportation agencies are part of the larger governmental system, they interact with a particular set of political and institutional actors (e.g., legislative transportation committees, transportation interest groups, state transportation commissions, federal DOT), have a particular set of institutional and organization relationships (e.g., DOTs, MPOs, local highway departments), and have distinct responsibilities and operating requirements (e.g., build operate and maintain state highway systems, and regional transportation planning). Furthermore, the political and institutional system in which transportation agencies operate is autonomous in the sense that the work of transportation service provision and regulation is left to them. Other agencies and actors may become involved in transportation, but the day-to-day business of transportation service provision is left to the transportation policy system. The making and implementation of transportation policy can be analyzed separately from the overall policymaking system.

Figure 11 shows the basic systems model (Easton, 1965). This model was first described by David Easton in the mid-1960s. Since that time, it has formed the basis for comparative public policy and public administration analysis (Rissmiller, 2010).

The basic systems model assumes that a policy system can be identified as a series of relationships, organizations, institutions, activities, or interactions between actors that relate more or less directly to a particular policy domain (e.g., transportation, environment, health). A policy system is a conceptual entity that is generally accepted by most individuals within a society as having the authority to measure demand and allocate public goods for a specific geographically defined community (e.g., city, county, state, region or nation). Thus, a state transportation policy system is the set of organizations, people, processes, and institutions that have the legitimate authority to take demands for transportation goods (e.g., roads, railways, regulations, safety programs) and translate them into specific public goods and services.

13 “Public goods and services” means the goods and services a government provides its citizens through the public sector, through financing private provision of services, or through policies that encourage individuals, the private sector, and other groups to provide those goods and services. Even when these things are not provided or financed publicly, they may be subject to regulation.
Figure 11: The Basic Systems Model

The policy system is separate from its external environment, which includes all elements that make up the physical, social, economic, legal/regulatory, and institutional world in which the policy system operates. The policy system is affected by its environment (via an input-output exchange), and the environment is affected by the actions of a policy system.

The policy system processes three main elements:

- **Inputs**: Changes in the social or physical environment surrounding a policy system produce “demands” and “supports” for action or the status quo directed as “inputs” towards the political system, through political behavior.

- **Outputs**: Demands and their supporting groups stimulate competition within a policy system, which result in decisions or “outputs” directed to changing or maintaining some aspect of the surrounding social or physical environment. After a decision or output is made (e.g., a specific policy), it interacts with its environment. If it produces change in the environment, there are “outcomes.”

- **Feedback**: When a new policy interacts with its environment, outcomes may generate new demands or supports and groups in support of or against the policy (“feedback”) or a new policy on some related matter. Feedback in turn creates new inputs, which create a new cycle of action.
4.1.1 Inputs

Inputs to a policy system should be understood broadly. Inputs may include but are not limited to the following:

- **Resources**: For example, money, time, available raw materials, energy, labor, grants of authority (i.e., recognition by another entity within the political system that a particular policy system has the right to influence the distribution of public goods within a particular domain).

- **Demands**: This involves legislative actions (e.g., laws, budget allocation); executive decisions (e.g., executive orders or direction from top elected officials, such as governors, mayors, or transportation commissioners); interest group lobbying; lawsuits and court orders; information collected from citizen outreach; business or citizen requests; or any other method by which demand, requests, or other claims on the direction of public goods can be made. Note: Demand may be positive (i.e., “do something”), negative (i.e., “don’t do something”), or sustaining (“continue to do something/don’t change”).

Typically, demands emerge through a three-stage process:

- **Awareness**: All individuals, groups, communities, businesses, and social groups experience a degree of stress between their preferred state and the current state of the environment in which they live. When this stress grows to a certain point, they may attempt to influence government to reduce this stress. Initially, these demands are rudimentary, but through collaboration and exchanging ideas, they gradually form into coherent demand.

- **Articulation**: This second stage of the process is known as “issue articulation,” in which various social groups and interested parties express their needs for policy outputs. Issue articulation may range from personal contact with government officials (e.g., lobbying, participation in public planning forums, peaceful protest, phone calls and letters to policymakers) to the development of interest groups (e.g., trade unions, professional associations, single issue campaign groups).

- **Aggregation**: Interest articulation leads to interest aggregation, where groups and individuals team up to make specific policy demands. For example, a number of local community interest groups, businesses, and environmental groups join together to form a program that demands that a city transportation agency reduce congestion by developing a public transit system. In this example, the presence of congestion would initially give rise to a degree of stress between many groups’ and individuals’ perceived ideal and the actual state of the local environment (e.g., perceived reduced business opportunities, long commutes, increased environmental contamination, etc.). Gradually, these groups and individuals would articulate their issues and then aggregate them to develop a coherent set of demands on the government.
Clearly, demand articulation is not a unitary process. Outside government, a variety of formal and informal mechanisms exist to formulate demands. Public sector agencies can play a positive role in this process to help various groups and individuals. For example, the development of MPOs and public participation mechanisms in the “3c” process instituted by the National Environmental Policy Act (NEPA) provide government with a positive outreach tool that brings stakeholders and interest groups into a planning process. As transportation agencies improve their support the articulation and aggregation of public demands, they become better able to support a sustainable society.

Another issue to consider is that “old” demands are replaced by “new” demands rarely. New demands are added to old demands and the burden on public policy systems increases. For example, the 20th century saw a constant expansion of the demands placed on transportation systems. From the “Good Roads Movement” movement of the late 19th, early 20th centuries to the current transportation system—mobility, economic competitiveness, equity, environmental protection, public participation, and safety remain paramount, but new demands are added constantly. Sustainability will be added to the existing set of demands and will have to manage tradeoffs between the old and the new.

The key function of the overall policy system is to transforms inputs into outputs. That is, resources and demands allocated to the policy system are translated into outputs that change the transportation environment. In recent years, the concept of the policy system has moved from the more mechanist vision of early public policy theorists toward the idea of “policy communities” or “policy networks” (Skogstad, 2005). Policy communities are networks with relatively few actors or participants collaborating continuously on a set of policy issues. They share a general agreement over the scope, goals, and general institutional processes leading to policy output. In addition, they share a belief system, accept formal and informal codes of conduct, and follow established patterns of behavior. Policy communities are also involved in the delivery and development of policy.

4.1.2 Policy Community

The concept of policy communities is well accepted in public policy literature (Skogstad, 2005). It grew out of the recognition that as policymaking had become more complex, specialized, and fragmented, the government realized it needed the resources and cooperation of non-state actors. Simply put, democratic, representative governments cannot function without the consent and involvement of its citizens. Their input into policy formation, and hopefully resulting support, were crucial. Focusing on formal and macro-level decisionmaking bodies like state legislatures, governors, or mayors ignores the realities of the policy process.
Transportation policy issues usually involve a relatively small number of actors or participants who are drawn together because they have a legal requirement or authority to participate (e.g., State DOT staff, MPOs), an interest in the policy outcome (e.g., business interests, environmental groups), or a technical interest in the issue (e.g., professional societies, academics). Only rarely do transportation issues reach the point where a large number of people and interests become involved (e.g., the development of a major new highway interchange or bridge, the addition of capacity on existing highways, the building of a new transit system, the expansion of a metro system, the adoption of congestion pricing strategies, proposing new revenue sources to fund transportation projects or programs).

In this approach, there are a number of critical characteristics of any policy community:

- **Policy paradigms**: These are a set of beliefs or basic principles that are used to organize any system and a series of preferences that suggest how policy should be delivered;
- **Actors**: They are specific individual, organizations, groups, interests or other entities that interact with each other to develop and implement different policy; and
- **Functions**: Every policy community has a set of functions (e.g., develop and deliver transportation services) and an internal subset of functions that each actor carries out to achieve the overall community’s assigned function. These functions may include needs assessment, budgeting, planning and programming, service delivery, and education and outreach.

Policy paradigms are deep-seated psychological and cultural structures that define the scope and extent of a policy community. They define what should be the scope and overall goal of the community (i.e., organizing principles, the actors that can or should be involved, and the relationship between those actors) (Wilson C., 2000).

The paradigm consists of three levels: (1) a deep core set of beliefs or organizing principles; (2) a set of policy preferences; and (3) a set of instrumental preferences.
“Deep core” beliefs or organizing principles express our foundational beliefs about society, human values, and the other related issues. These beliefs color all understandings and are unlikely to change. For example, the transportation policy goal of mobility emerges from a range of core beliefs associated with individual freedom, including free movement.

A second set of beliefs is constructed on top of the core beliefs. These “policy preferences” address fundamental positions on how best to achieve deep core beliefs. For example, an individual may believe that the free market is more effective in achieving social goals than the government. These beliefs tend to apply to specific policy areas, but are not held across all policy areas consistently.

Finally, “instrumental preferences” concern instrumental decisions and methods to achieve goals. For example, two individuals may differ substantially on the role of the Federal Government in environmental policy, but agree that the Federal Register should contain the information about decisions made on environmental policy.

Sample Policy Paradigm:

Transportation Policy Paradigm 1950-1970
- Financed through a combination of state and local taxes and fees, and federal grants funded by national motor fuel taxes
- Largely ignored environmental and social equity impacts that were associated with transportation capacity building
- Did not consider how decisions promoted long-distance urban-suburban travel and facilitated low-density sprawl developments
- Allowed pricing distortions that promoted motoring at the expense of walking, biking, and public transportation
- Took a “build-our-way-out-of-congestion” approach, rather than attempting to manage demand
- Favored one mode (roads and motor vehicles) and one technology (private automobiles), rather than a balanced multimodal view
- Adhered to technocratic decisionmaking and attempts to minimize public participation
- Defined safety narrowly, often as motorist safety only
  (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010)
Table 21: Structure of Belief Systems and Policy Acceptance

<table>
<thead>
<tr>
<th>Defining Characteristics</th>
<th>Organizing Principles or “Deep Core”</th>
<th>Policy Preferences or “Near Core”</th>
<th>Instrumental Preferences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fundamental normative and ontological axioms (e.g., “the earth is here for humans to use,” “we are all part of nature and must live in balance”)</td>
<td>Fundamental policy positions concerning the basic strategies to achieve normative and ontological axioms (e.g., “the market is always best,” “planning and management are the best way to achieve social goals”)</td>
<td>Instrumental decisions needed to implement a core belief</td>
</tr>
<tr>
<td>Scope</td>
<td>Basic personnel philosophy— influences everything</td>
<td>Applies to all policy areas</td>
<td>Specific to particular issues— especially technical issues</td>
</tr>
<tr>
<td>Susceptibility to Change</td>
<td>Very difficult to change— requires a “conversion experience”</td>
<td>Difficult to change, but can change if experience reveals fundamental anomalies and/or repeated “difficult-to-explain” phenomena</td>
<td>Moderately easy— this is the area where most policy discussions and debates occur</td>
</tr>
</tbody>
</table>

The policy paradigm determines who should be involved in policymaking and implementation. For our purposes, actors are divided into three major groups:

- **Group 1**: Government sector actors (e.g., governors, state legislators, state transportation officials, mayors, members of MPOs);
- **Group 2**: Private-sector economic actors (e.g., businesses, banks, farms, small business, major local economic interests, system operators (freight railroads, shippers, receivers))
- **Group 3**: Civic-sector actors (e.g., environmental interest groups, transportation use associations, community groups, unions, academics, professional bodies).

From: (Kraft & Furlong, 2012)

The distinction between groups 2 and 3 is somewhat arbitrary. Some firms and businesses can be organized into civic sector groups to attempt to lobby government (e.g., business involved in chambers of commerce). Some actors are “sovereigns” (Sabatier & Jenkins-Smith, 1993). Sovereigns are actors that have the final authority to make a policy decision for different levels. These individuals might be governors, heads of DOTs, mayors, etc. Actors may be described in terms of their role and responsibility in the policy system, their function or purpose, their power and authority (e.g., ability to allocate resources, ability to direct other actors or participate in
decisionmaking), the rules that apply to them, and the process they are required to follow to perform certain functions.

Considering all these factors, we can identify a number of different types of actors that are present in state transportation policy communities. Table 22 shows a generic overview of these actors.

**Table 22: Sample Generic Actors in State Transportation Policy Communities**

<table>
<thead>
<tr>
<th>Actors</th>
<th>Govt. Sector</th>
<th>Private Sector</th>
<th>Civic Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>State legislature (individual legislators, legislative committees)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Governors</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heads of DOTs</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation commissions</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federal government departments (DOT, EPA etc.)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>State DOTs</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPOs</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local governments</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other state government agencies (e.g., state environmental protection agencies)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other modal authorities (e.g., airports, ports, passenger rail)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>System operators (e.g., freight railroads, toll operators, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State and local economic interests (e.g., large business, small businesses)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developers (i.e., business and firms involved in developing property for high-value use)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation providers (i.e., business and firms involved in the provision of transportation services for both people and goods)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community and civic groups (e.g., community booster groups, chambers of commerce)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Environmental nonprofit groups</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional organizations and research organizations (e.g., National Association of Fleet Operators)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Single-issue transportation groups (e.g., CorridorWatch.org - concerned Texans and public officials opposed to the Trans-Texas Corridor)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Transportation user and advocacy groups (e.g., National Alliance of Public Transportation Advocates, American Public Transportation Association, Bay Area Bicycle Coalition, Tri-State Transportation Campaign)</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Based on this analysis, a number of key functions that policy community actors perform in the transportation arena are shown in Table 23.

<table>
<thead>
<tr>
<th>Functions</th>
<th>Functional Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consensus on Needs and Goals</td>
<td>Processes by which transportation policy systems identify needs, gaps, and requirements; build consensus around a prioritized ranking of potential needs; and develop acceptable goals and priorities for transportation</td>
</tr>
<tr>
<td>Planning and Programming</td>
<td>Processes by which transportation plans are created to carry out the goals developed in the consensus building, needs assessment, and goals setting processes. These plans are then turned into processes, which are created and authorized to carry out the goals set in the consensus building, needs assessment, project prioritization, and goals and objectives setting processes</td>
</tr>
<tr>
<td>Budgeting and Resource Allocation</td>
<td>Processes by which transportation policy systems determine how to collect and distribute resources among different projects and programs (includes budgeting and allocation)</td>
</tr>
<tr>
<td>Regulation and Rulemaking</td>
<td>Processes by which rules, regulations, standards, and guidelines are established for compliance with legislated mandates and laws</td>
</tr>
<tr>
<td>Service and Product Delivery</td>
<td>Processes by which transportation policy systems deliver transportation goods and services to the public and ensure that the level and quality of services meet goals and established standards</td>
</tr>
<tr>
<td>Compliance and Dispute Resolution</td>
<td>Processes by which the transportation community sees that the intent of legislation, standards, and regulations are complied with—and processes by which disagreements over interpretations or tradeoffs can be resolved</td>
</tr>
<tr>
<td>Education, Training, and Culture Change</td>
<td>Processes by which the transportation community is educated to understand and embrace evolving organizing principles and to adopt (and invest in) behavioral norms(^\text{14}) associated with those principles</td>
</tr>
<tr>
<td>Outreach and Communications</td>
<td>Processes by which information on needs, strategies, expectations, and results are shared broadly by stakeholders in the public and private-sector transportation community—critical processes to support consensus-building, policy-making, planning, and decisionmaking</td>
</tr>
</tbody>
</table>

4.1.3 Outputs and Feedback

A policy system produces various outputs. These include a wide variety of public goods, including direct allocation of money to specific groups, spending on investments or operations, or regulations and guidance. It should be noted that one of the decisions of the policy system may be not to do something. For example, the decision not to make a major investment in public transit may be as important as the decision to make a decision to invest in public transit, and may have major implications regarding who is able to use government resources.

\(^\text{14}\) Some examples of adopted behavioral norms include energy conservation, recycling, seat-belt habit, aversion to littering, acceptance of user charging, pursuit of diversity and social equity, self-regulation, etc.
A policy system’s decisions have direct and indirect impacts on the environment in which it operates. These, in turn, affect the demands made on the policy system and the resources available for future policy actions. For example, the decision after World War II to make cars the dominant form of personal transportation encouraged suburban sprawl. This, in turn, changed the resource balance between cities and suburbs, and placed new demands on local transportation agencies.

### 4.2 Policy Change

This issue of policy change is highly relevant to this project, as we are trying to explain not only the current situation, but also how transportation policy systems might change to be able to support a more sustainable society under different scenarios.

- **Exogenous Change**: Change can come from outside the policy system in the form of: (1) sudden, unanticipated shock (e.g., 9/11, Hurricane Katrina); or (2) gradual long-term change and growing stress (e.g., increasing energy price, global change, growing public demands for environmental protection, changing economic conditions); and

- **Endogenous Change**: Change can come from within system from: (1) changes in demands and resources produced by feedback; and (2) policy learning within the policy community, as members test out policies and identify those that are successful or fail

In general, the public policy literature on policy change tends to emphasize the limitation on decisionmaking and implementation processes that arise from the complex, multifaceted nature of public sector policymaking processes (Downs, 1967); (Wilson J. Q., 1989); (Moe, 1989). At one extreme, the incrementalist model (Lindblom, 1959) argues that policies change slowly as a result of gradual policy learning. This is due to the following:

- Policymakers are constrained by the existence of policies that limit the range of potential alternatives that may be considered and the need to develop consensus between policy actors;
- The nature of American political culture (which emphasizes strong public support for free enterprise, limited government, and local control) makes it difficult to create comprehensive public-sector led change (Lipset, 1997); and
- The character of the American constitutional system, with its checks and balances, and veto points, causes fragmentation in policymaking, specifically between levels of government and jurisdictions (Mettler, 1998); (Quadango, 1994).

This system tends towards the creation of important interest-group actors who can mobilize support to these veto points to block initiatives that affect their respective interests. At the extreme, these groups can fuse with the political and agency actors to create “iron triangles” that reinforce the status quo and make major policy creation or change extremely difficult.
Public apathy or inattention to issues allows these groups to dominate policymaking (Mills, 1956); (Schattschneider, 1975); (Lowi, 1979).

In the systems model, change occurs two ways as shown in Figure 12:

![Figure 12: Changes to the Policy System](image)

From: (Transport Studies Unit, University of Oxford, UK, Department of Transport, Technical University of Denmark, Denmark, Institute of Transport Economics, 2010)

In this environment, policy systems tend toward “policy monopolies” around issues—political alliances, institutional configurations, and conceptual understandings that structure the participation and policymaking over long periods of time (Baumgartner & Jones, 1993). The persistence of these systems generates patterns of political mobilization, citizens’ ways of thinking about the issue, and institutional structures that become “sticky” and “locked in” (i.e., difficult to change and resistant to outside influence).

Paradoxically, this situation may result from initial policy success. For example, successful policymaking results in positive feedback and increasing returns. This becomes self-reinforcing, and those that benefit from a policy begin to mobilize to ensure their benefits are not removed.
They become active in the policymaking process to ensure that the status quo remains in place. As policymakers are more likely to be responsive to mobilized interest groups than to the public at large, these groups gain privileged access to decisionmakers and become part of the policy community (Jacobs & Shapiro, 2000).

A more sophisticated view of this approach is the “path-dependent model” (Pierson, When Effect Becomes Cause: Policy Feedback and Political Change, 1993) (Pierson, Not Just What, but When: Timing and Sequence in Political Processes, 2000). This model attempts to explain continuity and resistance to change as part of the natural consequence of bounded rationality. Path dependence is a concept taken from economics. It explains how the set of decisions an actor faces are limited by decisions made in the past, even though past circumstances may no longer be relevant to the current situation. Thus, under this model, policy change is limited by previous policies, decisions, and the existence of various institutions that limit the extent of policy change. Pierson argues this leads to “policy lock-in” effects, where current policies are always limited in their ability to change by “policy inheritances” and “policy legacies.” For example, in the area of transportation policy, decisions taken decades ago on the transportation infrastructure continue to constrain and limit policy choice.

The “punctured equilibrium model” (Baumgartner & Jones, 1993) seeks to explain how policy change can be incremental and slow, yet subject to sudden rapid change. Under this model, policymaking is characterized by long periods of stability with minor policy change (equilibrium), followed by periods of instability and major policy change. During these periods of instability, a major issue challenges, changes, or destroys the policy frameworks resulting in major policy change. A new “path-dependency” is established as the dominant decisionmaking context and policy returns to its incremental development. Baumgartner and Jones’s work emphasizes that the American policymaking system tends toward equilibrium—that while this equilibrium is punctured when an issue rises on the public agenda occasionally, a new policy monopoly will arise and enforce a new status quo that will persist for years.

According to Wilson, each dimension of a policy system contributes to long-term policy stability (Wilson C., 2000). Power arrangements themselves tend to be stable. The paradigms of those in power are reinforced through news media coverage and active communication between the government and citizens; however, while these systems are resistant to change, they are under constant attack from a variety of forces. Political actors try to define and redefine issues in the pursuit of better public policy and/or electoral advantage. Policy entrepreneurs and advocates attempt to focus attention on specific events to draw public attention to new ideas and understandings about old problems and programs. In addition, major power shifts and institutional changes within the policy systems and the broader political system can enable advocates of change to force a reconsideration of existing policies.
Policy systems change when they “become stressed, alternative policy paradigms arise, legitimacy crises occur, and shifts in power become evident” (Wilson C., 2000). Stressors consist of natural or manmade disasters, cumulative processes like demographic shifts, new discoveries or disruptive technologies, or scandals. Cobb and Elder refer to these stressors as “trigger events,” Sabatier to “external perturbations,” and Jones, Baumgartner and True call them “exogenous shocks” (Cobb & Elder, 1983); (Sabatier P., Theories of the Policy Process, 1999b); (Jones, True, & Baumgartner, 1997). Stressors can generate pressure on organizational arrangements, undermine dominant policy paradigms, and raise the visibility of new problems. Paradigm shifts occur when events or stressors arise that are inconsistent with the dominant policy narrative. If this occurs, new paradigms may emerge or existing (but dormant) alternatives may gain traction. In this case, power arrangements, policy paradigms, and policymaking arrangements are rewritten to consider the new reality. For example, the passage of Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 changed radically the power arrangements (e.g., MPOs gained additional authority and credibility), policy paradigms (e.g., single mode to multiple modes), and policymaking arrangements (e.g., created two new categories of federal funds—the Congestion Management and Air Quality Improvement Program and the regional component of the Surface Transportation Program—and established a set of rules to use these funds).

Thus, new policy systems can be born out of instability initially and then slowly become more unstable and prone to radical change.

The second approach to understanding how policy systems change is to focus on the adoption of new ideas and issue frames from within the policy community. An issue or policy frame is a shared cognitive device used by individuals to understand a complex social reality. It involves the careful use of language and other symbols to create a shared understanding of the world. The frame (i.e., the cognitive device that states which elements belong and don’t belong to a particular problem or solution) is both an individual mental structure and social, interpersonal communication. The frame evolves gradually from a shared discourse, as individuals attempt to understand what they encounter and discuss potential interpretations. Once established, the frame becomes resilient. It serves as an easy way to understand the world and locates the policy “problem” and range of potential solutions within a larger body of potential “problems” and “solutions” (Lavrakas, 2008).

Studies of policy framing have shown that it is an important process that occurs in major policy debates (Gamson W. A., 1992); (Gamson & Modigliani, Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach, 1989); (Gamson, Croteau, Hoynes, & Sasson, 1992). Importantly, a frame can contain a range of positions on an issue. People can share a frame while holding different substantive policy preferences. For example, two planners can accept the framing of transportation as a sustainability issue and the same analysis of a
transportation problem, but see different solutions. The idea of framing is important to this study. Transportation agencies will have to adopt new policy frames that reframe the issue of transportation within a sustainability context and sell this to the public and specific policy actors within the process. The process by which frames are generated and change deserves some space.

Kingdon studied the process of agenda setting and found that the emergence of shared policy ideas occurs through diffusion in policy networks. Based on his study of the longitudinal development of consensus across different categories of actors in policy communities, he concluded that change emerged from “ideas, not pressure” and through “persuasion and diffusion” (Kingdon, 1984). From a related “social learning” perspective, policy actors change the way they frame problems in light of past decisions, new information, or in response to exogenous events (Hall, 1993). Social learning refers to the process through which individuals interact with their environment, formal and information education, and group discussion to develop new understandings. In the policy context, policy feedback is a major determinant of social learning, as members of transportation agencies, policy experts, and elected officials evaluate the performance of previously enacted policies ((Bennett & Howlett, 1992); (Hall, 1993); (Heclo, 1974); (Rose, 2004); (Sabatier P., An Advocacy Coalition Framework of Policy Change and the Role of Policy-Oriented Learning Therein, 1988)).

There are limits to the change that can be achieved by social learning; policy theorists Sabatier and Jenkins-Smith proposed a three-tiered model that connects a policy actor’s willingness to adopt new ideas with the degree to which it affects their core beliefs (Sabatier & Jenkins-Smith, Special Issue: Policy Change and Policy-Oriented Learning: Exploring an Advocacy Coalition Framework, 1988).

This approach fits well with the punctuated equilibrium model in that it explains how policy communities can switch from periods of stability (when policy change is limited, incremental, and driven by social learning) to periods of instability (when events and the gradual aggregation of anomalies lead to sudden dramatic change). In these moments, individuals may experience conversion when their core beliefs change or they leave the policy community because their ideas and insights are no longer valued or deemed useful to the system. For example, the attack on Pearl Harbor changed radically the American public’s opinion on world affairs and involvement in World War II. Similarly, 9/11 changed public views on terrorism, international threats, air travel, and security measures. Both of these events affected the defense and national security communities, and ushered in new policy frames, actors, power arrangements, policy paradigms, and policymaking arrangements.

Punctuated equilibrium also fits with the experience of the transportation policy system in the 20th century. In general the transportation policy system has been characterized by stable
predictable changes punctuated by periods of rapid change. For example, prior to World War II the states, localities, and private sector dominated the transportation system. States developed the intercity road system, local governments provided local roads, railroads, and most long-distance freight and passenger transportation. In metropolitan areas, public transit system, private street cars companies, and private railroads delivered local transportation services. The Federal Government had been a relatively minor player in the transportation system. Some initial federal investment and regulation had occurred after World War I and during the New Deal, but state and local governments were dominant in transportation.

In terms of the model described above, the policy system had entered a stable policy period. In the 1940s, however, this system became unstable when the demands of World War II illustrated its inadequacy to meet the stresses of global mobilization. In 1941, President Roosevelt responded by appointing the National Interregional Highway Committee, whose recommendation for a “National System of Interstate and Defense Highways” resulted in the “Federal-Aid Highway Act of 1944.” Its goal was to expand the interstate road system by the 1950s.15 Thus, after a period of instability, the system changed and the Federal Government became the dominant player.

A recurring comment made by the panel was that the “Crisis World” scenario, despite its negative conditions, does at least provide an opportunity for change. We should consider, however, what the public policy literature tells us about crisis, and when and under what circumstance it can lead to change

The Seeger, Sellnow, and Ulme (1998) study of a broad range of public policy-related crises found four defining characteristics that are “specific, unexpected, and non-routine events or series of events that [create] high levels of uncertainty and threat or perceived threat to an organization’s high priority goals.” They were (1) Unexpected; (2) Creates uncertainty; (3) Seen as a threat to important goals; and (4) Perceived as requiring need for change. Not all crises produce major changes in public policy. Many draw attention initially, but are then forgotten or result in relatively minimal change (Seeger, Sellnow, & Ulmer, 2003).

The research team reviewed more than 50 major economic, natural disasters, political and military crises in which the United States was involved and identified the following characteristics that seem to me most likely to lead to major policy change:

15 “The Interstate and Defense Highways Act of 1956” (also called the 1956 Federal-Aid Highway Act ( Interstate Act)), appropriated $25 billion (about $197 billion in 2009 dollars) to build 41,000 miles of multilane, limited-access highways.
• **Scope:** The scope of the impacts of the crisis (both in the people affected and the potential future threats) influences the response strongly. For example, a major fire or tornado may produce a local “crisis,” but does not change significantly the broader allocation of responses or policy community, since its impacts are inevitably local and limited.

• **Magnitude:** The larger the impacts of the crisis (e.g., property damage, loss of life) the more likely there is to be a major policy change, especially when these impacts are distributed broadly.

• **Control:** The degree to which the public believes that something could have been done to address a crisis, the more likely there is to be major policy change. So-called “acts of God” or random events are less likely to produce a major policy change than disasters deemed manmade or preventable.

• **Perceived Probability of Reoccurrence:** If something is perceived as a low-probability event (e.g., a major hurricane in New England), major policy change is less likely.

• **Effectiveness of Response:** If the response to the crisis is perceived as satisfactory, then major policy changes are unlikely.

• **Comprehension/Understanding/Technology:** A crisis is more likely to produce real change if its causes are well understood and the tools exist to respond to it. Crises which have a strong storyline, are easy to understand, and have clear solutions are more likely to lead to change than those that are not.

• **Maturity of the Policy System:** Highly stable, strong policy systems are more able to resist demands for change (no matter their performance in crisis situations) and explain failures as unique events unlikely to be repeated. Unstable, aging policy regimes are easier to challenge and are more likely to yield to change.

These findings explain why the policy systems and institutions associated with the transportation system generally are not prone to change due to shocks and short-term crises. In contrast to other policy systems (e.g., defense and national security, education, science and technology, environment), transportation has changed gradually, as technology and public attitudes have changed. One explanation may be that it is difficult to have a “national transportation crisis,” despite media alarmism to the contrary. Inevitably, transportation is experienced on a local level. Even highly dramatic events (e.g., the I-35W Mississippi River Bridge collapse of 2007, the Silver Bridge Collapse of 1967, the I-580 East Connector Collapse of 2007) tend to be seen as local events requiring local solutions, rather than signs of systemic failure. When these dramatic events occur, there is an initial national focus and questions are raised concerning whether the event is a symptom of a larger national issue. Normally, the initial public concern dissipates, and the problem is dealt with as a state and/or local issue. More typically, transportation issues emerge as a “slow crisis.” Problems mount up gradually (e.g., increasing congestion, increasing environmental damage) until public opinion shifts and
demands emerge to change transportation policy. This pattern has proved enormously resilient, and given the dispersed, decentralized nature of transportation, it is unlikely to change in the future.

This may explain why there seems to be more innovation in transportation policy at the local level. When transportation crises or shocks occur at the local level, they are rarely likely to have such dramatic impact that they cause state or Federal Governments to change policy. A local transportation crisis, such as a major bridge collapse, may cause innovation and rapid policy change in local transportation policy. For example, in Brisbane Australia, the trigger event for a new sustainability planning regime was the proposed “Route 20” expansion plan for the inner-western suburbs, which led to a citizens’ revolt and the enactment of new sustainable transportation initiatives (Engwicht, 1989). Similarly, the hosting of the 1972 Olympics in Munich was a “crisis” that led to increased transit spending (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010).

The more typical change occurs through slow, gradual stresses that build up over time. For example, in the 1960s, demand grew for public participation in the planning process. This was expressed as growing frustration over the impacts of highways in urban areas (the so-called “Freeway Revolt”). Opposition to top-down freeway planning began as early as 1955, when the San Francisco Chronicle published a map of proposed freeways for the Bay Area. Local activists organized to oppose numerous elements of the plan, and in 1959, the San Francisco Board of Supervisors canceled seven of 10 planned freeways.

It was not until the 1970s, however, that the movement took off. In the 1970s, most of South Florida’s expressways were canceled due to a public vote to divert funds from roads toward mass transit projects and the planned Miami Metrorail. Similarly, local opposition was the death knell of a number of freeway projects in metro Atlanta, that would have created an overwhelmingly complicated system of interchanges and destroyed entire neighborhoods (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010).

Parallel to this were increased demands for environmental protection. In 1973, environmentalists in Connecticut filed lawsuits that effectively killed construction of planned interstates and expressways in the Hartford area. After these freeways were cancelled, the State of Connecticut used those allocated funds to rebuild and expand existing freeways in the greater Hartford area. Similarly, environmental groups and the City of Bloomington long protested the completion of Interstate 69 through southwest Indiana. Their opposition pitted them against residents in the southwest corner of the state and the cities of Evansville, Petersburg and Washington, which long supported highway’s construction. For 40 years, opponents held up construction of I-69 through southwest Indiana through litigation, legislative maneuvering, and acts of vandalism, while the highway’s supporters accused
opponents of attempting to isolate them from the rest of the state. Ultimately, construction on I-69 began in 2008, with completion between Evansville and Bloomington scheduled for 2014.

At the same time, there was growing concern about mobility opportunities for special groups (minorities, poor, elderly, persons with disabilities) and the impact of roads and cars on their freedom of mobility. For example, in the 1970s, an extension of the Davison Freeway in Detroit was proposed to connect Interstate 96, the Jeffries Freeway, Interstate 696, and the Reuther Freeway. Detroit neighborhoods revolted and opposed having the freeway cut through their neighborhoods, which were predominantly poor and minority, and had already experienced substantial impacts from road building. As a result, the City of Detroit passed a moratorium on freeway construction and rerouted the planned Jeffries Freeway.

These battles changed the top-down, technocratic planning process that had dominated transportation planning up to that point and opened it up to new participants and issues. Most importantly, the “3C process” was established and then amended to require citizen participation at all stages of process, and the National Environmental Policy Act (NEPA) introduced the requirement for environmental impact statements (EISs). The “3C” transportation planning process (jointly developed by the FHWA and the Urban Mass Transportation Administration, now the U.S. Federal Transit Administration) was developed to ensure that effective, coordinated multimodal transportation planning and project implementation would be conducted on a nationwide basis.

### 4.3 Moving from “Safe Mobility” to “TBL Sustainability” Models

Based on the information collected in the preceding sections of this chapter, we can describe a series of models that represents different steps along a continuum ranging from the Safe Mobility Model to TBL Sustainability. These models represent a gradual evolution of the stages that transportation agencies undergo to shift from their current focus to supporting a more sustainable society. The following sections describe each element of these models and the intermediate stages between them. The research team used these stages to characterize state transportation agencies (in general), leading local governments, the Federal Government, private-sector sustainability leaders, and sustainability leaders in other countries. The team then conducted a gap analysis and identified potential strategies that would take state transportation agencies from their current position to a more advanced one.

The research team identified five potential stages through which policy systems move:

- **Level 0 Policy System – Safe Mobility Model**
- **Level 1 Policy System – Compliant Transportation**
- **Level 2 Policy System – Green Transportation**
- **Level 3 Policy System – Sustainable Transportation**
We designated the Safe Mobility Model as a Level 0 model, because this policy system does not address sustainability at all, but is included to contrast how the traditional transportation policy system differs from the sustainability-based or aspiring models.

### 4.3.1 Policy Systems

Table 24 shows the policy systems for evolving sustainability models. Following the public policy literature, we identified three distinct elements: (1) organizing principles; (2) policy paradigms; and (2) transportation agency roles.

The first dimension addresses the organizing principles or core values for the policy system. This varies from the “Safe Mobility” model to the “Sustainability” model. As discussed previously, until the 1970s, the key role of transportation policy systems was to expand and support the mobility of people and goods. In the 1970s and 80s, this changed to where transportation agencies were required by law to consider additional goals as part of their mission. The organizing principle began to focus on balancing mobility along with other legislatively required elements, such as environment, economic development, and various sociocultural concerns. Despite the broad social consensus behind these goals, the general orientation of culture and the core values of the transportation agencies were one of compliance. That is, balancing transportation needs against environmental concerns occurred because it was required by law, rather than because it was a social good.

This policy system has evolved into what we characterize as the “Green Transportation” model. Under this model, there is wide support for balancing out transportation needs with the environment. The system has moved beyond seeing environmental, economic, and social needs as merely requirements that must be followed, and now accepts and supports its societal benefits.

**Table 24: Policy Systems for Evolving Sustainability Models**

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ORGANIZING PRINCIPLES</strong></td>
<td></td>
</tr>
<tr>
<td>Level 0 Safe Mobility</td>
<td>Support Societal Mobility</td>
</tr>
<tr>
<td>Level 1 Compliant Transportation</td>
<td>Support Societal Mobility and Compliance with Environmental, Economic and Social Legislative Requirements</td>
</tr>
<tr>
<td>Level 2 Green Transportation</td>
<td>Support Societal Mobility and Environmental, Economic and Social Needs -- Emphasizes Environment</td>
</tr>
<tr>
<td>Level 3 Sustainable Transportation</td>
<td>Support Sustainable Transportation</td>
</tr>
<tr>
<td>Level 4 TBL Sustainability</td>
<td>Support Societal Sustainability</td>
</tr>
<tr>
<td><strong>POLICY PREFERENCE</strong></td>
<td></td>
</tr>
<tr>
<td>Level 0</td>
<td>Favors government ownership and control of the transportation</td>
</tr>
</tbody>
</table>
## Policy System Characteristics

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe Mobility</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>Level 1 Compliant Transportation</td>
<td>Favors government ownership and control of the transportation infrastructure</td>
</tr>
<tr>
<td>Level 2 Green Transportation</td>
<td>Favors government ownership and control of the transportation infrastructure</td>
</tr>
<tr>
<td>Level 3 Sustainable Transportation</td>
<td>Favors partnerships between public and private sector</td>
</tr>
<tr>
<td>Level 4 TBL Sustainability</td>
<td>Agnostic on issues of ownership or control of transportation infrastructure – whatever is most sustainable</td>
</tr>
</tbody>
</table>

### Role of Transportation Agency

| Level 0 Safe Mobility          | Infrastructure Owner-Manager and Regulator                |
| Level 1 Compliant Transportation | Infrastructure Owner-Manager and Regulator                |
| Level 2 Green Transportation   | Infrastructure Owner-Manager and Regulator                |
| Level 3 Sustainable Transportation | Infrastructure Coordinator (some owner-operator and some private) and Regulator |
| Level 4 TBL Sustainability     | Transportation System Steward                             |

While there is some support for sustainability (and frequently, even sustainability officers, programs, and metrics), sustainability is largely interpreted as environmental. In this system, one finds broad support for such issues as green procurement, green operations, green infrastructure, use of recycled or green materials, use of metrics and management systems that emphasize environmental progress, and a general bias toward considering environmental issues. Typically, the states most advanced in sustainability are at this stage. That is, they are developing sustainability programs, but still see it largely as an issue of environmental protection and balancing the environment against the demands of economic growth, rather than true sustainability.

This system is followed by one that incorporated sustainability more consciously into transportation policymaking; however, the focus is still on transportation. Thus, the model’s key organizing principle is the provision of sustainable transportation. The unspoken assumption is that if sustainable transportation is delivered, then societal sustainability will be delivered. This is the level achieved by the leading sustainability cities and local governments in the United States and around the world.

During the final stage, transportation agencies come to see that their organizing principle should be to support the overall sustainability of society. This means that a transportation agency might accept less than optimal mobility or safety if it led to greater sustainability. No current state or local, national, or other entity operates at this level currently.
Paralleling these distinctions reveals the evolution of different policy paradigms—that is, what is the best way to implement a particular core value or organizing principle? In the first two models, the basic assumption is that the transportation agency is the owner and manager of the transportation infrastructure. The basic role of a transportation agency is as owner, manager, and regulator. This begins to change under the Sustainable Transportation Model only. Under this model, there tends to be a move away from strict command and control toward a greater openness for public-private partnerships. This comes about both because of the costs of sustainable transportation systems (i.e., governments have to share control freely to achieve more sustainability and bring in new partners) and the realization that sustainability requires substantial stakeholder and private-sector involvement if it is to be accepted initially and operated successfully. In this case, the transportation agency comes to play the role of coordinator and regulator, in which it works to coordinate the overall function of several elements of the transportation system to ensure delivery of sustainable transportation.

Finally, the system evolves into a true societally sustainable model. Under this model, transportation agencies are agnostic on the issue of public or private ownership. Instead, they pursue any ownership and management combination that promotes societal sustainability successfully. Their role is one of stewardship of transportation resources.

The concept of stewardship is important to this model, but it is a difficult concept to define. The World Health Organization (WHO) has developed a concept of stewardship that identifies a number of essential ingredients or “core domains” that appear to constitute good stewardship. These domains are deemed essential elements for organizations to practice good stewardship of a policy area (Travis, Egger, Davies, & Mechbal, 2002):

- Generating intelligence and understanding of the policy area;
- Formulating strategic policy direction;
- Ensuring that the tools exist for the implementation of policy;
- Building coalition/partnerships;
- Ensuring a fit between policy objectives and organizational structure and culture;
- Ensuring accountability.

This concept fits well for transportation. Under a TBL Sustainability model, a transportation agency would express stewardship by collecting data, developing intelligence, and understanding transportation needs and how they affect societal sustainability; formulating strategic policy; developing tools for implementation; building support for policy; developing the appropriate structures to implement policy; and ensuring responsiveness and accountability. It would not necessarily design, build, or operate the transportation infrastructure as it does today.
4.3.2 Inputs to the Policy System

As discussed above, there are two main inputs to any policy system: demands and resources. In the case of transportation, there is a gradual evolution of demands from “mobility, accessibility, safety, and economic development only” to TBL Sustainability. Table 25 illustrates this evolution. The system moved from a situation where the public, stakeholders, and political elites demanded a simple good (mobility and economic growth); to one where they demanded that additional goods, such as environmental protection, protection of sociocultural assets, and public participation be considered; to one where they demanded that policy system outputs consider the TBL along with mobility and public participation.

During this transition, as the system changes from Compliant Transportation and Green Transportation to Sustainable Transportation and true TBL Sustainability, the public begins to accept that tradeoffs can be made. Thus, under the Compliance and Green models, each element of the TBL is viewed as separate. No tradeoffs may be made. The public, stakeholders, and political elites have not come to accept the sustainability paradigm and still attempt to have it all. They do understand that having more of one element of TBL will necessitate trading off another element. Only when they reach a level of sophistication where they accept that tradeoffs are necessary can they be said to have truly reached the support for sustainability.

Under the first three models, the main resources that are provided to the transportation system are: (1) gas taxes, excise taxes (e.g., tax on tires), and impact and licensing fees; (2) intergovernmental transfers (e.g., grants, revenue sharing, direct financing of projects); (3) bond issues; and (4) user fees (e.g., toll roads). Under the Sustainable Transportation Model, these sources are expanded to include more user fees and there is widespread use of market mechanisms to achieve goals and finance the transportation system. In addition, there is a much greater move toward public partnerships, where government might build and then transfer operation of an asset to a private firm to provide income for additional projects.

Under a truly sustainable system, the overall transportation system would be self-financing. That is, it generates sufficient revenue to ensure its long-term sustainability. This would be achieved through a mixture of user fees (e.g., congestion charges, tolls, vehicle miles traveled (VMT) taxes) and/or financing through some semipublic system that determines that the transportation system creates more value than it requires to operate (e.g., an infrastructure bank.

<table>
<thead>
<tr>
<th>Table 25: Inputs to Evolving Sustainability Models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy System</strong></td>
</tr>
<tr>
<td><strong>Demands and Priorities (in order of importance)</strong></td>
</tr>
<tr>
<td>Level 0 Safe Mobility</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Policy System</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>3. Economic development</td>
</tr>
</tbody>
</table>
| Level 1 Compliant Transportation | 1. Mobility  
       2. Safety  
       3. Economic development  
       4. Environmental compliance  
       5. Other (e.g., heritage and culture protection)  
       6. Public participation  
       Note: each are seen as separate demands with no trade-off |
| Level 2 Green Transportation  | 1. Mobility  
       2. Accessibility  
       3. Safety  
       4. Economic development  
       5. Environmental compliance  
       6. Other (e.g., heritage and culture protection)  
       7. Public participation  
       Note: each are seen as separate demands with no tradeoff |
| Level 3 Sustainable Transportation | 1. Sustainability (TBL):  
       1.1. Environment  
       1.2. Economic  
       1.3. Society (includes quality of life, accessibility, safety and security, preserving natural resources)  
       2. Mobility and safety  
       3. Accessibility  
       4. Connectivity  
       5. System efficiency  
       6. Public participation  
       Note: Tradeoffs are possible |
| Level 4 TBL Sustainability    | 1. Sustainability (TBL):  
       1.1. Environment  
       1.2. Economic  
       1.3. Society (includes quality of life, accessibility, safety and security, preserving national resources)  
       2. Mobility and safety  
       3. Accessibility  
       4. Connectivity  
       5. System efficiency  
       6. Public participation  
       Note: Tradeoffs are possible |

<table>
<thead>
<tr>
<th>Resources</th>
<th></th>
</tr>
</thead>
</table>
| Level 0 Safe Mobility         | • Gas tax, excise taxes, impact and licensing fees  
       • Intergovernmental transfers  
       • Bond issues  
       • Some user fees (e.g., toll roads) |
| Level 1 Compliant Transportation | • Gas tax, excise taxes, impact and licensing fees  
       • Intergovernmental transfers  
       • Bond issues  
       • Some user fees (e.g., toll roads) |
<p>| Level 2                        | • Gas tax, excise taxes, impact and licensing fees |</p>
<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Transportation</td>
<td>• Intergovernmental transfers</td>
</tr>
<tr>
<td></td>
<td>• Bond issues</td>
</tr>
<tr>
<td></td>
<td>• Some user fees (e.g., toll roads)</td>
</tr>
<tr>
<td>Level 3 Sustainable Transportation</td>
<td>• Gas tax, excise taxes, impact and licensing fees</td>
</tr>
<tr>
<td></td>
<td>• Intergovernmental transfers</td>
</tr>
<tr>
<td></td>
<td>• Bond issues</td>
</tr>
<tr>
<td></td>
<td>• Substantial use of user fees and market mechanisms</td>
</tr>
<tr>
<td>Level 4 TBL Sustainability</td>
<td>• Self-financing (e.g., user fees, VMT tax, infrastructure bank)</td>
</tr>
<tr>
<td></td>
<td>• Intergovernmental transfers</td>
</tr>
</tbody>
</table>

### 4.3.3 Actors and their Relationships

Table 26 shows the role of actors under different models. As can be seen, most governmental actors are major players under all models. Local governments, MPOs, non-transportation state agencies, and other modal authorities increase in importance gradually as the transportation policy systems move from a purely transportation focus to a societal sustainable focus.

Similarly, economic interests are always important. Economic interests include major state and local businesses, small business affected by transportation decisions, providers of transportation services (e.g., freight companies and shippers, private transit providers, railroads, and airlines concerned about local intermodal connections), firms involved in highway construction activities, land developers and builders, trade unions, and other entities with (1) a substantial, ongoing interest in the continued economic growth and development of a state; and (2) an interest in the distribution of transportation resources to the benefit of one party or another.

These interests are always and inevitably active in transportation policymaking and implementation. They influence policy via a number of mechanisms, including formal and informal participation in the development of the goals of state transportation policy (e.g., participation in elections by supporting one candidate versus another; participation in state legislative hearings, blue ribbon panels, and other mechanisms to solicit input for key local interests; formal participation in consultative processes). Furthermore, since one of the key goals of transportation policy is to support the economic development and growth of an area, transportation agencies must understand and respond to economic interests’ competing visions of the transportation system’s future. This does not mean that economic interests control or direct policy. Rather, they are an important and inevitable constituency that must be considered in policymaking and will always be a major consideration in how policy is developed and implemented.
The major change that occurs as the system moves from Safe Mobility to TBL Sustainability is the involvement of civic and social groups. Before, these groups were involved only in the initial stages of the policymaking process. Specifically, prior to the 1970s, their activities (to the extent they existed at all) were confined to the initial formal and informal political processes (e.g., participating in elections, lobbying elected representatives, testifying before legislative committees). With the emergence of the modern environmental movement and local citizens’ activist groups in the 1960s, they became more involved. The NEPA process, as well as the state and local versions of the Federal Administrative Procedures Act, gave civic and social interest groups more access to and involvement in the policymaking and implementation processes. Their involvement was strengthened further by their use of the courts and legal system, and direct action (e.g., picketing, land occupations, marches) to resist and delay transportation projects.

As the system develops toward a more sustainable system, civic and social groups need to become more integrated into the policymaking and implementation system. Our review of successful experiences of sustainability shows that involving civic and social groups from the beginning of the process through implementation is vital to both developing a coalition that will support the process and ensuring it is designed to meet community needs. As the system moves from a Safe Mobility to TBL Sustainability policy system, public participation and involvement in all levels of policymaking and implementation needs to increase.

Table 26: Actors and their Relationships in Evolving Sustainability Models

<table>
<thead>
<tr>
<th>GOVERNMENTAL SECTOR</th>
<th>Level 0 Safe Mobility</th>
<th>Level 1 Compliant Transport</th>
<th>Level 2 Green Transport</th>
<th>Level 3 Sustainable Transport</th>
<th>Level 4 TBL Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>State legislature, individual legislators, legislative committees</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Governors</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Transportation commissions (if present)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Federal DOT and other Federal transportation agencies</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
### Stages in the Evolution of Sustainability Supporting Transportation Agencies

<table>
<thead>
<tr>
<th></th>
<th>Level 0 Safe Mobility</th>
<th>Level 1 Compliant Transport</th>
<th>Level 2 Green Transport</th>
<th>Level 3 Sustainable Transport</th>
<th>Level 4 TBL Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Federal Government departments (e.g., EPA)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>State DOTs</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>MPOs</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Local governments</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Other state government agencies</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Other modal authorities</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>(e.g., airports, ports, passenger rail)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRIVATE SECTOR**

| State and local economic interests and businesses | 1                     | 1                           | 2                        | 3                             | 4                        |
| Transportation providers and system operators    | 1                     | 1                           | 2                        | 3                             | 4                        |

**INTEREST GROUPS**

| Community and civic groups (e.g., community booster groups, chambers of commerce) | 0                     | 1                           | 3                        | 4                             | 4                        |
| Environmental groups                                                              | 0                     | 1                           | 3                        | 4                             | 4                        |
| Professional organizations and research organizations                              | 0                     | 1                           | 3                        | 4                             | 4                        |
| Single-issue transportation groups                                                  | 0                     | 1                           | 3                        | 4                             | 4                        |
| Social-Economic-Ethnic and Cultural Interest Groups                                | 0                     | 1                           | 3                        | 4                             | 4                        |

In terms of the relationship between these groups, Safe Mobility through Green Transportation processes manifest similar power and organizational relationships. In Safe Mobility, systems policymaking and implementation are fundamentally hierarchical, siloed, and linear. That is, elected, political entities (e.g., governors, legislatures) decide and determine policy and goals, agencies implement with minimal public input and involvement from other agencies, while the Federal Government provides funding, basic standards, and technical assistance. In Compliant Transportation systems, the same overall process occurs; however, there is an active effort to elicit public input during the planning phase. This expands in both Green Transportation and
Sustainable Transportation systems, in which the policy systems become fundamentally more interactive, iterative, and flexible. Agencies work with elected bodies in a cooperative back and forth; mechanisms exist to engage and involve interest groups and citizens to develop goals, policies, and plans at all stages; and transportation agencies work with private sector entities to manage land use and transportation demand cooperatively. The Federal Government still provides funding (perhaps more limited), basic standards, and technical assistance. Finally, in TBL Sustainability systems, policymaking and implementation become more integrated. As with Sustainable Transportation systems, policymaking and implementation processes are open to the public and organized interests, but other state, local, regional, and federal agencies are explicitly involved and integrated into the process. Thus, transportation policy is linked explicitly to broader social sustainability policymaking and is coordinated and managed in the context of these broader social goals. Table 27 summarizes these relationships.

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 Safe Mobility</td>
<td>Hierarchical, Linear — fundamentally a linear process — elected bodies decide policy and goals, agencies implement with minimal public input and involvement from other agencies. Federal Government provides funding, basic standards, and technical assistance.</td>
</tr>
<tr>
<td>Level 1 Compliant Transportation</td>
<td>Hierarchical, linear — fundamentally a linear process — elected bodies decide policy and goals, agencies implement with active effort to elicit public input, limited involvement from other agencies. Federal Government provides funding, basic standards, and technical assistance.</td>
</tr>
<tr>
<td>Level 2 Green Transportation</td>
<td>Hierarchical, linear — fundamentally a linear process — elected bodies decide policy and goals, agencies implement with active effort to elicit public input, limited involvement from other agencies. Federal Government provides funding, basic standards and technical assistance.</td>
</tr>
<tr>
<td>Level 3 Sustainable Transportation</td>
<td>Interactive, iterative, flexible — agencies work with elected bodies, interest groups, and citizens to develop goals, policies, and plan. Public involvement at all stages. Federal Government provides funding (more limited), basic standards, and technical assistance.</td>
</tr>
<tr>
<td>Level 4 TBL Sustainability</td>
<td>Integrated, interactive, iterative, flexible — agencies work with elected bodies, interest groups, and citizens to develop goals, policies, and plan. Public involvement at all stages. Mechanisms exist for all agencies to be consulted and involved in transportation planning. Federal Government provides funding (more limited), basic standards, and technical assistance</td>
</tr>
</tbody>
</table>

### 4.3.4 Functions: Developing Consensus on Needs and Goals

Table 28 shows the function of developing consensus as needs and goals evolve under different policy systems. As can be seen, the process evolves from a fundamentally reactive system to an interactive, flexible open system. That is, in a Safe Mobility system, policymaking is reactive essentially. The process is driven by political decisionmakers and major stakeholders (e.g., key economic interests, important electoral groups). Once the policy has been made, a fundamentally technocratic process occurs in which experts implement policy that has been
defined by the political leaderships. As the system moves toward a Compliant Transportation system, it becomes more open. In this system, transportation agencies attempt to elicit comments and inputs from economic interests, and civic and social groups; however, their involvement is confined fundamentally to the initial stages of the process or carefully, legally defined opportunities. Transportation agencies view this process as disconnected from the rest of the policy process, since inputs are received from the public and little effort is spent on outreach, shaping public opinion, or developing consensus. Furthermore, public involvement is seen as a legal “chore,” rather than a vital part of the policy process. It is something that must be done as part of a legal mandate, rather than to improve policymaking.

### Table 28: Developing Consensus on Needs & Goals under Different Policy Systems

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 Safe Mobility</td>
<td>Driven by political decisionmakers, public, and stakeholders to identify transportation needs—waits for stakeholders to identify demands—once identified public participation limited to formal legally required processes</td>
</tr>
<tr>
<td>Level 1 Compliant Transportation</td>
<td>Attempts to elicit to demands from stakeholders on preexisting plans—allows commentary, but not much vehicle for implementing public feedback. Little outreach or consensus building</td>
</tr>
<tr>
<td>Level 2 Green Transportation</td>
<td>Elicits demands from stakeholders and mandates. Outreach and consensus building occurs.</td>
</tr>
<tr>
<td>Level 3 Sustainable Transportation</td>
<td>Works with stakeholders to identify and prioritize demands—tries to balance out against sustainability goals. Developing consensus is a major goal. Active outreach and consensus building.</td>
</tr>
<tr>
<td>Level 4 TBL Sustainability</td>
<td>Approaches decisionmakers and stakeholders proactively with goals and plans to support transportation needs sustainably. Developing consensus is a major goal. Active outreach and consensus building</td>
</tr>
</tbody>
</table>

In a Green Transportation system, public involvement expands. The system seeks to become responsive to public involvement. Public involvement in the needs assessment process is seen as vitally important and considerable effort is devoted to outreach and consensus building. This expands during the Green Transportation phase; then there is a substantial, continuous effort to involve the public not just in responding to plan, but in helping to develop them, identify and prioritize demands, and work towards a consensus. This climaxes in Sustainable Transportation systems, when all major interests are actively involved in developing goals and trading off between different goals. In doing so, the public and major stakeholders take ownership of these tradeoffs and understand and support the outcomes.

A good example of public participation and consensus building in Green Transportation and the Sustainable Transportation phases is shown in the experience of Boulder, Colorado. During the 1980s, the political and community leadership decided that a new approach to transportation was needed. As a result, the City sponsored a series of planning conferences that brought together citizens, interest groups, and experts to discuss Boulder’s transportation needs. These conferences involved more than 70 stakeholder groups, including the Sierra Club,
PLAN-Boulder County (PBC), Environmental Defense League, Chamber of Commerce, League of Women Voters, and numerous community and neighborhood groups. The result was a new Transportation Master Plan (TMP) that had the main goal of shifting 15 percent of single occupancy vehicle (SOV) trips to other modes by 2010. The broad consensus reached during these conferences and the practicality of the approach adopted meant that these goals were largely achieved (Project for Public Spaces, Inc., 1997); (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010).

It should be stressed that this form of citizen participation in identifying needs is not limited to the initial stages of the planning process, but can be carried on throughout the implementation process to encourage support for and implementation of transportation policies. For example, Seattle has been very successful in implementing traffic circles by involving the public in their siting and maintenance. The City of Seattle invited neighborhood residents to analyze their street problems. It provided them with the technical assistance to conduct these analyses and then encouraged them to submit a proposal if they found that traffic circles would be a useful response to their problems. Once a traffic circle was constructed, the City solicited volunteers from the local community to maintain the traffic circle as a garden spot and provided them with tools, plants, and soil to maintain it (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010). Similarly, the City of Portland, Oregon, has engaged citizens in a repair process. The City has adopted a number of citizen-organized intersection repair and renovation groups. These groups responded to declining pedestrian conditions at local intersections by repairing and improving these intersections on their own. The City adopted their efforts, changed policy to respond to their needs and involved them in the planning and improvement process. As a result, citizens now organize local celebratory events around intersections, decorate public intersections, and agree to support ongoing maintenance with their own labor (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010).

Another characteristic of the Green Transportation and Sustainable Transportation systems that transportation agencies move beyond being either technocratic managers of public demand or passive responders to politically articulated demands to becoming active in defining and developing public demands and requirements. This helps build a constituency for sustainability. Elder and Georghiou note that there are many tools available to the public sector to create and manage demand for specific policies and services (Elder & Georghiou, 2007). These include leveraging public procurement, direct provision of financial incentives to support certain behaviors, awareness building, competence building, information provision, and regulatory interventions. For example, tax incentives to adopt electric vehicles are likely to create increasing market pressures for charging stations and lead to increasing demands on government to adopt policies that encourage the provision of charging stations. Thus, correctly designed public policy can create a “virtuous circle,” where initial “nudges” towards a socially desirable behavior can lead to demands for further governmental action that will reinforce and encourage that behavior.
The news media relentlessly criticized Portland’s light rail transit (LRT), known as the Metropolitan Area Express (MAX), during its planning and construction; however, the system has become such a success, that arguments about building extensions have ceased. Now, these communities argue over which should receive an extension (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010). Thus, initial public investment and communication made the public more aware of the benefits of sustainability and led to expanded demands for sustainable transportation. In terms of sustainability initiatives, the point is (1) to recognize that government can act to shape and define demand; and (2) that all initiatives (e.g., regulation, procurement, and outreach) need to be part of an overall strategy to build support for sustainability policymaking.

4.3.5 Functions: Planning and Programming

Table 29 shows how planning and programming evolve through numerous changes from Safe Mobility to TBL Sustainability. During Safe Mobility, the system focuses fundamentally on the development of one mode (the automobile) and emphasizes quantity and mobility (more roads, faster transportation). Planning follows anticipated travel demands and a “predict and provide” mind-set, where travel demand is forecasted and then plans are made to provide transportation to meet that demand. Transportation planning is siloed from other governmental functions and is not linked to land-use decisions. Performance measures and metric systems are confined to specific transportation-related metrics and do not attempt to capture the broad social and economic impacts of the transportation policies. Furthermore, transportation planning is limited to a single jurisdiction. Regional or megaregional planning and programming are extremely limited, and the extra-jurisdictional impacts of plans are not considered.

**Table 29: Planning and Programming under Different Policy Systems**

<table>
<thead>
<tr>
<th>Level</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>• Emphasizes mobility, safety, and quantity (more, faster)</td>
</tr>
<tr>
<td>Safe Mobility</td>
<td>• Emphasizes one mode (unimodal, automobility)</td>
</tr>
<tr>
<td></td>
<td>• Expands to response to travel demand (“accept and accommodate”)</td>
</tr>
<tr>
<td></td>
<td>• Transportation planning is siloed and disconnected from environmental, social,</td>
</tr>
<tr>
<td></td>
<td>and other planning areas</td>
</tr>
<tr>
<td></td>
<td>• Transportation planning is not connected to land-use decisionmaking</td>
</tr>
<tr>
<td></td>
<td>• Plans, builds based on forecasts of likely demand (predict and provide)</td>
</tr>
<tr>
<td></td>
<td>• Limited by political jurisdiction</td>
</tr>
<tr>
<td></td>
<td>• Limited data and related performance measures to support current planning</td>
</tr>
<tr>
<td></td>
<td>goals, objectives, and investment decisions</td>
</tr>
</tbody>
</table>
### Level 1: Compliant Transportation
- Emphasizes mobility, safety, and quantity (more, faster)
- Emphasizes multimodal and connections between modes
- Expands to respond to travel demand
- Transportation planning is siloed and disconnected, but considers environmental, social, and other planning areas
- Transportation planning is not connected to land-use decisionmaking
- Plans, builds based on forecasts of likely demand (predict and provide)
- Limited by political jurisdiction
- Limited data and related performance measures to support current planning goals, objectives, and investment decisions

### Level 2: Green Transportation
- Emphasizes mobility, accessibility, safety, and quantity (more, faster), but considers flexibility, accessibility, connectivity, system efficiency, and quality (closer, better)
- Emphasizes multimodal and connections between modes
- Manages transportation and mobility demand
- Formal and informal links exist between other planning entities in other governments (e.g., local, regional and federal) and agencies (e.g., environment)
- Plans, builds based on forecasts of likely demand (predict and provide)
- Limited by political jurisdiction
- Compliance-based reporting

### Level 3: Sustainable Transportation
- Emphasizes flexibility, accessibility, connectivity, system efficiency, safety, security, and quality (closer, better)
- Emphasizes multimodal and connections between modes
- Manages transportation and mobility demand
- Uses analysis to interrupt and reverse tends
- Works from preferred vision to planning and provision (deliberate and decide)—build scenarios, backcast, deliberate, and decide
- Planning and investment decisions are driven by reliable and up-to-date data that reflect full range of impacts from investing in transportation

### Level 4: TBL Sustainability
- Emphasizes flexibility, accessibility, connectivity, system efficiency, safety, security, and quality (closer, better)
- Emphasizes multimodal and connections between modes
- Manages transportation and mobility demand
- Emphasizes integrated planning combining transportation (all modes) with other relevant areas (environment, demographic trends, cultural resources) and levels of government
- Uses analysis to interrupt and reverse trends (predict and prevent)
- Works from preferred vision to planning and provision (deliberate and decide)—build scenarios, backcast, deliberate, and decide
- Flexible regional focus that engages multiple jurisdictions
- Planning and investment decisions are driven by reliable and up-to-date data that reflect full range of impacts from investing in transportation

As the system evolves, there are slow, gradual changes. At first, formal and informal links are built with other agencies and planning entities (e.g., local governments, other modal authorities, MPOs) to coordinate planning under Compliant Transportation and Green Transportation. By
Sustainable Transportation, a new approach to planning has emerged. Under this approach, the system now emphasizes flexibility, accessibility, connectivity, and quality (closer, better); emphasizes multiple modes and connections between modes; manages transportation and mobility demand; uses analysis to interrupt and reverse trends; works from preferred vision to planning and provision (“deliberate and decide”) – in particular, building scenarios, backcast; and makes planning and investment decisions using reliable and up-to-date data that reflect the full range of impacts from investing in transportation.

In terms of planning itself, TBL Sustainability requires a change in the specific techniques, time-horizons, and disciplinary expertise used. For example, Table 30 shows that the mechanics of the planning process needs numerous changes to incorporate sustainability.

Table 30: Planning Techniques and Requirements

<table>
<thead>
<tr>
<th>Planning Element</th>
<th>Policy Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Green Transportation</td>
</tr>
<tr>
<td>Time scale</td>
<td>10-15 years</td>
</tr>
<tr>
<td>Time frame</td>
<td>Static</td>
</tr>
<tr>
<td>Spatial orientation</td>
<td>Single jurisdiction</td>
</tr>
<tr>
<td>Disciplinary focus</td>
<td>Transportation engineering</td>
</tr>
<tr>
<td>Data</td>
<td>Quantitative</td>
</tr>
<tr>
<td>Approach</td>
<td>Reactive, Predict and Provide</td>
</tr>
<tr>
<td></td>
<td>Deliberate and decide</td>
</tr>
</tbody>
</table>

Adapted from: (Zuidegeest, Witbreuk, & van Maarseveen, 2000)

In terms of the break between “predict and provide” /“accept and accommodate” and “deliberate and decide” /“predict and prevent,” there are a number of tools that are available to help decisionmakers move toward a more sustainability-based system. For example, scenario planning and backcasting have been found to be useful tools for sustainability planning, (Schiller, Preston; Bruun, Eric C.; Kenworthy, Jeffrey R., 2010). Backcasting is especially useful, because it starts with defining a desirable future and then works backwards to identify policies and programs that will connect the future to the present. It treats the future as the past and asks, “If we want to attain a certain goal, what actions must be taken to get there?” Figure 13 shows the difference between forecasting and backcasting. By separating policymakers from the present, the technique allows policymakers to free themselves from developing a vision of the future limited by today’s realities, and forces them to think into the future and then work backwards to identify the route to get there. This technique has been used in a number of sustainability initiatives. For example, the Capital Regional District Water Services, which services the greater Victoria area in British Columbia, Canada, committed to backcasting to the year 2050 as a formal element of all future strategic water planning initiatives.
4.3.6 Functions: Budgeting and Resource Allocation

Table 31 shows the evolution of budgeting and resource allocation systems under different policy systems. The process evolves from a fundamentally antagonistic, competitive system that is highly siloed and inflexible, and ignores larger social costs, to one that is integrated, flexible, and incorporates the full social, economic and environmental costs. It should be noted that states and localities operate under different budgetary rules and processes. In fact, there are over 85,000 governments in the United States, including the Federal Government, 50 state governments, and local governments. Generalizations become difficult when one discusses any government function and its variations. A true analysis of how all these systems must change to support sustainability would require an extremely detailed analysis. This is beyond the scope of this report. As such, we have concentrated on key indicators of changes and identified specific techniques that might be useful in moving toward sustainability.

Table 31: Budgeting and Resource Allocation under Different Policy Systems

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Level 0 Safe Mobility | • Budget process is competitive (e.g., agencies compete for funds), siloed and driven by previous allocation decisions (e.g., last year’s budget is always the template)  
• Ignores larger social, regional, and economic costs and benefits of transportation—focuses on immediate cost benefit analysis  
• Inflexible—funds are bucketed and segregated by legal requirements  
• Politicized—Transportation funding is driven by prevailing trends in politics |

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16 See (Head & Sigritz, 2008). This document describes all the budgeting process in the 50 states and District of Columbia.
### Table 32: Regulation and Rulemaking under Different Policy Systems

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 Safe Mobility</td>
<td>• Expert-led&lt;br&gt;• Heavily influenced by organized interests and economic stakeholders&lt;br&gt;• Minimal public involvement</td>
</tr>
<tr>
<td>Level 1 Compliant Transportation</td>
<td>• Expert-led&lt;br&gt;• Heavily influenced by organized interests and economic stakeholders&lt;br&gt;• Increased public involvement&lt;br&gt;• Highly politicized and conflict-based</td>
</tr>
</tbody>
</table>
Rulemaking refers to the process executive and independent agencies use to create regulations. In general, legislatures first set broad policy mandates by passing statutes; agencies then create more detailed regulations through rulemaking. Transportation is subject to a variety of regulations affecting topics that include safety standards for different modes of transportation and cargo, operational requirements (e.g., speed, maintenance, driver qualification and hours of service, equipment, employee safety and health, transportation of hazardous materials), registration and record keeping, traffic control, and the environmental impacts of transportation. In addition, numerous regulations affect transportation that are not targeted at transportation primarily. For example, due to the importance of transportation as a contributing source of air pollution, clean air regulations affect transportation regularly, while water runoff regulations may affect roadways, because chemicals used to treat roadways may spill into off-road bodies of water. Rulemaking and regulation are major functions of state transportation systems. As promulgators of new regulations and implementers of federal regulations, the states play a key role in the process, and regulation drives a substantial amount state transportation activities. As such, any movement toward sustainability will require major changes in the rulemaking and regulation processes.

This section outlines the current process used in many states, describes the core characteristics of this process in regard to transportation, identifies how this may change under sustainability, and describes the gaps between these states (i.e., current, conventional, and sustainable operations).

Early regulation of transportation began at the state level. Before the emergence of the U.S. DOT and the federal regulatory system, the states were the main actors in transportation regulation.
Initially, state regulation developed out the common law concept of “business affected with the public interest.” With the railroad age, however, state statutory regulation emerged with the development of various “granger laws” to regulate railroad rates and service. In the early 20th century, state regulation played a key role in standardizing U.S. road and car operations, and laid the framework for many succeeding federal regulations. In the later 20th century, the involvement of the Federal Government in transportation meant that many states had to expand their rulemaking activities to develop regulations that met federal requirements and brought their systems into compliance with national standards (frequently under the threat of federal funding loss or inducement for additional funding).

Paralleling these trends was a greater movement at both the federal and state levels toward greater openness and standardization of the rulemaking process. In general, the goal was to open the rulemaking process to the public and affected parties and increase the transparency and accountability of government. In support of this, numerous legislative requirements were established to demonstrate the economic benefits of regulation and to place regulation on a more standardized, predictable, and scientific basis. This legislation follows a number of general principles:

- The agency promulgating to the rule should be able to demonstrate that it has used the administrative discretion granted it by the authorizing statute to create a regulation that processes net economic and social benefits, is informed by the best available information and scientific and technical insight, and explains clearly how the authorizing statute justifies the proposed rule;
- Rulemaking should follow general rules of due process;
- The public should be informed of proposed rules before they take effect;
- The public should have the opportunity to comment on the proposed rules and provide additional data to the agency;
- The public should be able to access the rulemaking record and analyze the data and analysis behind a proposed rule;
- The agency promulgating the regulation should analyze and respond to the public’s comments;
- The agency promulgating the regulation should create a permanent record of its analysis and the process; and
- The agency’s actions may be reviewed by a judge or others to ensure the correct process was followed.

The result was a series of statutes at the state and federal levels that mandated a standardized process for developing and promulgating regulations. In terms of the purposes of this study, a number of key characteristics can be identified for this process:
- **Highly structured legalistic process:** The current rulemaking process is highly structured and legalistic. Regulations emerge from a standardized, routine process that identifies the requirements for each stage of the process and controls the degree of interaction between different actors in the process (e.g., when and where in the process the public and affected parties may be heard). As a result, arguments of regulations degenerate frequently into discussions of the process and whether it has been followed. Furthermore, the openness of the process to the public and affected parties (via the public comment period and the opportunity for judicial review) means that opponents of regulations have numerous opportunities to challenge or influence rules. The result is that rulemaking can often be stymied by numerous efforts to slow down or halt proposed changes and that the structure of the process discourages cooperation and encourages legalistic opposition frequently.

- **Confrontational system:** The regulatory system in the United States is characterized by a high degree of confrontation. During our interviews with transportation agencies, agency staff emphasized that their regulatory actions are often accused of favoring industry, environmental groups, or a particular interest too heavily. Honest debates over regulatory standards can degenerate to name calling and a perception that whatever final decision is made, it has been made in the interest of one party or another. Facing this, agencies tend retreat in process-based decisionmaking, where the justification for the decision becomes that the agency has followed the correct process. This at least provides a rationale for the decision and ensures that the courts support their efforts.

- **Prescriptive and process-based outcomes:** Current regulatory efforts tend to be prescriptive and process-based. That is, they mandate specific actions to be undertaken and describe how they should be undertaken. The rationale for this is that given the complexity of the problems that regulations attempt to address and the natural tendency of affected parties to try to evade regulatory costs, regulations tend to be either overly complex (to specify exactly what regulated parties should do) or overly simplistic (wherein flexible mandates are introduced in an effort to avoid ambiguity). The result is that regulatory compliance costs tend to increase, and further confrontation and resistance are encouraged.

One of the key challenges to this system that TBL Sustainability will require is the development of flexible standards that can consider tradeoffs between different elements of the TBL. This will require regulators to understand the following:

- The opportunities for potential tradeoffs between different regulatory and policy initiatives (i.e., how to establish standards between competing regulations and policy alternatives to achieve optimal sustainability, while not overly burdening regulated parties); and
• The condition of regulated entities in terms of their abilities and opportunities to achieve sustainability goals within the constraints of their budget.

This situation represents a double information asymmetry:

• **Regulatory agencies**: They can understand the necessary big-picture tradeoffs between different regulatory options and potential methods for regulated parties to comply, but lack the information of the specific circumstances of individual regulated parties and the options for compliance they may face.

• **Regulated parties**: These parties (e.g., individual firms, local governments, households, individuals) have detailed information about their individual situation and options for complying with regulations, but lack information on potential innovative methods to comply or how their apparently minor actions may affect the overall sustainability equation when acting collectively.

This occurs often in regulation, but the asymmetry is worsened when sustainability is at issue. For sustainability, the options for compliance, potential tradeoffs, and potential impacts increase exponentially over traditional regulatory problems. One proposed response is to increase the number of voluntary or negotiated rulemakings. Under this system, regulatory agencies and affected parties negotiate voluntary codes of compliance that embrace a wide variety of behaviors and options. Table 33 shows the range of potential voluntary regulatory arrangements and programs that could be used to replace more top-down regulation and rulemaking.

### Table 33: Sample Voluntary Rulemaking and Regulation Arrangements

<table>
<thead>
<tr>
<th>Type of Arrangement</th>
<th>Key Features</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Firm Standards</td>
<td>Unilateral action on dimensions of environmental performance chosen by the firm</td>
<td>3P – Pollution Prevention Pays</td>
</tr>
<tr>
<td>Trade Association</td>
<td>Specific actions or codes of conduct agreed upon by at least a large segment of an industry</td>
<td>Keidanren Voluntary Action Plan, Chemical industry Responsible Care program</td>
</tr>
<tr>
<td>Cross-Industry Efforts</td>
<td>Codes of conduct or commitments designed by industry to address performance across a range of industries</td>
<td>International Chamber of Commerce, Global Environmental Management Initiative,</td>
</tr>
<tr>
<td>Nongovernmental Organization</td>
<td>Voluntary codes of conduct developed by organizations focused on objectives for corporate social responsibility</td>
<td>CERES Principles (Coalition for Environmentally Responsible Economies)</td>
</tr>
<tr>
<td>Type of Arrangement</td>
<td>Key Features</td>
<td>Examples</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Government-Led Voluntary Challenges</td>
<td>Opportunities for firms to take voluntary action and receive</td>
<td>Energy Star SmartWays</td>
</tr>
<tr>
<td></td>
<td>technical assistance in coordinating with other actors, and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>public recognition</td>
<td></td>
</tr>
<tr>
<td>Government-Led Voluntary Agreements (Negotiated Rulemaking “Reg-Neg”)</td>
<td>Contractual agreement, in lieu of regulation or as part of</td>
<td>European Union (EU) voluntary</td>
</tr>
<tr>
<td></td>
<td>regulation</td>
<td>regulatory agreements</td>
</tr>
</tbody>
</table>

The advantage of these systems when applied to sustainability is that they leverage the asymmetries of information inherent in multiplayer, multigoal, tradeoff problems and allow each participant to bring his or her own best information to the process to negotiate or create rules best suited for the situation.

The experience of such programs is mixed. In some cases (e.g., EPA’s Energy Star program), they have achieved substantial benefits. In others cases, critics accuse regulatory agencies of becoming captured by their regulatory community. In general, the evidence suggests that these voluntary or negotiated programs work best in the following situations:

- **Benefits symmetry:** Compliance is in the best interests of all parties and substantial gains can be demonstrated to be achieved by all major parties;
- **Threat of regulation:** Agreement on meaningful behavioral changes seems to occur when there is a real or perceived threat of a “worst” outcome from unilateral government regulation—the more realistic and draconian, the greater the willingness to compromise;
- **Mutually supported asymmetries of information:** When all parties have knowledge and information that will benefit the others (as is typically seen in complex technical problems where there is no single “right” answer and a number of “about right” answers), agreement over goals and process occurs most likely in the form of a meaningful exchange of information;
- **Culture of cooperation:** Systems with a high degree of cooperation (or few large actors that dominate the regulatory community) promote voluntary rulemaking (e.g., there are over 31,000 regulatory agreements in Japan and a far smaller number in the United States); and
- **Preexisting behavioral codes or agreements:** Voluntary programs work best when they build on preexisting agreements (e.g., industry standards, professional ethics) that can then be codified or expanded.

Sustainability appears to have all these characteristics. In the future, it would seem that a greater move to sustainability in transportation may support and move to collaborative, negotiated, or voluntary rulemaking.
To date, the United States has been characterized by a general bias toward voluntary rulemaking for sustainability. For example, a benchmark survey of corporate sustainability programs identified nine major components—energy conservation, renewable energy purchases, LEED building construction, greenhouse gas emissions, production and transportation, supply-chain accountability, product stewardship, solid-waste conservation, and water conservation (The Global Reporters, 2000). All this had been achieved despite the absence of a specific set of federal rules, regulations, or generally accepted guidelines that specify what practices or related requirements are “sustainable.”

Consensus on industry standards has long coexisted with regulations (and in some cases, incorporated in regulations over time), and sustainability seems to be no exception. For example, the U.S. Green Building Council (USGBC) is conducting a pilot project to grant LEED credits for sustainability (including energy savings, water efficiency, and improved indoor environmental quality). Also, ASTM International released a compilation of Standards for Sustainability in Buildings (4th edition), including the Standard Guide for General Principles of Sustainability Relative to Buildings, which describes methods of decisionmaking in “applied sustainability” (real-world sustainability involving cost-benefit tradeoffs). The ASTM standards have been incorporated into (a) the Federal Green Construction Guide for Specifiers, (b) the current public draft of the International Green Construction Code, and (c) the Green Globes sustainability rating system (Bennett A. K., 2011).

This suggests that a more flexible sustainability regulatory system may be developing in the United States as a result of long-term culture change and the demands of customers and suppliers. The emergence of this model suggests that it is possible for Sustainability systems to emerge from the current regulation process to create a more open, flexible regulatory policy.

4.3.8 Functions: Service and Product Delivery

Table 34 shows the evolution of service and product delivery from Safe Mobility to TBL Sustainability. Moving toward sustainability in service and product delivery involves embedding sustainability in every element of the service delivery, from sustainable procurement to service delivery. This means not only organizing transportation to support sustainable transportation and a sustainable society, but also delivering transportation service in a sustainable manner. For example, the District of Columbia’s Department of Transportation sustainability plan incorporates and integrates sustainable practices throughout the department’s work, ranging from office operations to construction and maintenance.

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>• Efficiency and best-value all business processes</td>
</tr>
<tr>
<td>Safe Mobility</td>
<td>• Transportation and mobility performance measured and reported</td>
</tr>
</tbody>
</table>
Paralleling the inclusion of sustainability into business practices, transportation agencies would need to develop a series of indicators to measure and manage sustainability. To date, this is where most agencies have focused their attention (Georgia Tech Research Corporation, 2011). In fact, states and local transportation agencies are in many ways the leaders in this area, thus, further progress will be able to build on a solid basis of achievement.

### Functions: Compliance and Dispute Resolution

Table 35 shows the evolution of compliance and dispute resolution from Safe Mobility to TBL Sustainability. In this model, the compliance and dispute resolution process evolves slowly out of a highly politicized, conflicting systems with a dependence on informal brokering of compromises between powerful stakeholders. As the process becomes more law-based and compliance-driven, informal brokering diminishes (but never quite disappears) and is replaced by more formal challenges via the courts. In many ways, this is the state of the current system when dissatisfied groups turn to litigation to slow down or reverse transportation issues that do not favor their interests. Sustainable Transportation and Sustainability models would attempt to minimize these occurrences by depoliticizing policymaking by involving the public in a participatory process and moving toward a “deliberate-and-decide” approach. The idea is to involve as many interests in decisionmaking, allow them to compromise, and take ownership of decisions and thus avoid unresolved issues.

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Level 1 Compliant       | • Ad hoc sustainability initiatives  
                          | Transportation                                                                 |
|                          | • Efficiency and best-value all business processes — some environmental         |
|                          |  and social issues considered                                                    |
|                          | • Transportation and mobility performance measured and reported                 |
| Level 2 Green           | • Sustainability organizations established within agencies                      |
| Transportation          | • Sustainability performance reporting and management                           |
| Level 3 Sustainable     | • Sustainability embedded in all business processes (e.g., procurement, O&M)    |
| Transportation          | • Sustainability performance measured and reported for continual improvement    |
| Level 4 TBL Sustainability | • Sustainability embedded in all business processes (e.g., procurement, O&M) |
|                          | • Sustainability performance measured and reported for continual improvement   |

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Level 0 Safe Mobility | • Highly politicized  
                      | • Informal brokering between powerful stakeholders                              |
4.3.10 Functions: Internal Education, Training, and Culture Change

Table 36 shows the evolution of internal education, training, and culture change from Safe Mobility to TBL Sustainability. The critical elements in this process are to move away from an organization whose key function and self-perception is of an agency that provides transportation services to one that supports an overall sustainable society. This requires changing every element of a transportation agency’s operation. A more diverse workforce must be developed that contains numerous different specialties ranging from transportation engines to ecologists, social scientists, communication experts, and community specialists. Extensive internal education and training needs to take place to educate staff on sustainability issues, practices, and processes that emphasize sustainability. Furthermore, performance standards and promotion criteria need to be changed to reward behavior that supports the sustainability mission of the agency. The overall aim is to develop a culture of sustainability and stewardship in which every individual understands the mission and is committed to achieving that goal in all aspects of his or her work.

Table 36: Internal Education, Training, and Culture Change Compliance under Different Policy Systems

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 Safe Mobility</td>
<td>• Focus on technical specialties (transportation engines) and standards</td>
</tr>
<tr>
<td></td>
<td>• Performance standards and incentives associated with traditional performance measures</td>
</tr>
<tr>
<td>Level 1 Compliant</td>
<td>• Focus on technical specialties (transportation engines) and standards</td>
</tr>
<tr>
<td>Transportation</td>
<td>• Performance standards and incentives associated with traditional performance measures</td>
</tr>
<tr>
<td>Level 2 Green Transportation</td>
<td>• Focus on multidisciplinary workforce – acceptance of flexible standards</td>
</tr>
<tr>
<td></td>
<td>• Commitment to sustainability education, training and internal incentives to be sustainable</td>
</tr>
<tr>
<td></td>
<td>• Emerging culture of sustainability and stewardship</td>
</tr>
</tbody>
</table>
4.3.11 Functions: Outreach and Communications

Table 37 shows the evolution of internal education, training, and culture change from Safe Mobility to TBL Sustainability. A great deal of the discussion on functional changes required to achieve a Sustainable organization has focused on the importance of public outreach and communication. The key element that is useful to emphasize here is the importance of moving from one-way outreach (e.g., “this is what is going to happen”) to more open two-way outreach (e.g., “what do you think? How can we better understand your needs?”). As a policy system moves from Safe Mobility to TBL Sustainability, it needs increasingly to develop an outreach system that encourages and incorporates citizens and affected parties into the decisionmaking and policymaking processes. This will build support for sustainability, ensure that policies address citizens’ and affected parties’ interests, and encourage people to use and gain the full benefit of sustainability-related investments.

<table>
<thead>
<tr>
<th>Policy System</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 Safe Mobility</td>
<td>One-way communication to explain transportation priorities and plans</td>
</tr>
<tr>
<td>Level 1 Compliant Transportation</td>
<td>One-way communication to explain transportation priorities and plans</td>
</tr>
<tr>
<td>Level 2 Green Transportation</td>
<td>One-way communication to explain transportation priorities and plans</td>
</tr>
<tr>
<td>Level 3 Sustainable Transportation</td>
<td>Two-way active engagement and communication between transportation agencies, public, stakeholders and decisionmakers</td>
</tr>
<tr>
<td>Level 4 TBL Sustainability</td>
<td>Two-way active engagement and communication between transportation agencies, public, stakeholders and decisionmakers</td>
</tr>
</tbody>
</table>

4.3.12 Summary of Policy Systems Models

What follows is a series of system model diagrams that summarize the key elements of the policy system models described previously (see Figure 14-Figure 18). We have identified the inputs, key characteristics of the policy community, key players, outputs, and feedback. It should be noted that as the system moves toward sustainability, the feedback loops tends to reinforce and strengthen the trend toward sustainability. This “virtuous circle” is an important
dimension of sustainability that has been noted in many instances when sustainability initiatives have been launched. For example, Portland’s sustainability initiatives were launched in the mid-1970s. Their success led to more support for sustainability, which spread to more cities in Oregon. Finally, this led to the development of a statewide sustainability program. Stakeholders conveyed a broad consensus that sustainability will require substantial culture change, both within agencies and with public and state leaders. In addition, the current fiscal and economic climate means that many agencies lack state support to engage in new initiatives. In general, stakeholders felt that there was a need to sell sustainability as way to save money and as a more efficient means of delivering service. In particular, there was a need to change the mindset of some transportation agency staff away from focusing on the traditional level of service (LOS) and transportation as an end in itself, toward how transportation will improve community life and meet community needs. As such, stakeholders felt there was a need for new return-on-investment (ROI) tools that could develop the business case for sustainability and communicate its value as a common-sense initiative.

One of the major challenges that stakeholders felt existed with sustainability was the need to create new planning and implementation processes or entities that would manage transportation across multiple jurisdictions. This would require huge changes and would be difficult to achieve unless the Federal Government offered some financial incentive to cooperate. In addition, many stakeholders doubted the benefits of relying on foreign models to build support for sustainability, believing that their political, economic, and institutional systems were too different, and that only strong leadership, targeted outreach to key communities and interest groups, and public support could bring about change.

Recently, several state DOTs have already begun to move away from the traditional LOS. For example, in response to a perceived lack of confidence from stakeholders, limited funding, employee turnover, and political pressure to outsource, the Louisiana Department of Transportation and Development (DOTD) began to change its culture and adopted a new five-pronged approach. First, it developed tools to demonstrate the ROI of any proposed change and identified changes that would improve performance and service delivery. Second, it engaged the department head as the chief sponsor of the initiative. He communicated forcefully that this was a “change-or-die” situation requiring maximum commitment. Multiple communication initiatives were launched to demonstrate the need for change, explain the rationale and proposed changes, and how people could participate in the change. The program focused on quick-wins, claiming low-hanging fruit and building momentum for change.

Some governments have attempted institutional change through massive public participation programs. In western Australia, the City of Perth provides an example of this process in action. In 2003, it began a broadly based consultation process to create a vision of the city. This process coalesced citizens, business groups, and more than 42 government departments to create a vision of Perth in 2030. As part of this exercise, a household survey was conducted of more than
1,700 households and 1,000 citizens participated in a one-day planning forum. Forum participants were grouped in teams of 10 and given a particular transportation problem. Each team was tasked with finding solutions to problems city planners faced involving sustainability, mobility, and economic growth. The result was a consensus plan known as “Network City,” which was endorsed by all major interests involved. One of its major goals was to have 60 percent of all new construction be a part of a car-free, sustainable network of transportation.

Figure 7 shows two alternative models that the research team generalized from the literature review for building support for sustainability initiatives.
Figure 14: Safe Mobility (Level 0) Policy System Model

**INPUTS**

- **Resources:**
  - Gas tax, excise taxes, impact and licensing fees
  - Intergovernmental transfers
  - Bond issues
  - Some user fees (e.g., toll roads)

- **Demands:**
  - Mobility
  - Safety
  - Economic development

**POLICY SYSTEM**

**TRANSPORTATION POLICY COMMUNITY**

- **Organizing Principles:**
  - Support Societal Mobility
  - Favors government ownership and control of the transportation infrastructure
  - Transportation agency
  - Infrastructure Owner-Manager and Regulator

- **Key Actors Include:**
  - State Government Executives and Legislators
  - US DOT
  - State DOTs
  - Local Governments
  - Economic Interest

**OUTPUTS**

- Increase spending on road building (focus on construction)
- Spending and policy focused on Interstate development and suburbanization

**FEEDBACK**

- Development of Interstate system
- Rapid suburbanization
- Decline in inter-city rail
- Decline in public transit

- Increasing requirements for O&M
- Increasing demands for more road building to relieve congestion
Figure 15: Compliant Transportation (Level 1) Policy System Model

**INPUTS**

- **Resources:**
  - Gas tax, excise taxes, impact and licensing fees
  - Intergovernmental transfers
  - Bond issues
  - Some user fees (e.g., toll roads)

- **Demands:**
  - Mobility
  - Safety
  - Economic development
  - Environmental compliance
  - Other (e.g., heritage and culture protection)
  - Public participation

**POLICY SYSTEM**

- **Transportation Policy Community**
  - Organizing Principles:
    - Support Societal Mobility
    - Compliance with Environmental, Economic and Social Legislative Requirements
    - Transportation agency Infrastructure Owner-Manager and Regulator
    - Top-down, planning

  - **Key Actors include:**
    - State Government Executives and Legislators
    - US DOT and other Federal Agencies
    - State DOTs
    - Local Governments
    - Interest groups
    - Economic Interests

**OUTPUTS**

- Increase spending on road building (focus on construction)
- Spending and policy focused on roads – O&M major concern

**FEEDBACK**

- Continuing road expansion
- Rapid suburbanization
- Decline in inter-city rail
- Decline in public transit
- Increasing time and resources for compliance
- Increasing requirements for O&M
- Increasing demands for more road building to relieve congestion
Figure 16: Green Transportation (Level 2) Policy System Model

**INPUTS**

- **Resources:**
  - Gas tax, excise taxes, impact and licensing fees
  - Intergovernmental transfers
  - Bond issues
  - Some user fees (e.g., toll roads)

- **Demands:**
  - Mobility
  - Safety
  - Economic development
  - Environmental compliance
  - Other (e.g., heritage and culture protection)
  - Public participation

**POLICY SYSTEM**

**TRANSPORTATION POLICY COMMUNITY**

**Organizing Principles:**

- Support Societal Mobility and Environmental, Economic and Social Needs -- **Emphasizes Environment**
- Transportation agency Infrastructure Owner-Manager and Regulator

**Key Actors include:**

- State Government Executives and Legislators
- US DOT and other Federal Agencies
- State DOTs
- Local Governments, MPO, RPO
- Interest groups
- Economic interests

**OUTPUTS**

- Road still spending dominant but increasing spending on transit, rail and multimodal
- Focus on preservation of existing infrastructure and prioritization of investments
- Improved environmental compliance

**FEEDBACK**

- Revival of public transit
- Growing support for sustainability
- Increasing demands for alternatives to roads to relieve congestion
Figure 17: Sustainable Transportation (Level 3) Policy System Model

**INPUTS**
- **Resources:**
  - Gas tax, excise taxes, impact and licensing fees
  - Intergovernmental transfers
  - Bond issues
  - Substantial use of user fees and market mechanisms
- **Demands:**
  - Sustainability (TBL)
  - Mobility
  - Safety
  - Accessibility
  - Connectivity
  - System efficiency
  - Public participation

**POLICY SYSTEM**
- **Transportation Policy Community**
  - Organizing Principles:
    - Support Sustainable Transportation
    - Favors partnerships between public and private sector
    - Infrastructure Coordinator (some owner-operator and some private) and Regulator
  - Key Actors include:
    - State Government Executives and Legislators
    - US DOT and other Federal Agencies
    - State DOTs and other Agencies
    - Local Governments, MPO, RPO
    - Interest groups
    - Economic interests
    - Citizens groups

**OUTPUTS**
- Road still spending dominant but increasing spending on transit, rail and multimodal
- Increasing support for alternative transportation modes (e.g., walking, biking) and alternative fuel vehicles (AFV)
- Substantial coordination with local governments, other modal authorities
- Focus on preservation of existing infrastructure and prioritization of investments — increasing reuse and refocusing of older transportation assets to new purposes
- Improved environmental, social (e.g., heritage, equity) compliance

**FEEDBACK**
- Growth in public transit, alternative modes and AFV
- Greater coordination between...
4.4 CURRENT POSITION OF TRANSPORTATION AGENCIES AND GAP ANALYSIS

Table 38 shows the current position of transportation agencies and other entities vis-à-vis the different policy system models identified and described previously. Additional follow-up tables at the end of this chapter summarize ratings for specific groups on different functions. Most states are between the Safe Mobility system (Level 0) and the Compliant Transportation system (Level 1). Specifically, many of the leading states have gone beyond simple compliance and moved into a more “green” system, where they have developed numerous internal initiatives to support sustainability practices, expanded participatory policymaking practices, and developed advanced sustainability indicator and planning systems. None has yet developed a Sustainable
Transportation model or true TBL Sustainability. Similarly, federal agencies are emphasizing compliance, internal standards, and performance metric development and culture change.

Table 38: Current Position of Different Organizations and Sectors vis-à-vis Sustainability Models

<table>
<thead>
<tr>
<th></th>
<th>Sustainability Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>States</td>
<td></td>
</tr>
<tr>
<td>Leading Localities</td>
<td></td>
</tr>
<tr>
<td>Leading Non-Use Examples</td>
<td></td>
</tr>
<tr>
<td>Private Sector</td>
<td></td>
</tr>
<tr>
<td>Federal Government</td>
<td></td>
</tr>
</tbody>
</table>

To date, Sustainable Transportation (Level 3) models have been seen only at the local and international levels. This is for several reasons. First, localities and other major countries have great authority over land use and other issues that are critical to sustainable transportation. For example, the success of Portland, Oregon; Seattle; and Vancouver are due partly because they have the ability to control land use via zoning, and have authority over or are able to influence all modes of transportation in their jurisdiction. In contrast, most state transportation agencies control only the state highway system and have limited influence over other modal agencies and no control over land use.

Second, transportation is a regional or local issue inevitably. Its impacts are always keenly felt at a local level. Transportation problems, such as congestion, are felt first at a local level and the pressure to respond to them is first attempted at the same level. States are generally larger and more diverse than the local levels. A transportation problem in one part of the state may not be experienced in another part of the state, and there will be little statewide political support to address this problem. As such, localities (and possibly smaller states with highly concentrated populations) are the first to address problems.

Third, localities often have access to additional resources to address sustainability issues. Due to the two issues identified above (local versus state government powers, and concentrated versus
distributed transportation problems), it is easier for local governments to develop a coalition around change, gain widespread support for the change, and then develop the local solutions (e.g., transit) to respond, than it is for more diverse states. Furthermore, as cities can build supportive coalitions from individuals that experience transportation problems directly, they are more likely to gain their support for bond issues, user fees, or increases in local taxes. For example, in Northern Virginia, special local districts were established in 2010 to levy a special tax on retail businesses to support the expansion of the Washington, DC metro system. This was after the state had failed to provide funds, because it was viewed as a project that benefited only one part of the state.

Finally, the analysis of local sustainability leaders suggests that rich cities and localities are much more likely to support sustainability than poor cities. We have found no examples of economically distressed cities and localities that have developed advanced sustainability initiatives. Without exception, they tend to be richer, rapidly growing cities, such as Portland, Seattle, Boulder, and New York. Sustainability is expensive, and for an economically depressed city, it may seem the least of its problems. Similarly, for states currently experiencing major fiscal downturns and with a range of diverse economic conditions existing within their borders, sustainability often takes a back seat to more pressing issues.

For all these reasons, cities and local governments are the leaders in sustainability. States, despite considerable progress, still lag behind. For them to catch up to cities, they would have to change a number of key factors. Critically, they would have to build a coalition within the state to support sustainable transportation. Local governments provide numerous examples of how this could be done; however, the proximity of the local governments to citizens makes it much easier for them to develop support. This suggests that one model for building sustainability at the state level may be to build sustainability from the ground up. For example, according to the interviews conducted for this project, southeast Florida’s regional partnerships found themselves blocked by unresponsive leadership at the state level and began to develop coalitions to pursue their own transportation and sustainability initiatives. These islands of sustainability can expand gradually to include more communities and eventually reach a tipping point when sufficient political support has been built to change overall state policy.

The following chapters review how transportation might be able to change and advance beyond Sustainable Transportation in the future.
5. SCENARIO DEVELOPMENT METHODOLOGY

5.1 BACKGROUND

Transportation agencies face growing uncertainty. Changing state and federal budget priorities, potential major regulatory changes related to greenhouse gas (GHG) emissions, and major technology change (e.g., connected vehicles, high-speed rail) mean that state transportation executives are increasingly uncertain about the future (American Association of State Highway and Transportation Officials, 2010). In particular, these issues are likely to affect the organizational principles around which state transportation agencies are established.

These challenges are even greater when long-term perspectives are required from transportation decisionmakers, such as that necessitated by a commitment to sustainability (i.e., sustainability requires that decisionmakers consider the impact of their transportation decisions on future generations’ ability to support and sustain their society). Specifically, shifting demographics, disruptive technologies, major statutory and regulatory changes, increasing environmental stress, and uncertainty about the future distribution and rate of economic growth all mean that traditional organizations will be challenged to find new operating principles (Friedman G., The Next Decade: Where We’ve Been...and Where We’re Going, 2011); (Friedman G., The Next 100 Years: A Forecast for the 21st Century, 2010); (Friedman T. L., Hot, Flat, and Crowded 2.0, 2009); (Friedman T. L., The World Is Flat 3.0: A Brief History of the Twenty-first Century, 2007). Traditional input-output planning models have been of little value in helping agencies navigate environments characterized by a high degree of uncertainty (Shoemaker, Scenario Planning: A Tool for Strategic Thinking, 1995) (Shoemaker, Disciplined Imagination, 1997) (Shoemaker & Gunther, Profiting from Uncertainty: No Matter What the Future Brings, 2002) (van der Heijden, 2005) (Schwartz, 1991). Instead, scenario planning has emerged as a means to help analysts and decisionmakers envision the different requirements that organizations will have to address in the radically different future conditions (often referred to as “future worlds”) (American Association of State Highway and Transportation Officials, 2010).

Scenario planning helps organizations look into the future and anticipate events and trends, understand risk, provide ideas for preemptive organizational response, and help managers break out of their established mental models as they become aware of alternative future possibilities. A scenario is a set of related possibilities that describe one possible future that the strategist cannot control. Although there is no consensus on the definition or approach to scenario planning, typically, a scenario is a rich narrative or story describing a possible outcome (Schwartz, 1991). Despite the difficulties in defining scenarios or developing a single approach to scenario development, there is a clear consensus that scenarios are not
predictions (van der Heijden, 2005). Instead: “Scenarios are consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past present and future developments which can serve as a basis for action” (van Notten P., 2005).

Scenario planning has a long history, dating back to its roots in 19th century military operational planning. In the 20th century, interest in scenario planning reemerged in the work of the RAND Corporation and the writings of Herman Kahn (Kaplan, 1991). Essentially, Kahn’s approach was to develop three basic scenarios: (1) the most likely or baseline case; (2) a worst-case scenario; and (3) a best-case scenario. By the 1960s, the scenario planning approach was moving beyond the worst-case/most-likely/best-case paradigm to consider more open-ended alternative futures. In large part, this was because the simple, linear, single-dimension approach to scenario development was well suited to military planning (where originally outcomes were anticipated to occur as a single event, with a single, logical, short-term and long-term chain emerging from that event), but was hopelessly limited when facing the ambiguous and open-ended environment of government and business (Michel & Roubelat, Creating the Future: The Use and Misuse of Scenarios, 1996); (Michel & Roubelat, Scenario Planning: An Open Future, 2000).

General Electric and Royal Dutch Shell pioneered an alternative approach to scenario planning that was based on the development of a number of different future worlds that were neither “good” nor “bad,” but possible. The goal of this approach to scenario planning was to sensitize management and planning staff to alternative planning assumptions (Diffenbach, 1983). In particular, Royal Dutch Shell’s Group Planning Department, led by Pierre Wack, explored the environment for events that might affect the price of oil. The team identified several issues, including the steady exhaustion of U.S. oil reserves and the expanding role of the Organization of Petroleum Exporting Countries (OPEC), which might demand higher prices for oil, and developed full scenarios for two cases: (1) steady oil prices, and (2) massive oil crisis triggered by OPEC. In October 1974, the second scenario was realized, and Shell was the only major oil company able to respond. Shell’s adept response enabled the firm to move from seventh to first in profitability in the industry (Cornelius, Van de Putte, & Romani, 2005).

The perceived success of the Shell experience led to a sudden increase in the use of scenario planning and an enormous proliferation in scenario planning approaches and goals. Policy theorist Philip Van Notten conducted a detailed analysis of the use of scenario planning in government, industry, and the private sector, and developed a typology that described the range of goals and methodologies. This typology used three broad “macro” characteristics and nine “micro” characteristics.

Macro characteristics addressed the why, how, and what of a scenario exercise (i.e., its goals, the process design, and the scenario contents); micro characteristics described the specific
goals, participants, methodologies, and analytical techniques used to build these scenarios, such as:

- Function of the scenario exercise;
- Role of values in the scenario process;
- Subject area and issues covered;
- Nature of change addressed (discontinuity versus evolutionary);
- Nature of the inputs into the scenario process;
- Methods used in the scenario process;
- Degree of group participation versus model-based analysis;
- Role of time in the scenario; and
- Level of integration of different scenario elements.

From: (van Notten P., 2000)

The result of this analysis is that there is no firm consensus concerning the “correct” approach to scenario analysis, and that the methods are highly context dependent. Thus, the use of specific techniques (e.g., the use of “wild card” — high-impact, low-probability events) in scenario planning exercises is best in tabletop or wargaming/strategic simulation exercises, where decisionmakers explore how their plans and assumptions might be disrupted by unexpected, high-impact events, or in crisis-prone systems, where sudden radical discontinuities can change long-held assumptions and methods of doing business (Rockfellow, 1994); (Petersen, 1999).

In longer-term, society-wide scenario analysis, individual events are less likely to have major long-term effects due to the relative strength of macro-level trends. For example, despite numerous policy changes and major historical and social events, U.S. gross domestic product (GDP) has shown a remarkable stable upward pattern that can be modeled easily as an exponential trend (Figure 19). Furthermore, when U.S. GDP is plotted on a log-scale to smooth out year-by-year fluctuations, an even more remarkable stable growth pattern emerges (Figure 20). In fact, when the entire period from 1870-2009 is considered, despite numerous “wild cards” (e.g., wars, economic fluctuations, policy changes), U.S. real GDP grew at an annual rate of approximately 3 percent.
From a scenario planning perspective, the power of long-term trends suggests that many events are “over-determined,”—there are many drivers that are shaping long-term changes—and that the power of any one event or wild card to affect long-term change is vastly
overrated. This does not mean that individuals or events cannot change the direction of the future; it simply means that their power to disrupt decades-old forces and trends that are the combination of millions of people’s individual acts is limited and that these events or people rarely have truly long-term consequences. While such paradigm shifts do occur (e.g., the shift from rail to car), they are often the result of numerous long-term forces acting on each other (e.g., technology, economic development, national policy shifts, and millions of individual decisions led to the adoption of the automobile).

Paradigm shifts that occur separate from these long-term trends are difficult to identify and, for purposes of this phase of the project (i.e., identify requirements in the shape of challenges and opportunities for Phase II), are of limited value. Thus, for longer-term, macro scenario building, an approach that focuses on long-term powerful social, economic, technological, and geographical factors is more appropriate than considering shorter-term events. Specifically, this approach is more likely to capture the main forces to which individual organizations (such as state DOTs) will have to respond over several decades rather than the day-to-day, year-to-year events that may distract organizational planners from important long-term changes.

This approach is consistent with the FHWA scenario-based planning methodology. The FHWA approach involves six general steps and is a dynamic methodology, allowing transportation planners to generate new scenarios as events occur (see Figure 21: Overview of the Scenario Development Approach). The first step in the FHWA process is to identify driving forces, or macro-level trends. Driving forces are “the major sources of change that impact the future” (Program and Organizational Performance Division, 2010). Commonly used driving forces include local land use, levels of congestion, and local demographics. The second step is to determine patterns of interactions. Determining patterns of interactions between driving forces can be done in a variety of ways. The FHWA recommends that transportation planners use a matrix and develop a metric related to positive or negative outcomes. The third step involves creating scenarios from these matrices by fitting realistic situations to predicted patterns between the driving forces. The FHWA describes the goal of creating scenarios as bringing life to possible alternatives in a way that community stakeholders can easily recognize and connect the various components. The fourth step is to analyze the implications of the scenario. In this step, transportation planners and stakeholders develop potential transportation policies that mesh with the scenarios. Evaluating scenarios is the fifth step in the FHWA’s methodology. FHWA describes a variety of methods, such as using various criteria and presenting the scenarios to community stakeholders (e.g., through a

17 For more discussion of this point see (Thompson, 1978)
decision-analysis session or individual interviews). The sixth and last step is monitoring relevant indicators of the scenario.

5.2 SCENARIO DEVELOPMENT METHODOLOGY

Figure 21 provides an overview of the research team’s approach. The project began with a meeting with the NCHRP Panel to agree on key assumptions, strawman drivers that could affect organizing principles, and the scope of the project. Based on this meeting, the research team conducted an in-depth scan of the current futurist literature, conducted interviews with subject matter experts (SME), held internal SME discussions and panels, and identified a series of drivers that will affect the long-term development of U.S. society and thus affect state transportation agencies’ organizing principles.
Figure 21: Overview of the Scenario Development Approach

1. Establish scope, key assumptions, and review “strawman” drivers and scenarios with the NCHRP Panel
2. Conduct in-depth scan of literature and interviews with SMEs
3. Identify and analyze drivers
   - Driver 1
   - Driver 2
   - Driver 3
   - Driver 4
   - Driver 5
4. Analyze trends and alternative visions of the future
5. Review data, literature, and conduct SME interviews and panels to identify potential range of outcomes
6. Synthesize and integrate drivers to create
7. Review, refine, and revise through discussions, interviews, and inputs from SMEs
8. Finalize scenarios and determine challenges and opportunities for state transportation agencies

Challenges  Opportunities

World 1  World 2  World 3  World 4  World 5
Table 39 presents the drivers the team identified using our approach; Section 4.3 describes each driver in detail. For each driver, the research team established a series of alternative outcomes or stories that described how that driver might evolve or change between 2010 and 2050.

**Table 39: Scenario drivers that will affect organizing principles**

<table>
<thead>
<tr>
<th>Scenario Driver</th>
<th>Definition</th>
<th>Impact on State Transportation Agencies and Organizational Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Factors</td>
<td>The size, distribution, and characteristics (e.g., age, sex, ethnicity) of the U.S. population.</td>
<td>This driver will affect organizing principles by helping to determine travel demand and, indirectly, the resources that are available to transportation agencies.</td>
</tr>
<tr>
<td>Economic Growth and Public Sector Spending on Transportation</td>
<td>Future patterns of economic growth (e.g., GDP, inflation, investment, employment, income growth) and public sector spending (e.g., federal, state, and local) on transportation.</td>
<td>This driver will affect organizing principles by determining the resources that are available for transportation agencies and the level of transportation demand (as generated by economic activity).</td>
</tr>
<tr>
<td>Energy (Includes Transportation Energy Uses and Fuel Prices)</td>
<td>Future changes in energy use and the proportion of energy derived from different sources. Includes the price and fuel sources used, by modes of transportation.</td>
<td>This driver will affect organizing principles by helping to determine travel demand (e.g., via fuel prices and energy availability).</td>
</tr>
<tr>
<td>Climate Change, Environment, and Resource Use</td>
<td>Future changes in the environment (in particular, climate change), resource availability, and resource use.</td>
<td>This driver will affect organizing principles through impacts on environmental resource shocks, travel demand, and state-specific environmental challenges that transportation agencies will face.</td>
</tr>
<tr>
<td>Transportation Technology</td>
<td>The development of future transportation technologies and the degree to which these technologies are adopted by individuals and networks.</td>
<td>This driver will affect organizing principles by determining the transportation options available, travel demand, requirements for investment and capital decisions in the future, and the choices that need to be made.</td>
</tr>
<tr>
<td>Land Use</td>
<td>Population distribution, demographics, land-use patterns, and development factors.</td>
<td>This driver will affect organizing principles through travel demands and the requirements for state transportation agencies.</td>
</tr>
<tr>
<td>Future Transportation System Funding, Operation, and Control</td>
<td>The funding, degree of shared ownership with the private sector, and the centralization/decentralization (i.e., the roles of federal, state, regional, and local governments).</td>
<td>This driver will affect organizing principles via the resources they have; challenges and opportunities caused by shared ownership, and the role of federal, state, regional, and local governments.</td>
</tr>
</tbody>
</table>
Please note, detailed descriptions of each driver, the data and methodology used to develop driver outcomes and additional supporting information can be found in Appendix 1 of this report.

The research team then used a scenario-building technique known as morphological analysis (MA) (Zwicky, Discovery, Invention, Research—Through the Morphological Approach, 1969; Zwicky & Wilson, New Methods of Thought and Procedure: Contributions to the Symposium on Methodologies, 1967). General MA was developed as a method for structuring and investigating the total set of relationships contained in multidimensional, non-quantifiable problems (Ritchey, 2006). Traditional scenario planning emerged as an alternative to formal (mathematical) methods and causal modeling as a form of non-quantified modeling that relied on judgmental processes and internal consistency, rather than on causality. However, scenario planning did not provide any guidelines as to how to place the non-quantifiable dimensions of scenario development on a sound methodological basis.

MA offers a solution to this problem by extending the traditional scenario-planning techniques through a cross-consistency assessment (CCA) approach. CCA is a method for rigorously structuring and investigating the internal properties of inherently non-quantifiable problem complexes, which contain any number of disparate parameters. It encourages the investigation of boundary conditions and virtually compels practitioners to examine numbers of contrasting configurations and policy solutions.

Essentially, general MA is a method for identifying and investigating the total set of possible relationships or “configurations” contained in a given problem complex. In this sense, it is closely related to typology construction, although it is more generalized in form and conceptual range. The approach begins by identifying and defining the parameters (or dimensions) of the problem complex to be investigated, and assigning each parameter a range of relevant “values” or conditions. A morphological box (also known as a “Zwicky box”) is constructed by setting the parameters against each other in an n-dimensional matrix. Each cell of the n-dimensional box contains one specific “value” or condition from each of the parameters, and thus marks out a specific state or configuration of the problem complex.

For example, imagine a simple problem complex, which we define as consisting of three parameters or dimensions (e.g., “color,” “texture,” and “size”). Further, assume that the first two dimensions consist of five discrete “values” or conditions each (e.g., color = red, green, blue, yellow, brown) and the third consists of three values (size = large, medium, small). We...
then have $5 \times 5 \times 3 = 75$ cells in the Zwicky box, each containing three conditions—one from each dimension (e.g., red, rough, large). The entire three-dimensional matrix is a morphological field that contains all of the (formally) possible relationships involved.

For this study the research team identified several different drivers and identified the range of potential values that each driver could take on. The team then considered each potential combination of drivers. Those that did not make logical sense were excluded from further analysis. Those that were included were expanded to form full scenario descriptions for further analysis.

Using this approach, the research team developed a series of scenarios that expressed a number of alternative worlds for 2050. The NCHRP Panel then reviewed and modified slightly the general descriptions of the scenarios. Based on the panel’s comments, the research team conducted detailed research to fill out the scenarios, held interviews with SMEs and futurists, and developed detailed descriptions of the scenarios. Booz Allen SMEs then reviewed these scenarios in an all-day session to validate and review assumptions. These SMEs included transportation planners and experts, transportation technology experts, environmental experts, economists, and individuals who formerly had been state and local transportation officials before joining Booz Allen. These SMEs were supplemented with several academics external to Booz Allen to rule out the potential for organizational biases. Based on their comments, the research team again revised the scenarios and submitted a draft report describing them to the NCHRP Panel. The panel made additional comments, and the research team revised the scenarios to reflect the consensus of the future. These finalized scenarios formed the basis for identifying the challenges and opportunities that different types of state transportation agencies would face in the next 40 years.
6. DESCRIPTION OF SCENARIOS

Using the approach described above, the research team developed five scenarios: Crisis World, Mega World, Suburban World, Wonder World and Green World. In developing these scenarios, there were a number of key assumptions made:

### Key Assumptions, Caveats, and Limitations for All Scenarios

- All scenarios assume that there will be no major international major war involving the US, social and/or economic collapse, or technological singularly (i.e., extremely rapid convergence of technologies leading to a huge acceleration of technological progress and economic growth).
- All scenarios include some reference to major economic and social trends (e.g., population, economy) and follow anticipated trends with minor variations. In these cases, the research team uses simple projections to portray the future direction of events. The scenarios vary from each other by using other drivers, including environmental change, fuel prices, social/cultural choices, market and individual responses, and technological change.
- Scenarios are not simply driven by technology. Technology will play an important part in the future of the U.S. transportation system, but many factors will affect the rate of technology adoption and how current and future technologies are integrated into future transportation systems. As a result, the team included low adoption and high adoption technology scenarios.
- No single scenario will happen everywhere across the country in the same way. There will always be variations and differences—some areas, even in the most negative scenarios, will experience extremely positive futures; some areas in positive scenarios will experience extremely negative futures.
- Scenarios should reflect a variety of different situations that are sufficiently dissimilar to be able to show meaningful variances. As a result, the research team includes a “less-than-credible” scenario (e.g., Crisis World) to contrast the different potential outcomes.
- Scenarios focus on implications for transportation systems, organizing principles for state DOTs, and challenges and opportunities for state transportation agencies.
- Scenarios emphasize challenges and opportunities to all dimensions of sustainability—environmental, economic, and social/cultural.

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18 Note: in the early stages of the project, the research team identified two negative scenarios (Crisis World and Dirty World). Dirty World was identical to Crisis World apart from the assumption that Dirty World experienced no major environmental crisis. Based on comments received from the NCHRP Panel, Dirty World was dropped as a scenario because it was thought to be too similar to Crisis World.

19 For a full description of what is envisioned under a “singularity” scenario see: Garrean, J., 2005, Radical Evolution, Doubleday; Kurzweil, R., 2006, Singularity is Near, Penguin.
Scenarios are not intended to make “political” assumptions or policy recommendations. These descriptions attempt only to convey plausible business environments for transportation agencies.

In terms of negative scenarios, the research team developed a very negative scenario, Crisis World, in which slow economic growth, rapid environmental degradation, and slow technology improvement combine to create a world where the United States faces a series of crises that place considerable stress on the transportation system and the ability of state transportation agencies to meet basic transportation needs.

The research team developed two mid-range scenarios: Mega World and Suburban World. Mega World is essentially a continuation of current trends. Population and the economy grow as anticipated by most mainstream analysts, and technology improves in a predictable manner. Environmental change and resource use is manageable and there are gradual manageable improvements in environmental conditions and resource use. The main difference of between this scenario and the other mid-range scenario, Suburban World, is that population becomes increasingly concentrated in megaregions; thus creating major problems for governance and inter-governmental coordination.

Suburban World is identical to Mega World in every respect except for the distribution of population. Under Suburban World, technological and sociocultural changes allow the population to become more evenly distributed. Small towns and mid-range cities grow and suburban and exurban areas around cities continue to grow. As a result, there is a “rural renaissance” during which the United States comes to resemble the early 20th century in terms of population distribution.

The research team identified two positive scenarios: Wonder World and Green World. In Wonder World, technological change is rapid and produces dramatic economic growth. The United States remains a dynamic, fast-growing country with a diverse, youthful population from immigration. Environmental stressors are minor and are easily dealt with by technology and abundant resources. The major challenge that state transportation agencies face is keeping up with technological change and managing the transitions to new forms of mobility.

In Green World, there is a fundamental reorganization of society toward a more sustainable and environmentally benign form of operation. Spurred by new green technology, the economy grows rapidly while dramatically reducing environmental and resource stressors. Population is decentralized into relatively small communities and highly centralized urban cores. State transportation agencies face considerable challenges in transitioning the existing transportation systems to a more sustainable system, but are assisted by a public which eagerly supports the “greening” of infrastructure.
Below, for each scenario the research team summarizes key drivers for that scenario, and provides a “Scenario Story” that dramatizes the situation, providing background and helping readers grasp the world and the opportunities and challenges for state transportation agencies. As noted above, for more detail on the drivers and the assumptions used to develop these scenarios, see Appendix 1.

**Crisis World**

Crisis World, the most pessimistic scenario the research team developed, is a world undergoing a persistent, recurrent, multi-dimensional crisis (see Table 40). Under this scenario, environmental crises and resource depletion are occurring much sooner and more quickly than currently anticipated, while the United States is trapped in an unrelenting, ongoing economic recession where growth rarely rises above 2 percent. As a result, the United States is under considerable stress and lacks the resources to respond to the challenges it encounters. The stresses and strains of the Crisis World scenario lead people to begin to change how they live and to move to more sustainable ways of living in response to environmental, economic, and rapidly increasingly resource prices. In the public sphere, these trends and the seriousness of these problems lead to a new public commitment toward sustainability and toward creating transportation systems that support a sustainable society.

<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>• Low economic growth and recurrent crisis leads to slow population growth – 399 million</td>
</tr>
<tr>
<td>Economic Growth</td>
<td>• After 2020, GDP falls by 8 percent over the next 30 years over the low-growth projected case.</td>
</tr>
<tr>
<td></td>
<td>• Spending on transportation for federal, state, and local governments stays at the historic average of just under 2 percent of GDP</td>
</tr>
<tr>
<td>Climate Change, Environment</td>
<td>• Dramatic, worst-than-expected climate change – multiple acute events (e.g., floods, heat waves, worsening hurricanes and storm surges)</td>
</tr>
<tr>
<td>and Resource Use</td>
<td>• Major resource shortages – gas prices in excess of $9/gallon for long periods with huge fluctuations in price</td>
</tr>
<tr>
<td></td>
<td>• Petroleum and carbon fuel remain an important source of fuel</td>
</tr>
</tbody>
</table>

Please note, in order to facilitate discussion, for the tables in this chapter we have collapsed a number of drivers into a smaller number of drivers (e.g., “transportation” includes transportation technology (vehicles and infrastructure) and potential organization of transportation agencies.

An “acute event” is a sudden, unplanned negative event that can cause serious harm to human health, the environment, economic resources, or items of historical, cultural or social value.
<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
</table>
| Transportation | • Transportation technology does not deliver – no major breakthroughs, new transportation technologies remains too costly for widespread adoption  
• MPO and megaregional organization dominates transportation planning and management  
• Federal government highly involved in emergence resources -- |
| Land Use and Distribution of Population | • Population concentrated in megaregions  
• Mix of megacities and suburban sprawl continue |

**Scenario Story - How the World Might Change: Crisis World**

After the financial crisis of 2008, the initial optimism for a 2012-2013 recovery stalled. The U.S. economy failed to recover to its previous dynamism. As analysts debated the causes of the so-called “Long Recession” of 2010 to 2050, debt overhangs, long-term structural deficits, dramatic increases in resource prices, and a collapse in global demand all contributed to the depth and magnitude of the recession. Oil was not the only resource to approach peak output; minerals such as copper, magnesium, iron, and rare earth minerals vital for modern life also experienced rapid price increases. In addition, energy-intensive fertilization and mono-crop cultivation led to rapid depletion of top soils, while energy prices made extensive irrigation cost-prohibitive. Throughout the entire period, economic growth barely reached 2 percent, leading to persistent, long-term unemployment and a collapse of living standards in many areas. One result was that state and local governments lacked the resources to address the growing challenges they faced and were forced to rely on the increasingly overburdened Federal Government for relief.

Conditions worsened substantially due to growing indicators of rapid global change. The Great Storms of 2018 hit numerous U.S. coastal cities along the Gulf of Mexico and the Atlantic Coast, leading to major disasters that overwhelmed the ability of state and local governments to respond and causing major damage to private property and infrastructure. Early melts of snow packs and winter rains led to floods throughout the West and Mid-West on a recurrent basis. At the same time, long droughts in the Central Plans led to declining yields, a collapse in agriculture in the Southern High Plains and to a decline of many cities in drought areas. More rapid exhaustion of the Ogallala Aquifer, combined with increasing fuel prices to operate irrigation systems, led to a return to dry land farming in southern Kansas, Oklahoma, and Texas, while the increasing number of windstorms and the higher wind speeds caused soil loss in agricultural areas and reduced soil moisture.

The Pacific Northwest, already dealing with the onset of new climatic patterns and severe storms, also experienced “climate refugees” as the economy of the southwest and southern California collapsed, leading to mass migrations. Arizona, southern California, Nevada, New Mexico, and Utah all faced major water shortages during record heat waves, major wildfires,
and dust storms.\textsuperscript{22} By 2040, global temperature had increased, leading to periods of dramatic temperature instability and the first clear indicators of the collapse of the Greenland Ice Shelf.

Simultaneously, United States and other Northern Hemisphere countries experienced a dramatic rise in sea level, leading to flooding of major coastal cities and the loss of significant coastal infrastructure (e.g., subways, rails, sewer systems, bridges, roads, ports, and shipping systems). In response, skyrocketing insurance and reinsurance costs further retarded economic growth, creating more economic turmoil and increasing business and consumer costs. Even for those areas not affected by sea level rise, increasing fuel prices made it cost-prohibitive to heat homes and work in the long, deeper winters. The more intense storm season stressed the abilities of many families and communities to maintain their standard of living and hopes for a better life.

In terms of transportation technology, the hopes of the early part of the 21st century did not materialize. Slow economic growth and a lack of public investment in new technologies meant that only relatively wealthy communities adopted the technologies, and only a few individuals adopted new automobile technologies. Furthermore, increases in the price of rare-earth elements and the Chinese embargo of rare-earth elements that followed the United States’ default on its debt payments in 2040 ended substantial investment in electric-vehicle technologies.\textsuperscript{23} As a result, despite rising petroleum prices, Americans remained committed to their automobiles and a carbon-based economy.

In terms of transportation, the increase in petroleum prices (rising to more than $9 per gallon in 2010 dollars with massive fluctuations) made private automobiles a thing of the past. Families moved closer to cities to avoid the increasing costs of mobility. Commuting costs increased dramatically, deeply affecting home values in all areas and creating more economic problems. Increased transportation costs for almost all goods led to spiraling price increases, the end of “just-in-time” delivery and distribution systems, and further declines in global trade. Long-distance travel of personal vehicles on interstate highways was beyond the reach of most individuals, increasingly being reserved for freight. Increases in fuel costs meant that air transportation was available only for the very rich. Most people traveled by train or bus when they had to travel between cities.


\textsuperscript{23} For more on the issue of rare-earth elements and the U.S. dependence on foreign production, see “Replacing Oil Addiction with Metals Dependence? China’s rare-earth minerals monopoly gives it key clean energy supply role,” \textit{National Geographic}. \url{http://news.nationalgeographic.com/news/2010/10/101001-energy-rare-earth-metals/}
In terms of institutional and governance issues, political paralysis in the face of massive, long-term, structural federal deficits severely limited the Federal Government’s freedom and ability to act and help state and local governments. Low growth, combined with uncontrolled federal spending, led to massive deficits and a crowding-out of the private sector from the capital markets. Even without the additional spending caused by emergencies related to climate change, the federal deficit would reach staggering levels of more than 340 percent of GDP by 2050 (U. S. Congressional Budget Office, 2010). With the additional spending on new seawalls, flood barriers, and relocation of infrastructure, deficits became ever higher. As a result, the Federal Government increasingly withdrew from its transportation and many other responsibilities and increasingly focused on the national crisis.

The federal interstate highway system fell into rapid decline as state and local governments made hard choices to prioritize only the surface transportation systems required for commerce and economic viability. In many areas, there was ad hoc, unplanned privatization as state and local governments shifted assets to the private sector in an effort to reduce operations and maintenance (O&M) costs and focus on essential assets.

Within urban areas, state and local governments were increasingly unable to maintain infrastructure. Bridge failures, poorly maintained roads and highways, and collapsing public transit systems increased congestion to record levels, leading to reduced demand in many cities. Without federal support, states and localities accelerated the move toward self-financing policies. However, after promising starts, rapid increases in the price of fuel led to public protests against congestion pricing, which in turn led to a general rollback in congestion pricing and even to the reduction or abolition of the gas tax in some states. As a result, only a few cities were able to retain congestion pricing policies.

As the period progressed, there was a general move toward uncontrolled privatization, with many wealthy individuals “buying” their way out of congestion by using private roads. By 2030, it was not uncommon for transportation assets in wealthier areas of cities and suburbs to be owned entirely by local homeowners associations, with their operation contracted out to private surface transportation management companies. In other parts of cities and in poorer suburbs (where lower income families were increasingly found), there were fewer and fewer transportation options as state and local transportation agencies increasingly focused on providing only crucial transportation links. As with the privatized system, state and local governments contracted out operations to privatized transportation O&M, focusing instead on planning, decisionmaking, and oversight.

At the same time in rural areas, the ongoing recession and the collapse of local revenue bases led to the collapse of rural infrastructure and further economic decline. As a result, transportation systems in many rural areas collapsed to almost pre-industrial levels, or shifted.
responsibility to a mix of local transportation companies, transportation cooperatives, or single individuals or companies that were prepared to take over O&M of surface transportation systems.

The situation was worsened by the fact that the U.S. population was aging rapidly. The declines in immigration meant that the U.S. population was considerably older, but without the benefits of younger immigrants to help support that aging population. The increasing “dependency ratio” meant that individuals were working longer as social security and long-term medical-care benefits were cut to deal with more immediate needs. Older Americans increasingly worked from home and relied on ride-shares and shared drivers to meet their transportation needs.

However, there were signs of hope. The Internet (for telecommuting, entertainment, delivery efficiencies, coordination of commuting, shopping, and more) became more important. Although cheap consumer goods and the consumer society were things of the past, increasing energy costs meant an end of outsourcing and energy-intensive farming. Local operations similar to eBay and Craigslist developed, and other swap-sell-share online markets, swap meets, local markets, and “buy and share” groups became common. Communities became smaller, with work, home, and shopping centers all located within a short distance of each other (“walking-distance centralization” won out over “driving-distance centralization”) and the community “general store” made a comeback. In some cases, this was the result of planned rezoning; in other cases, the pace and pressure of change caused local zoning systems to break down altogether as enterprising households converted their now-too-big homes into corner stores. Low-energy handcrafts, community gardens, small for-profit plots, bicycles, community cooperation, and friend and church networks increased in value and practical utility, leading many people to claim that “bottom-up sustainability” was breaking out throughout the United States.

**MEGA WORLD**

Mega World is one of two “as-expected” scenarios (the other is Suburban World) (see Table 41). Under both Mega World and Suburban World, the future of the United States is viewed as the continuation of current trends. Economic and population growth is anticipated to be in the “most-likely” projected range, technology is anticipated to develop along all anticipated paths, and there is a slow adoption of new transportation funding mechanisms. The main difference between Mega World and Suburban World is that under Mega World, the population is increasingly concentrated into 10 major megaregions. Within these megaregions, there is a general tendency toward urban concentration and mixed land use; in Suburban World, there is a more decentralized society.
### Table 41: Scenario Drivers -- Mega World

<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>- Population continues to follow current tendencies, with population concentrated in megaregions – population reaches 419 million</td>
</tr>
</tbody>
</table>
| Economic Growth | - Real GDP increases by 2.4 percent per year  
- Spending on transportation for federal, state, and local governments stays at the historic average of just under 2 percent of GDP |
| Climate Change, Environment and Resource Use | - Climate change is slow and predictable  
- No major resource shortages or environmental crisis  
- Petroleum and carbon fuel remain an important source of fuel. |
| Transportation | - Transportation technology develops along predictable paths – no breakout, dramatic breakthrough  
- State and local government agencies dominate transportation policy planning and implementation |
| Land Use and Distribution of Population | - Massive decentralization to small towns and suburban |

### Scenario Story - How the World Might Change: Mega World

After the challenges of the first decade of the 21st century, the next 40 years were relatively quiet for the United States and were recognized as a period of slow but steady improvement in the lives of the American people. Major economic problems, such as the growing federal deficit, were gradually brought under control and the inherent dynamism of the U.S. economy reasserted itself as the country grew apace with its major international rivals in the advanced economies. Environmental problems remained manageable and within the predicted range and population grew gradually, with the U.S. population increasing by more than 100 million from 2000 to 2050.

Technology followed anticipated patterns, with gradual adoption of major technological changes. By 2050 there were many automatic, guideway, and connected-vehicle systems along major roads and self-drive cars were common (but by no means universal). Very-low-emission vehicles, electric cars, and intercity high-speed trains were common and the country was gradually weaning itself away from its dependence on carbon fuels.

The most striking change was the emergence of megaregions. By 2050, well over 95 percent of all Americans lived in these massive urban areas. Although they were not mega-cities, because there were low-density neighborhoods and cities throughout the megaregions, the ten population centers dominated the United States. The result was a move toward regional planning and control for many state and local functions. The Federal Government took the lead in establishing the intercity and interstate pacts, where new integrated transportation, environment, and economic development authorities formed out of the confusing existing pattern to create a more rational and comprehensive planning and decisionmaking structure.
Suburban World is the second of two “as-expected” scenarios (the other is Mega World). Under Suburban World, the future of the United States is viewed as the continuation of current trends. Economic and population growth is anticipated to be in the “most-likely” projected range, technology is anticipated to develop along all anticipated paths, and there is slow adoption of new transportation funding mechanisms. However, unlike Mega World, technology allows people to live in a variety of settings that best suit their preferences (in the 20th Century, these preferences were clearly towards greater decentralization). As a result, there is a generalized move to the suburbs, small towns, and second-tier cities, leading to an America that resembles that of the early 20th century, with a more decentralized population.

Table 42: Scenario Drivers -- Suburban World

<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>• Population continues to follow current tendencies, with population concentrated in megaregions – population reaches 419 million</td>
</tr>
<tr>
<td>Economic Growth</td>
<td>• Real GDP increases by 2.4 percent per year</td>
</tr>
<tr>
<td></td>
<td>• Spending on transportation for federal, state, and local governments stays at the historic average of just under 2 percent of GDP</td>
</tr>
<tr>
<td>Climate Change, Environment and Resource Use</td>
<td>• Climate change is slow and predictable</td>
</tr>
<tr>
<td></td>
<td>• No major resource shortages or environmental crisis</td>
</tr>
<tr>
<td></td>
<td>• Petroleum and carbon fuel remain an important source of fuel.</td>
</tr>
<tr>
<td>Transportation</td>
<td>• Transportation technology develops along predictable paths – no breakout, dramatic breakthrough</td>
</tr>
<tr>
<td></td>
<td>• State and local government agencies dominate transportation policy planning and implementation</td>
</tr>
<tr>
<td>Land Use and Distribution of Population</td>
<td>• Massive decentralization to small towns and suburban</td>
</tr>
</tbody>
</table>

Scenario Story - How the World Might Change: Suburban World
During the first half of the 21st technology and vibrant economic growth led to gradual decentralization of America and a return to a settlement and land-use pattern similar to that of the late 19th and early 20th centuries. Specifically, economic growth, decentralization of governmental powers as the Federal Government focused its activities on its core responsibilities, and technological developments that favored decentralization led to a United States in which suburbs, small towns, rural areas, and second-tier cities returned to predominance. While large cities, such as New York and Los Angeles, remained important, population growth was increasingly seen in smaller cities and rural areas as people took advantage of the freedom technology gave them to live and work in quieter, slower places. Specifically, technology led to many people working at home or in small facilities near their home. Goods were delivered to central pickup points and then transferred to individual homes via energy-efficient small vehicles. Simultaneously, the increase in fuel prices led to a decrease in travel and mobility, with most people staying closer to their homes and rarely
traveling to other cities or regions in person, and to an increase in people taking advantage of telepresence and virtual reality to experience other places.

In terms of transportation, technology followed anticipated patterns, with gradual adoption of major technological changes so that by 2050 there were many automatic, guideway, and connected-vehicle systems along major roads and self-drive cars were common (but by no means universal). Very-low-emission vehicles, electric cars, and intercity high-speed trains were common and the country was gradually weaning itself away from its dependence on carbon fuels.

Planning and decisionmaking in the transportation space gradually became decentralized down to the local and sub-state regional authorities. State transportation agencies were increasingly “hollowed-out” as responsibilities, funding, and personnel were left to local and sub-state regional governments. These governments, closer to and more representative of the people, were able to develop clear consensuses about user fees and pay-for-use transportation systems. As a result, these authorities dominated the transportation landscape and made most of the planning decisions. Within this system, there was a general move toward privatization as local and regional governments attempted to reduce their operating costs by focusing on planning, decisionmaking, and overseeing and contracting out O&M responsibilities for transportation. Gradually, market forces led to the development of common standards for operation of most surface transportation systems, which led to a small number of major transportation management companies dominating the transportation market and competing for local transportation business.

**WONDER WORLD**

Wonder World is the first of two “positive” scenarios (the other is Green World) (see Table 43). Under this scenario, there is better-than-currently-expected economic growth and technology development and adoption is more rapid than currently anticipated. Environmental challenges remain manageable and population grows rapidly. Although resource prices increase dramatically, the pace of technology improvement and adoption reduces U.S. dependence on many resources as substitutes are found. The spread of new technology and the dynamic state of the U.S. economy means there is a generalized decentralization of the economy as people use their wealth and the freedom technology brings to live where they choose.
Table 43: Scenario Drivers – Wonder World

<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>• Better than expected economic growth causes increase in net immigration - population rises to 458 million</td>
</tr>
<tr>
<td>Economic Growth</td>
<td>• Real GDP increases by 3.5 percent per year.</td>
</tr>
<tr>
<td></td>
<td>• Spending on transportation for federal, state, and local governments stays at the historic average of just under 2 percent of GDP</td>
</tr>
<tr>
<td>Climate Change, Environment and Resource Use</td>
<td>• Climate change is slow and predictable</td>
</tr>
<tr>
<td></td>
<td>• No major resource shortages or environmental crisis</td>
</tr>
<tr>
<td></td>
<td>• Petroleum and carbon fuel remain important sources of fuel, but alternative sources are rapidly emerging.</td>
</tr>
<tr>
<td></td>
<td>• By 2050, the price of a gallon of gasoline is more than $7, forcing further innovation and changes in travel behavior</td>
</tr>
<tr>
<td>Transportation</td>
<td>• Radical new technologies are introduced that revolutionize transportation</td>
</tr>
<tr>
<td></td>
<td>• MPOs and megaregional organizations dominate transportation policy planning and implementation</td>
</tr>
<tr>
<td>Land Use and Distribution of Population</td>
<td>• Population concentrated in megaregions</td>
</tr>
<tr>
<td></td>
<td>• Mix of megacities and suburban sprawl continue</td>
</tr>
</tbody>
</table>

Scenario Story - How the World Might Change: Wonder World

The first half of the 20th century was a period of rapid social, economic, and technological change for the United States. Spurred by dramatic changes in technology in virtually every area, the U.S. economy experienced the “Super Boom,” a period of more than 40 years of dramatic economic growth. During that period, the U.S. economy doubled in size more than three times, creating a country that was almost unrecognizable by the end of the period from that which had been envisioned in 2000. Super-efficient electrical engines, new biotech fuels, carbon negative fuels, room-temperature superconductors, artificial intelligence, nanotechnology, and new wonder drugs transformed society. New medical technologies enabled people to live longer healthier lives, such that despite the aging population, people remained active, working and using transportation well into their 80s.

Carbon fuels still played an important role in the economy, but they were being rapidly phased out first more carbon-neutral modes (e.g., fusion and super-efficient solar for electrical power generation, super-fuels for automobiles). For example, carbon-capturing bioengineered algae were used in coal plants to produce biofuel feedstocks, and advanced nanotubes and nonfibers were used to absorb carbon emissions on a massive scale throughout industrial complexes (American Institute of Biological Sciences, 2010). Safer nuclear technology, an emerging fusion power system, and high-generation-capacity wave, solar, geothermal, and wind power provided significant parts of the nation’s energy.

For transportation, the dramatic growth in the economy and technology gave people a range of choices of where and how to live. Small towns, rural areas, and urban cores all boomed.
New types of “smart suburbs” emerged which integrated intelligent transportation technologies with Smart Growth land use strategies. Guideways, intelligent vehicles, super-efficient drive trains, and new fuel sources were nearly universal. Travel between cities was via super-efficient maglevs and other high-speed trains. Freight experienced a major mode shift from road to high-efficiency rail. In cities, smart multimodal systems were common and heavily used. Many people worked from home (in smart homes that carefully controlled carbon emissions) and operated machinery or performed other complex tasks remotely via telepresence systems. Intelligent machines performed many tasks that previously demanded substantial human involvement, thus reducing labor, materials, and energy costs.

**GREEN WORLD**

Green World is another mostly positive scenario (Table 44). Under this scenario there is rapid economic growth, technology development and adoption, and population growth. However, there is a broad social and political consensus to move toward a more sustainable, “green” society. As a result, there is substantial investment in green technologies and infrastructure and a movement to a greener, sustainable environment. Despite the apparently benign sound of this scenario, there is substantial regulation and greater social and economic control. Many personal goals and aspirations are limited by the effort to make society greener and more sustainable.

**Table 44: Scenario Drivers – Green World**

<table>
<thead>
<tr>
<th>Driver</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>• Better than expected economic growth causes increase in net immigration – population rises to 458 million</td>
</tr>
<tr>
<td>Economic Growth</td>
<td>• Real GDP increases by 3.5 percent per year.</td>
</tr>
<tr>
<td></td>
<td>• Spending on transportation for federal, state, and local governments stays at the historic average of just under 2 percent of GDP</td>
</tr>
<tr>
<td>Climate Change, Environment and Resource Use</td>
<td>• Climate change is slow and predictable</td>
</tr>
<tr>
<td></td>
<td>• No major resource shortages or environmental crisis</td>
</tr>
<tr>
<td></td>
<td>• Petroleum and carbon fuel remain important sources of fuel, but alternative sources are rapidly emerging.</td>
</tr>
<tr>
<td></td>
<td>• By 2050, the price of a gallon of gasoline is more than $7, forcing further innovation and changes in travel behavior</td>
</tr>
<tr>
<td>Transportation</td>
<td>• Radical new technologies are introduced that revolutionize transportation</td>
</tr>
<tr>
<td></td>
<td>• MPOs and megaregional organizations dominate transportation policy planning and implementation</td>
</tr>
<tr>
<td>Land Use and Distribution of Population</td>
<td>• Population concentrated in megacities and high concentrated urban areas</td>
</tr>
</tbody>
</table>

**Scenario Story - How the World Might Change: Green World**

The first half of the 21st century saw development of a broad social and political consensus on the need to develop a sustainable society. Consumer choice and public decisions pushed investment into green technologies, which led to the development of an entire suite of green
technologies by 2050. The rapid economic growth that this “green-revolution” created supported a major social and economic shift toward a new and sustainable society.

One of the most obvious results was the collapse of the suburbs. By 2050, few suburbs remained; families generally lived in dense, urban developments. These emerging complexes were enormous habitats of extremely high human population density, containing a variety of residential, commercial, and agricultural facilities that minimized individual human environmental impact. In some cases, they were almost self-contained or economically self-sufficient, where work, life, and even food production were concentrated. At the same time, outside the urban cores, automation reduced the number of individuals and families living in rural areas. Huge biofuel farms were managed by a single family and food production was largely automated.

The role of oil and coal rapidly diminished as they were rapidly phased out in favor of sustainable, green technologies, including high-generation-capacity wave, solar, geothermal, and wind power. Super-efficient batteries stored energy for use when it was needed, and wind and solar generators were common features on most buildings and homes. Personal transportation outside the urban cores was rare; within the urban cores, most transportation occurred via high-efficiency actively managed transit. Personal transportation vehicles were small and based on carbon-neutral fuels (e.g., green electricity, low-carbon alternative fuels). Carbon-capture systems and wind generators were common on most roadways. Interstates were limited to freight, although, in general, freight transportation was shifting from road to rail. The few trips that individuals made between different urban areas were by train.

While the move to sustainability was based on a general social consensus and there were numerous voluntary changes in the private sector and in individuals’ lives, the requirement to maintain a sustainable society led to heavy regulation and social and economic control. Large cars, big homes, and extensive use of air travel for vacations or business purposes were a thing of the past. The high cost of energy ruled out these as options for any but the very rich. In addition, all major public and private sector investments or social or economic choices that might threaten the long-term sustainability of society were severely limited, and private use of resources was controlled by numerous regulations.
7. FUTURE CHALLENGES AND OPPORTUNITIES FOR AGENCIES

As discussed above, changes in policy systems may occur in response to two types of changes: exogenous changes and endogenous changes. Exogenous changes largely result from shocks and from gradual changes over time. Endogenous changes result from social learning that occurs from feedback and from responses to external changes.

This chapter focuses on how a changing external environment will create pressure on individual transportation agencies to change and how the agencies can best use these pressures to learn and to make changes toward a more sustainable system.

Table 45 shows the main exogenous changes that will act on transportation agencies in each scenario. Table 46 shows how these will affect inputs (e.g., demand requirements and the resources available) into the system. Table 49 and Table 48 show the key challenges and opportunities this situation offers to the transportation agencies.

First, there are as many problems or challenges in the “positive” scenarios as in the “negative” scenarios. Although there is a general perception that positive scenarios do not produce major problems, the analysis does not support this. For example, in Green World and Wonder World, transportation agencies face numerous problems, ranging from decommissioning non-green infrastructure and transportation assets (Green World) to repeatedly managing the impacts of disruptive technologies (Wonder World).

Second, not all scenarios will experience greater pressures for change. Crisis World and Wonder World may experience repeated shocks and acute events that provide an impetus for change, but the other scenarios will experience more gradual pressures for change, which may make it more difficult to develop a coalition for change.

Third, the resources available in different scenarios vary greatly. In Crisis World, resources are severely constrained due to slow economic growth and multiple demands on resources to address recurring events. In contrast, resources in Wonder World and Green World are more available, but the demands on them also are substantial because higher income individuals demand more from the transportation system and a higher standard of living as well as sustainability.

The following sections discuss in detail each of these pressures for change, inputs, and challenges and opportunities.
### Table 45: Exogenous Change Transportation Agencies under Different Scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Exogenous Changes (Shocks and Gradual Change)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crisis World</td>
<td>• Recurrent environmental crises that have dramatic negative impacts on transportation infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Transportation disasters (e.g., bridge and freeway interchange collapses) from lack of maintenance on transportation infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Energy and resource price shocks leading to sudden dramatic increases in fuel prices</td>
</tr>
<tr>
<td></td>
<td>• Gradual, persistent long-term economic decline and slow growth</td>
</tr>
<tr>
<td></td>
<td>• Reduced Federal Government spending and transfers to state and local government</td>
</tr>
<tr>
<td></td>
<td>• Reduced resources to support transportation investments</td>
</tr>
<tr>
<td></td>
<td>• Lack of technological progress</td>
</tr>
<tr>
<td></td>
<td>• Climate change causing increased stress on the economy and environment</td>
</tr>
<tr>
<td>Mega World</td>
<td>• No major shocks</td>
</tr>
<tr>
<td></td>
<td>• Gradual centralization to megaregions and megacities</td>
</tr>
<tr>
<td>Suburban World</td>
<td>• No major shocks</td>
</tr>
<tr>
<td></td>
<td>• Gradual decentralization to suburbs and small towns</td>
</tr>
<tr>
<td>Wonder World</td>
<td>• Recurrent disruptive technologies causing dramatic changes to society and the economy</td>
</tr>
<tr>
<td></td>
<td>• Increasing population growth and greater diversity of population (more diverse ethnic population and aging population)</td>
</tr>
<tr>
<td></td>
<td>• Increasing economic and technological growth leading to greater demands for mobility of goods and people</td>
</tr>
<tr>
<td>Green World</td>
<td>• Increasing population growth and greater diversity of population (more diverse ethnic population and aging population)</td>
</tr>
<tr>
<td></td>
<td>• Demand that all sectors of society become substantially “greener”</td>
</tr>
<tr>
<td></td>
<td>• Greater concentration of population in green urban areas</td>
</tr>
</tbody>
</table>
Table 46: Demand and Available Resources under Different Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Demands and Resources</th>
</tr>
</thead>
</table>
| Crisis World | • Maintain and expand mobility  
• Afford multiple opportunities for public participation  
• Support sustainability  
• Address transportation-related impacts of recurrent environmental crises that have dramatic negative impacts on transportation infrastructure  
• Address numerous transportation disasters (e.g., bridge and freeway interchange collapses) from lack of maintenance on transportation infrastructure  
• Respond to energy and resource price shocks by providing alternatives or subsidies  
• Substantially reduced resources  
• Dramatically reduced intergovernmental transfers  
• Gas tax revenue does not keep up with requirements |
| Mega World    | • Maintain and expand mobility  
• Afford multiple opportunities for public participation  
• Support sustainability  
• Shift resources to megaregions and megacities  
• Gas tax revenue does not keep up with requirements  
• Growth in user fees |
| Suburban World| • Maintain and expand mobility  
• Afford multiple opportunities for public participation  
• Support sustainability  
• Decentralization, leading to shift in resources to small towns and suburbs  
• Gas tax revenue does not keep up with requirements  
• Growth in user fees |
| Wonder World | • Maintain and expand mobility  
• Afford multiple opportunities for public participation  
• Shift existing infrastructure and transportation systems toward more advanced technologies; respond to rapidly changing technology, including decommissioning older infrastructure  
• Support wide variety of land-use and settlement patterns permitted by technology  
• Gas tax revenue does not keep up with requirements, but other resources are available  
• Growth in user fees |
| Green World  | • Move to more sustainable TBL-focused transportation policy  
• Maintain and expand mobility  
• Afford multiple opportunities for public participation  
• Shift existing infrastructure and transportation systems toward more “green” systems, including decommissioning older, non-green infrastructure  
• Shift resources toward concentrated megacities  
• Shift resources from “wasteful” non-green less dense areas  
• Gas tax revenue does not keep up with requirements, but other resources are available  
• Growth in user fees  
• Green taxes and other revenue sources that encourage sustainable behavior |
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| Crisis World  | • Recurrent environmental crises that have dramatic negative impacts on transportation infrastructure; greater demands to maintain basic services  
                   • Gradual, persistent long-term economic decline and slow growth means less resources available to achieve goals  
                   • Reduced Federal Government spending and transfers to state and local government means greater inequality between regions  
                   • Lack of technological progress reduces the likelihood of technological solutions  
                   • Difficult to maintain all transportation facilities with constrained resources – need to prioritize crucial assets  
                   • The best assets that can be maintained and operated with user fees are privatized; agencies must make decisions to maintain or decommission the less-popular bus routes and low-demand bridges and roadways  
                   • Limited resources to enforce traffic rules and user safety  
                   • Difficulty maintaining funding (worsening economic growth)  
                   • State government shrinks in response to declining revenues, resulting in fewer staff at transportation agencies  
                   • Mishandled, poor, or missing information leads to bad decisions about funding priorities  
                   • Different entities have different priorities, forcing the agency to make tradeoffs in deciding where to allocate limited funds  
                   • Need for a process for decommissioning unsustainable infrastructure |
| Mega World    | • Gradual centralization to megaregions and megacities requires changing funding mechanisms and increasing spending on infrastructure  
                   • Need to address social and economic equity impacts on the “left-behinds” outside megaregions (i.e., regions that are trapped in long-term decay and economic decline) |
| Suburban World| • Gradual decentralization from megaregions and megacities requires changes in funding mechanisms  
                   • Need to address social and economic equity impacts of the “left-behinds” in the cities (i.e., regions that are trapped in long-term decay and economic decline) |
| Wonder World  | • Recurrent disruptive technologies cause dramatic change to society and the economy  
                   • Increasing population growth and greater diversity of population (more diverse ethnic population and aging population)  
                   • Increasing economic and technological growth, leading to greater demand for mobility of goods and people  
                   • Rapid technology innovations, leading to one region implementing a technology that quickly becomes outdated; technologies may not link across regions  
                   • Some technologies may require new infrastructure (e.g., new right of way for smaller, lighter vehicles; “air train” rapid transit; multijurisdictional management systems)  
                   • Agency staff unable to keep up with technologies and needed changes  
                   • New technologies require new standards and safety considerations  
                   • Need for new transportation revenue sources as new sources of fuel and propulsion are used |
### Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies

#### Interim Report #1

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Challenges</th>
</tr>
</thead>
</table>
| Green World    | • Increasing population growth and greater diversity of population (more diverse ethnic population and aging population)  
                  • Demand that all sectors of society become substantially “greener”  
                  • Greater concentration of population in green urban areas results in need to address social and economic equity impacts on the “left-behinds” in less dense regions (i.e., regions that are trapped in long-term decay and economic decline)  
                  • Major decrease in personal vehicle travel, requiring agencies to provide sufficient alternatives for intracity and intercity travel  
                  • Move away from carbon-based fuels requires new vehicles and new infrastructure |

#### Table 48: Opportunities under Different Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Opportunities</th>
</tr>
</thead>
</table>
| Crisis World   | • Crisis allows for local and regional response to problem  
                  • Withdrawal of Federal Government opens up new areas of regional, state, and local action; more flexibility  
                  • Austerity forces transportation toward “low-level” sustainability; that is, reduce the size of the network and focus on key sustainable elements |
| Mega World     | • Gradual centralization to megaregions and megacities means cities and regions have the resources to address problems |
| Suburban World | • Gradual decentralization means cities and regions have the resources to address problems |
| Wonder World   | • Resources available to support expanding sustainability-based transportation system  
                  • Technology facilitates new planning and participation mechanisms, real-time performance management, and control and flexible resource allocation |
| Green World    | • Crisis allows for local and regional response to problem  
                  • Withdrawal of Federal Government opens up new areas of regional, state, and local action; more flexibility  
                  • Austerity forces transportation toward “low-level” sustainability; that is, reduce the size of the network and focus on key sustainable elements |
7.1 Crisis World

Crisis World is the scenario where acute events and transportation disasters are most likely to provide the shock necessary to provoke change. Potential impacts of such events are shown in Figure 22. In Crisis World, every part of the country will experience significant climate change, ranging from sea-level rise and increased storm surges that damage railroad tracks to severe temperature swings that damage bridge joints to flooding and drought (National Research Council (U.S.), Committee on Climate Change and U.S. Transportation, 2008). In terms of surface transportation, one of the major likely acute events that will affect transportation is more intense precipitation, leading to increased flooding of coastal roads and rail lines. Expected sea level rise will exacerbate flooding because storm surges will build on a higher base, and reach farther inland. In fact, the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report on North America identifies coastal inundation from expected sea level rise and storm surges, especially along the Gulf and Atlantic Coasts, as one of the most serious effects of climate change. The TRB Climate Change Study projected that transportation infrastructure in some coastal areas along the Gulf of Mexico and the Atlantic Coast will be permanently inundated sometime in the next century. Low-lying bridge and tunnel entrances for roads, rail, and rail transit also will be more susceptible to flooding, and thousands of culverts may be too small to accommodate the flows. The resulting erosion and subsidence of road bases and rail beds, as well as erosion and scouring of bridge supports, will further disrupt transportation. The impact of coastal flooding is not limited to coastal areas. Record-breaking rainstorms inland also can cause major recurrent flood damage by swelling rivers, causing massive transportation outages. Equally, changes in seasonal precipitation levels, with more precipitation falling as rain than as snow, offers the potential for major acute events. For example, California’s transportation infrastructure could be sensitive to even modest changes in precipitation, whether liquid or frozen. But, when precipitation falls as rain rather than snow, it leads to immediate runoff, thus increasing the risk of floods, landslides, slope failures, and consequent damage to roadways, especially rural roadways, in the winter and spring months.

With these changes in mind the team can imagine a number of potential acute events that could cause major human, economic, and environmental disasters.

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24 TRB’s report, Potential Impacts of Climate Change on Transportation, provides a clear overview of the impacts of climate change and climate change–induced acute events on transportation.
Figure 22: Impacts of 2°C increase in global temperature on the lower 48 states

- Northwest
  - Reduced summer streamflows, strain water supplies
  - Increased insect outbreaks, wildfires, and changing species
  - Salmon and coldwater species experience stress
  - Sea-level rise along vulnerable coastlines results in increased erosion and the loss of land

- Midwest
  - Summer heat waves, reduced air quality, and increasing insect and waterborne diseases
  - Increased precipitation in winter and spring, more heavy downpours leading to both floods and water deficits
  - Increases in heat waves, floods, droughts, insects, and weeds
  - Native species very likely to face increasing threats

- Northeast
  - Extreme heat, declining air quality cause problems for human health
  - Agricultural production declines
  - Severe flooding occurs more frequently
  - Winter tourism declines
  - Fishing industry declines

- Coasts
  - Significant sea-level rise and storm surges adversely affect coastal cities and ecosystems around the nation; low-lying and subsiding areas are most vulnerable
  - More spring runoff and warmer coastal waters increase the seasonal reduction in oxygen resulting from excess nitrogen from agriculture
  - Higher water temperatures and ocean acidification due to increasing atmospheric carbon dioxide present major additional stresses to coral reefs, resulting in significant die-offs and limited recovery
  - Changing ocean currents affect coastal ecosystems

Adapted from: Potential Impacts of Climate Change on Transportation
MEGA FLOODS IN NEW YORK CITY

Heidi Cullen, in her book *The Weather of the Future*, presents a vision of New York City in the 2020s experiencing a series of increasingly stronger storms. In her scenario, four freak storms dump 7.5 inches of rain on lower Manhattan in one day—a new record. The storm water floods the subway and brings chaos to the transportation system. Rainwater seeps through subway walls and flows toward the stations and the gates and stairwells. Sump pumps are activated to pull the water out to street level and to the storm drains, but the exceptional rainfall overwhelms the system, and the rainwater reaches the subway tracks, eventually hitting the third rail. The 600 volts of electricity from the third rail boils the water and sets debris on fire, and the water shorts out electrical signals and switches, making it impossible to move trains or identify safe zones within the system. Eventually, the city brings in more pumps and manages to gain control over the system, but the subway system incurs substantial damage, forcing new spending to defend the system against future flooding.

Also in the 2020s, the city begins construction of four tidal barriers, each 30 feet high and 1,000 feet long, that are able to withstand a thousand-year flood. Two are constructed off the coast of Staten Island, one off the coast of the Bronx to protect LaGuardia Airport, and one off Far Rockaway to protect John F. Kennedy Airport. The construction is intended to last 8 years. However, given slow economic growth and a declining share of national resources for infrastructure projects, the seawalls are not completed until well into the 2040s. As a result, the city initiates other protective measures. The runways of local airports are raised and plans are made to close the West Side Highway and construct a new highway farther inland. By 2050, the city is many years behind in its plans to protect the city from higher storm surges and more intense hurricanes. This leads to a major disaster in 2050, when Hurricane Xavier, a Category 4 storm, hits New York City directly.

From: (Cullen, 2010)
SUPERSTORMS HIT THE SOUTHEAST
In 2025, Hurricane Lyle, packing maximum sustained winds of 195 mph, slams into Coral Gables just south of Miami. The breadth and intensity of the storm stun meteorologists, who rank it the strongest hurricane ever to hit the U.S. mainland. On the north side of the storm’s eye, Miami Beach, which has the second highest housing density in the country, is in shambles. Many residents did not evacuate, believing they are safe in concrete high-rises. They are wrong. Then it is too late, as the causeways connecting them to the mainland wash out. Waves riding a 15-foot storm surge gut oceanfront condos up to the third story; windows blow out, allowing wind and rain to ravage the upper floors. The storm surge sweeps over the island, carrying wreckage into downtown Miami, where the 70-story Four Seasons Hotel and Tower is reduced to a sodden shell. Block after block of homes in Coral Gables, West Miami, and Sweetwater are blasted down to roofless frames. Waist-deep floodwater inundates areas as far north as Fort Lauderdale. Insured losses exceed $100 billion—nearly twice the amount caused by Hurricane Katrina—making Lyle the costliest natural disaster in U.S. history.

The storm tacks moves back out to sea and continues up the coast. Gaining momentum from exceptionally warm Atlantic waters it becomes a Category 5 hurricane. As it moves along the coast it creates record rain falls, before unexpectedly and rapidly moving inland again just south of Savannah. Although not as strong as when it hit southern Florida, the storm still has 120 mph winds and promises a massive storm surge. Doing major damage to Savannah and Charleston, it moves inland, producing flooding that inundates major parts of the I-95 Corridor in the Carolinas and causing bridge collapses and massive traffic accidents. Evacuation routes and major freight corridors are flooded. Combined with the devastation in southern Florida, federal resources are stretched to the breaking point. Attention focuses first on saving human lives in Southern Florida and the Carolinas; there are little or no resources available to address major transportation problems. With several of the nation’s major ports out of commission from the storm and the I-95 Corridor impassable for huge stretches, the nation faces its first major transportation crisis.

From: (Gorman, 2006)

In the wake of disasters such as those described above, there would be major demands for change. It is likely that federal, state, and local resources would be mobilized to deal with the immediate response and with the long-term rebuilding. However, in Crisis World, there are few resources to address the problems. Crisis World assumes that economic growth will be less than 2 percent over the entire period (barely large enough to keep up with population growth) and that the Federal Government, given fiscal constraints, gradually will reduce its role in transportation. Combined with a lack of technological progress and dramatic increases in resource prices there will be limited resources to address these problems.
Despite these problems, there still will be demands to maintain and expand mobility, support sustainability, address transportation-related impacts of recurrent disasters and acute events, and respond to transportation resource shortages. In fact, the seriousness of the crisis experienced would increase demands on the transportation policy system and require even more resources to be expended at a time when fewer resources are available.

Against this background, the transportation policy system faces numerous challenges, which are easy to identify and innumerate:

- Recurrent environmental crises have dramatic negative impacts on transportation infrastructure
- Gradual, persistent long-term economic decline and slow growth lead to fewer resources available to achieve goals
- Reduced Federal Government spending and transfers to state and local government means greater inequality between regions and less ability for poor regions to resolve their problems
- Lack of technological progress, thus reducing the likelihood of technological solutions

Paradoxically, however, the depth of the crisis also may provide new opportunities, as follows:

- Acute events and disasters may provide the shock that permits federal, state, regional, and local governments to act. The public and political leaders may experience a “Sputnik moment” that drives formation of a new consensus at different levels of government that empowers them to address the crisis, increase financial support, and mobilize all levels of government to address the problem.
- Withdrawal of the Federal Government from transportation efforts and other areas may open up new areas for regional, state, and local action. Forced to call on their own resources, regional, state, and local governments may find new ways to address problems, develop powerful statewide, regional, and/or local consensus behind action, and, by releasing themselves from many federal requirements, gain new flexibility and freedom to pursue new solutions.
- The prolonged austerity of this scenario and the occurrence of sudden shocks to the system may force the public and political leaders to accept the need to prioritize and focus efforts. A new “low-level” sustainability (e.g., reduce the size of the network, focus on key sustainable elements, reduce mobility, and/or transfer assets to user control) may emerge where people are willing to make the hard decisions to move ahead.

### 7.2 MEGA WORLD AND SUBURBAN WORLD

Mega World and Suburban World anticipate broadly similar futures. Economic growth, population change, and technological progress follow anticipated predicted patterns and climate and environmental stress is relatively minor. Thus, there are no major shocks that are likely to shake the transportation policy system and require a major rethink of the
fundamentals. Instead, there will be two different ongoing changes, which likely will produce very different demands and, therefore, different challenges and opportunities.

In Mega World, the gradual and continuous concentration of the population and economic activity in the megaregions is likely to produce demands to focus more available national resources in these areas. With more than 95 percent of the population centered in these areas, federal, regional, state, and local governments all will be pulled to devote the bulk of their resources to these areas. This produces two major challenges:

- Gradual centralization to megaregions and megacities will require providing additional resources to these regions to support growth and new funding mechanisms to address multistate regional infrastructure investments
- Centralization will create a number of “left-behind” regions outside the megaregions that are trapped in long-term decay, economic decline, and de-population crisis. This will create profound social and economic equity issues that must be addressed

However, as in Crisis World, Mega World’s problems also will create opportunities. Most significantly, the power and economic dynamism of the megaregions means they will have the resources to address their problems. As noted in this report, the more economically dynamic cities and regions are leaders in sustainability and transportation services. They are experimenting with different kinds of programs, from user fees to congestion charges to integrated land-use planning. As these regions grow in strength and wealth, they likely will be in an even better position to address these challenges and work toward increased sustainability.

In contrast, Suburban World will experience the opposite trend. Gradual decentralization will lead to a renaissance in small towns, suburbs, and areas outside the megaregions. In this case the major challenges will be as follows:

- Gradual decentralization from the megaregions and megacities will require changing funding mechanisms, building new infrastructure to support growing rural and small town populations, and developing a sustainable decentralized infrastructure
- Social and economic equity issues will arise related to the impacts on the “left-behinds” in the cities and less affluent rural areas, small towns, and suburbs (i.e., regions that are trapped in long-term decay and economic decline)

The equity issue is especially important; the team’s analysis of sustainability experiences indicates that cities with few resources have not been leaders in sustainability. Thus, major economic hubs for the nation (as cities will remain important) may face huge problems in the future in financing sustainability.
As in Mega World, Suburban World also may present considerable opportunities. For example, decentralization of cities and regions will mean that local government is extremely close to its citizens, which may make it easier to develop a consensus behind action and may lead to increased support for sustainability. In addition, the increase in the number of small towns and suburbs will create substantial opportunities for innovation, which in turn may lead to new projects and programs that have unforeseen benefits for sustainability.

### 7.3 Wonder World

In Wonder World, one of the two optimistic scenarios, annual economic growth exceeds previous U.S. average growth since the 1860s (on average, slightly more than 3 percent annually) and there are numerous technology breakthroughs. The result is a society that is almost unrecognizable from that of the present day. Multiple disruptive technologies have changed the way people live. As a result, the transportation system has faced repeated demands to update technologies and to respond to user demands. This situation will lead to several challenges, including the following:

- Recurrent disruptive technologies cause dramatic and unanticipated changes to society and the economy
- Increasing population growth and greater population diversity (more diverse ethnic population and aging population) leads to demands for more diverse transportation services (e.g., growing elderly population requiring assisted mobility)
- Rapid technology innovations may lead to one region implementing a technology that quickly becomes outdated. The technologies may not link across regions
- Some technologies may require new infrastructure (e.g., new rights of way for smaller, lighter vehicles; “air train” rapid transit; multijurisdictional management systems)
- Agency staff may have difficulty keeping up with the technologies and needed changes.
- New technologies may require new standards and safety considerations
- A need for new transportation revenue sources arises as new sources of fuel and propulsion are used

At the same time, new opportunities also will be created:

- Resources may be available to support an expanding sustainability-based transportation system
- Technology will facilitate new planning and participation mechanisms, real-time performance management and control, and flexible resource allocation

A disruptive technology or disruptive innovation is a change that helps create a new market that eventually disrupts or destroys an existing market (Kurzweil, The Law of Accelerating Returns, 2001) (Kurzweil, The Singularity Is Near, 2005); (Wu, 2010). The effect of the
technology is to render an established technology obsolete, along with its associated industrial processes, plants, and supporting infrastructure, and to usher in a period of “creative destruction” in which firms, workers, communities, and states must adapt if they are to continue to play a role in the new technology.

Classic examples of disruptive technologies include the automobile, which displaced the horse and railroad as the dominant means of transportation; the microcomputer, which displaced the mainframe and other calculating machines; and digital photography, which displaced chemical photographic film. The defining characteristic of disruptive technologies is that they are not a gradual improvement, but rather a radical change in system performance and operations. They initially may appear to have a relatively limited impact, but if a disruptive technology is widely adopted it can impact or create entirely new markets and ways of life, and totally transform society. The Internet, for example, initially was a way to exchange scientific data, but it has since changed society beyond what any of its founders could have imagined. Similarly, the automobile totally reconfigured society between the time of its emergence in the late 19th century and the mid-20th century. Figure 23 illustrates this trend. The U.S. transportation system has gone through a series of waves with a peak and then a major paradigm shift caused by the emergence of new disruptive technologies (canal development, steamships, steam locomotives, and the automobile).

Figure 23: Disruptive Technologies and Transportation

In the past, disruptive technologies required many decades to change society. However, the past few decades have seen a vast increase in the speed of innovation and a tremendous decrease in the time between the development of a new technology and its acceptance and use.
by society as a whole. For example, Kurzweil’s (2001) analysis of technological change concludes that technological progress follows a pattern of exponential growth, what he calls “The Law of Accelerating Returns.” He theorizes that other technologies will benefit from and follow the pattern of growth acceleration experienced by integrated circuits predicted by Moore’s law.²⁵ Thus, as information technology becomes omnipresent, its benefits impact more and more elements of society. Furthermore, applying expanding computer power to persistent challenges means that these problems can quickly be resolved. For example, expanded computing power can lead to the development of new materials or new ways of manufacturing materials to higher and higher tolerances, thus improving performance in many industrial applications.

Kurzweil argues that technological progress is increasing so quickly that a time is approaching in which society experiences “technological change so rapid and profound it represents a rupture in the fabric of human history” (Kurzweil 2001). He believes that the singularity (when artificial intelligence, biotechnology, and nanotechnology fuse to create a self-sustaining, continuous burst of dramatic innovation) could occur before the end of the 21st century, estimating the date at 2045 (Kurzweil 2005).

Even if one does not accept Kurzweil’s vision, there are ample opportunities for major disruptive technologies to emerge between now and 2050, such as the following:

- Development of new alternative fuels or power systems (e.g., vehicle-to-grid [V2G] electric cars,²⁶ as-yet unknown biotech-developed super-fuels), carbon neutral fuels (i.e., fuels that remove GHG from the atmosphere).
- Development of new freight and delivery systems (e.g., short-distance airborne delivery drones, small airborne vehicles that automatically deliver small high-value payloads).
- At-home customized manufacturing using 3-D printers to create most simple items in people’s homes rather than having them manufactured elsewhere and delivered.
- Vastly improved telepresence and telesubstitution systems (e.g., real-time 3-D full-immersion virtual projection, where the differences between in-person and virtual interactions nearly disappear).

²⁵ Moore’s Law describes geometric growth in integrated semiconductor complexity. It predicts that the processing powers of a single chip will double every 18 to 24 months.
²⁶ Vehicle-to-grid (V2G) describes a system in which plug-in electric vehicles, such as electric cars (BEV) and plug-in hybrids (PHEV), communicate with the power grid to sell demand response services by either delivering electricity into the grid or by throttling their charging rate. V2G can be used with such gridable vehicles; that is, plug-in electric vehicles (BEVs and PHEVs) with grid capacity. Because most vehicles are parked an average of 95 percent of the time, their batteries could be used to let electricity flow from the car to the power lines and back, with a value to the utilities of up to $4,000 per year per car.
• Nanotech-driven smart materials in vehicles and infrastructure that monitor their condition and automatically identify and fix problems
• Molecule-level computing and telecommunications that can operate transportation systems and subsystems
• Carbon-based nanotubes as hydrogen carriers for fuel cells
• Nanotech flash capacitors large enough to replace slow-charging electric vehicle batteries

The challenge of disruptive technologies is that they are not apparent at first sight. Normally, multiple contenders appear when a current technology encounters a “systems break” (i.e., a point beyond which efforts to improve performance have diminishing returns). For example, the early 20th century saw the development of steam, electric, and internal combustion vehicles, and it was difficult at that time to determine which would triumph. Similarly, high-definition video saw the development of several formats; video tape two formats; and, initially, television saw a conflict between “mechanical television” and “electronic television” (Wu 2011).

Furthermore, it is unclear how the new technology will be used and adopted. For example, in the early days of radio, the future of broadcasting was seen as belonging to small, decentralized local and regional networks. However, within 10 years, the broadcast system was dominated by two major national networks (Wu 2011).

Disruptive technologies related to transportation normally require extensive response and support from public policymakers. For example, decisions must be made about how to integrate the new technologies into the current transportation system, what standards will be used, to what degree the infrastructure must be modified, and how these technologies affect current plans and revenue projections. This is the challenging aspect of disruptive transportation technologies. In Wonder World, numerous disruptive technologies would crowd the stage, demanding action and requiring that public policymakers make bets on highly uncertain and unpredictable technological futures. This also has the potential drawback of having the government play a role in picking the winners and losers. Furthermore, the speed of technological advance might be such that the moment that one innovation is integrated into the system another equally disruptive technology emerges.

This rapid technological advance could lead to a paradox whereby the very success of the technological and economic system provides individuals and firms with the resources to develop and adopt technologies, but provides insufficient resources for transportation agencies to develop and implement responses. The result may be a disjointed, uneven system that fails to deliver the full benefits of new technologies and makes sustainability planning extremely difficult.
Green World assumes a radical social shift in favor of a “green” and sustainable future. Although at first sight this scenario may seem extremely positive, it will produce many pressures for change. Most significantly, it will require whole-scale replacement and redesign of the current transportation infrastructure to meet the new demands and expectations for sustainability. As individuals move into more concentrated sustainable communities (probably in urban areas), there will be massive demand for transportation, which in turn will lead to new transportation requirements. Thus, in Green World, as in Wonder World, almost as many challenges will arise from success as arise from negative events in Crisis World. For example, there may be dozens of different options for new green technologies that require extensive infrastructure reconfiguration and no obvious “winner.” Similarly, decommissioning, reorienting, or redesigning “gray” infrastructure to meet the demands of new “green” public preferences may present considerable challenges to transportation agencies.

Specific challenges associated with Green World include the following:

- Increasing population growth and greater diversity of population (more diverse ethnic population and aging population) leads to demands for much more diverse transportation services (e.g., increasing elderly population requiring assisted mobility).
- There is a demand that all sectors of society become substantially “greener”
- Greater concentration of population in green urban areas leads to a need to address equity impacts of the “left-behinds” in less dense regions (i.e., regions that are trapped in long-term decay and economic decline)
- Major decreases in personal vehicle travel means that agencies must provide sufficient alternatives for intracity and intercity travel
- Moving away from carbon-based fuels may require new vehicles and new infrastructure

Opportunities in Green World will include the following:

- Social and political consensus on green policies and sustainability means that resources will be available to support an expanding sustainability-based transportation system
- Technology will facilitate new planning and participation mechanisms, real-time performance management and control, and flexible resource allocation
- Green technology will support sustainable transportation
8. ADDRESSING THE FUNCTIONAL GAPS UNDER SCENARIOS

This chapter discusses how transportation agencies might address key functional gaps under different scenarios. Section 8.1 presents some general principles for managing public sector change that are relevant to all scenarios, based on analysis of the scenarios, review of the literature on sustainability, transportation and public policy, and interviews with subject matter experts. Section 8.2 addresses each potential sustainable end-state and probable conditions under the various scenarios. Finally, Section 8.3 identifies organizational, policy, and management implications and strategies for agencies to consider stay ahead of evolving conditions and policy systems related to TBL sustainability.

8.1 KEY PRINCIPLES IN PREPARING FOR CHANGE UNDER ALL SCENARIOS

As emphasized throughout this report, national and global futures are highly uncertain. On the one hand, a convergence of technology and economic growth may deliver substantial benefits and opportunities. On the other, society may face an environmental and social crisis. Over the next 30 to 50 years, the United States will likely experience significant demographic shifts and economic changes, perhaps on the order of the urbanization of the late 19th and early 20th centuries. In some regions, population may shrink to near pre-settlement levels; in others, concentrations of people and economic activity may reach very high levels. But it is important to bear in mind that the nation has experienced repeated bouts of major technological, social, and economic change over the last two centuries: the railroad system, instantaneous information transmission over long distances, the automobile highway system, two world wars, the Cold War, the civil rights movement, Vietnam, and Watergate. So while future challenges and opportunities may be significant, the social and economic resources available to respond are also formidable.

If TBL sustainability does evolve as an overarching organizing principle (or policy system) for transportation, experience and literature on sustainability-related initiatives suggest that some basic principles should be kept in mind for decisionmaking and change response, including the following:

- **Adopting a precautionary approach to policymaking and decisionmaking:** A precautionary approach to decisionmaking means taking into account the level of risk, using existing knowledge, and accounting for uncertainties. The approach recognizes a

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27 Please note, this chapter brings together key findings from the research. As such, it references findings and materials mentioned and expanded upon earlier in the report. Parts of the text from earlier in the report are repeated in this chapter so readers do not have to reference earlier sections.
social responsibility to minimize the community’s exposure to harm as much as possible when detailed situational analysis and investigation have found a plausible risk arising from a decision or policy choice. This precautionary approach should be used when making planning decisions that relate to new policy, as well as when changing existing policy. The precautionary approach is even more advisable when there is a high level of uncertainty, where decisions are effectively irreversible, or where there are effects of low probability but potentially high impact (e.g., the decision to locate transportation infrastructure assets near areas susceptible to floods or rising sea water).

- **Choosing flexible or adaptive management options and building internal adaptive capacity:** Flexible or adaptive management strategies are based on the insight that knowledge and understanding of social, economic, and environmental conditions is inevitably partial, limited, held in different forms (e.g., data, tacit knowledge and understanding, experiential information), and widely distributed among different individuals, groups, and organizations. As such, one single entity can never develop an all-encompassing vision of the world that correctly models all factors and elements that are likely to affect the outcome of a decision or public policy. A more realistic approach is to adopt a flexible or adaptive management strategy. Under this approach, policies are adopted and implemented incrementally or as small steps over time. The capability for policy change based on new information is built into the process such that the implementation or design of a program can be adjusted gradually. Monitoring is an important part of this approach—data must be available so policymakers can identify unintended consequences and act quickly to limit damage or build on successes. More open, responsive, and resilient structures that focus on outcomes rather than process and possess an expectation of change can be helpful, but this may require a culture change and a different organizational and institutional system. A change-expecting, resilient organization provides safety (but not necessarily security or stability) in the midst of change; manages the emotional consequences of continuous mission and organizational transformation and change (e.g., anxiety, grief at the loss of status or role); and emphasizes constant learning, development, and internal capability growth.

- **Using “no-or-low regrets” options:** No-or-low regrets options are built around the idea that insofar as possible, good policy should bring benefits regardless of the reasonable future. While this might reduce the potential for a policy to maximize benefits by “doubling down” on an attractive near-term policy option, caution may ultimately increase constituent value because it can help agencies deal with uncertainty. In practice, this means moving away from simple statements of the costs and benefits of policies or infrastructure investments and moving toward a more nuanced approach that explicitly acknowledges uncertainty and clearly expresses benefits as a range that could occur under different conditions. For example, under this approach, a decisionmaker may have to choose between two policies—one that produces an expected net social benefit of $1 million and one that produces a range of net social benefits from $500,000 to
$750,000. Under classic cost-benefit analysis, the decisionmaker would select Option 1 (Option 1 net benefit exceeds Option 2). However, if the benefit from Option 1 would only accrue if the future is exactly as predicted, while Option 2 benefits will accrue under a wide range of scenarios, the decisionmaker would select Option 2 as the no-or-low regrets option. Thus, the decisionmaker would accept suboptimal decisionmaking in exchange for an “insurance policy” against uncertainty. It should be noted that the literature on these policy approaches stresses that no-or-low regrets options are particularly suitable for near-term projects where small investments can deliver obvious and immediate benefits no matter what the outcome and provide experience on which to build further actions and support for more ambitious policy programs (Eales, White, Owen, Kent, & Sing, 2006).

- **Avoiding burden shifting:** This principle suggests that decisionmaking and policymaking should not resolve problems by shifting them to other areas, jurisdictions, modes, or other economic or social sectors. For example, congestion management policies might deal with the problems in one area by pushing traffic to another or create new economic or social problems by imposing costs on vulnerable commerce or populations. This principle emphasizes the need to integrate policymaking across departments and agencies. It is difficult to apply and often impeded by legislative mandates, but it is vitally important in a TBL policy system.

- **Dealing with “messy” futures, citizen cooperation, and enabling innovation:** Social, environmental, and economic innovation can be messy and confusing. The future rarely comes as a unitary, easily understood event that everyone immediately comprehends and accepts. The future arrives at an uneven pace. As the science fiction writer and futurist William Gibson observed, “the future is already here—it is just not evenly distributed” (National Public Radio, 1999). For example, for someone living in Northern California and working in the technology industry, it can seem that Wonder World is well on its way to arriving. Similarly, for someone living on the Gulf Coast and still recovering from hurricanes Katrina and Rita and the Deepwater Horizon oil spill, it might seem that Crisis World is already here. Furthermore, even generally experienced events can be open to a wide range of interpretations. For example, a review of 21 books on the 2008 financial crisis found little consensus on the basic facts of the crisis, its causes, and the policies that should be adopted in response (Lo, 2012). Inevitably, politics, different interests and experiences, and personal biases affect interpretations. The “messiness” of the future is part of the reason why locations pursuing strong TBL initiatives have adopted the precautionary principle and the other methods discussed in this section. However, the messy and “joint and uneven” nature of change is also a reason transportation agencies may wish to prepare for the future by building relationships with communities and groups that are affected differently, developing connections with individuals with different perspectives, working across jurisdictional borders, and accepting variability. In this sense, government can act as an enabler of
innovation and communication. Change experienced “on the ground” can be an important part of the solution to emerging problems. Government-enabled collaboration can incorporate a diversity of perspectives, allow experimental policy design, and create an environment where it is possible to fail safely.

- **Making public participation a positive force**: Technological, social, legal, institutional, political, and economic changes have created an environment where citizens, social groups, activists, and “super-empowered individuals” are a fact of life in public policymaking. Whatever happens in the future, it is very unlikely that this environment will change (Friedman T. L., 2000). Most aspects of public policymaking and implementation will become more open to citizen review and inspection, and public comment, review, and involvement are almost inevitable. However, this does not necessarily mean that every decision and program is condemned to “death by discussion” or interminable delays from external actions. Public participation can be a vital, positive force. Indeed, the experience of sustainable transportation policy suggests that public participation is a critical element of successful policy. Citizens are “co-producers” of these outcomes; that is, they are critically involved in the success of a policy because substantial behavioral change is required from them if a policy is to deliver its full benefits (Brandsen & Pestoff, 2006). Successful approaches to public participation are likely to be those that design policy around the assumption that the public is involved in decisionmaking and will be critical to successful implementation, and that building and earning trust are crucial to being able to take necessary decisions in periods of uncertainty.

This last principle is of critical importance in preparing for a prospective shift to a TBL-based policy system. While effective public policy requires a democratic foundation, traditional participation models are often not well-suited to handling the challenges of TBL because the public is rarely involved in policy choice beyond electoral activity (Dryzek, 1994).

### 8.2 AGENCY ROLES AND RELATIONSHIPS UNDER SCENARIO

This section discusses in detail specific actions and policies that agencies could undertake under the scenarios. Generally speaking, certain policies, actions, programs, and concepts are appealing no matter what the scenario, as illustrated in Figure 24.
In the near term, all scenarios appear to be similar. Major differences only begin to become apparent in the midterm, and truly significant changes only occur in the long term. Thus, major policy differences are only really apparent in the long term (assuming that external conditions drive policy). Therefore, recommendations for options focus on this initial period and allow maximum flexibility and adaptability for the future to (1) provide useful, usable, actionable information and (2) not lock transportation agencies into policies that may not be useful in the future. The research shows a likely TBL end-state condition and plausible roles and relationships that would exist between different government entities under the different scenarios. As Table 49 shows, the future scenarios developed for this research, range from “crisis austerity” conditions to “managed austerity” conditions, with a range of possibilities in between. The research team believes that while the roles and relationships are necessarily somewhat speculative, public policy logic supports them. Table 49 summarizes key themes, and a further review follows.

### Table 49: Plausible Roles under Future Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Plausible Roles</th>
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<tbody>
<tr>
<td><strong>OVERALL ORIENTATION OF TRANSPORTATION POLICY</strong></td>
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<tr>
<td>Crisis World</td>
<td>• Crisis austerity – TBL with a low standard of living</td>
</tr>
<tr>
<td>Mega World</td>
<td>• Regionally managed TBL</td>
</tr>
<tr>
<td>Suburban World</td>
<td>• Decentralized TBL</td>
</tr>
<tr>
<td>Wonder World</td>
<td>• Managed sustainability – high living standards and management of systems to deliver TBL</td>
</tr>
<tr>
<td>Green World</td>
<td>• Managed austerity – TBL but lower living standards</td>
</tr>
</tbody>
</table>
## Scenario | Plausible Roles
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**ROLE OF FEDERAL AGENCIES**
Crisis World | • Strong influence on crisis response and transportation planning – focus on emergency planning, response and action. Focus on major transportation corridors and TBL tradeoffs
Mega World | • Possible diminished role in megaregions. More focus on intercity corridors, national network efficiency, and support of rural infrastructure
Suburban World | • Probably similar focus and interest as present. TBL initiatives are more distributed. Federal and state agencies may have to share new roles if urban influence declines
Wonder World | • Increased challenges in assisting agencies with rapid technological changes. Helping reinvent infrastructure if needed. Otherwise similar or somewhat diminished influence, depending on how the team pay for transportation
Green World | • Major role in national TBL policy systems. Development of new standards and work with states and localities to integrate and derive maximum synergy from state and local TBL programs

**ROLE OF STATE AGENCIES**
Crisis World | • Strong influence on crisis response and transportation planning – focus on emergency planning, response, and action. Focus on key transportation corridors and TBL tradeoffs in the state
Mega World | • Possible diminished role in megaregions. More focus on intercity corridors and support of rural infrastructure. More regional, interstate interaction and coordination needed, particularly in megaregion areas
Suburban World | • Increased influence and role in state transportation and TBL management. Coordination of increased numbers of players in transportation planning and TBL issues
Wonder World | • Increased challenges in assimilating rapid technological changes and effects of infrastructure changes, as well as faster demographic shifts. Overall influence may depend on how the team pay for transportation. TBL will be a difficult management challenge as rules and assumptions will change faster
Green World | • Major role in balancing state TBL programs, working with localities to deliver TBL, and managing transportation infrastructure changes

**ROLE OF REGIONAL TRANSPORTATION ORGANIZATIONS**
Crisis World | • Moderate role in planning response, coordinating rebuilding and rehabilitation programs, and shaping priorities for use of scarce transportation resources
Mega World | • Regional and megaregional planning entities likely play stronger parts in coordinated TBL-related decisionmaking
Suburban World | • Similar to current roles, possibly diminished by increased dispersion of population and transportation patterns
Wonder World | • Regional and megaregional planning entities likely play stronger parts in coordinated TBL-related decisionmaking
Green World | • Regional and megaregional planning entities likely play stronger parts in coordinated TBL-related decisionmaking
In the Crisis World scenario, crisis austerity represents a forced march to a somewhat balanced TBL, as ongoing environmental crises, recession conditions, and social needs all compete for attention. However, this TBL will likely be combined with a low standard of living, reduced mobility, and reduced transportation options. Furthermore, the unpredictable nature of Crisis World means sustainability will constantly be under threat and will need closer attention to maintain stability.

In the Mega World scenario, the main changes will be in consolidation and growth of megaregions. Those regions will likely strongly influence TBL policy, as they do for many sustainability initiatives today. In contrast, Suburban World is a dispersed, decentralized society that will have to manage sustainability at a more local level and on a smaller scale, raising more challenges for coordination and resource balancing.

It is important to understand the challenge that Suburban World would pose to sustainability. Suburban World envisions a radical decentralization of political and economic power. Small towns and individual homesteads would emerge as major economic hubs as people took advantage of the opportunities technology offered to move away from crowded cities. This would lead to enormous proliferation of interests, plans, and goals. Under a reenergized localism the more than 87,000 governments in the U.S. would be actively involved in planning for sustainability. The simple number of governments would make coordination very difficult to achieve. Furthermore, sustainability requires careful balancing and coordination. For the TBL to function properly there must be trade-offs. As the number of participants in these trade-off decision increase the difficulty in developing these trade-offs would increase exponentially. In addition, the range and diversity of communities would be extremely great. They could vary from wealthy communities deeply committed to sustainability to poor communities will to relax sustainability standards to attract economic development.

On the positive side, the decentralization of authority and economic power would mean that local communities could take on a larger burden in maintaining and operating their

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Plausible Roles</th>
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<tbody>
<tr>
<td><strong>ROLE OF LOCAL GOVERNMENTS</strong></td>
<td></td>
</tr>
<tr>
<td>Crisis World</td>
<td>• Front-line responders and managers of crisis response — manage local TBL compliance</td>
</tr>
<tr>
<td>Mega World</td>
<td>• Key roles in planning and implementation. Influence in TBL policy could be strengthened depending on funding structures in respect to user fees</td>
</tr>
<tr>
<td>Suburban World</td>
<td>• Key roles in planning and implementation. Influence in TBL policy could be somewhat stronger depending on funding structures in respect to user fees</td>
</tr>
<tr>
<td>Wonder World</td>
<td>• Key decisionmakers on adoption and implementation of new TBL-related technology</td>
</tr>
<tr>
<td>Green World</td>
<td>• Major decisionmakers on the implementation of new TBL-related technology. Involved in key decisions to decommission and/or reuse older infrastructure</td>
</tr>
</tbody>
</table>
transportation resources. Similarly, the plurality of approaches to managing transportation would lead to huge opportunities for experimentation and innovation. However, this in itself could be a challenge. Fuller’s (2002) in his analysis of radical decentralization in education that has occurred with charter schools movement notes the “paradox of radical decentralization” (Fuller, 2002). The paradox is that while decentralization allows innovation and experimentation is also can cause groups to retreat back into their parochial interests and become resistant to change. Thus, there is a vast set of innovations but managers of new organization are deeply emotional commitment to practices and have the power and authority to resist change.

In the Wonder World scenario, new technology will likely create opportunities for a much more dynamically managed system where information and sensor technologies could provide minute-by-minute management of factors that affect TBL. Simultaneously, technology and economic growth will deliver a high standard of living and numerous transportation and mobility options. In contrast, Green World represents a managed austerity condition. That is, the strength of the social commitment to TBL and green choices means society has accepted environmental tradeoffs that may reduce or limit standards of living and strength of economy.28

It should be emphasized that Green World is based on the assumption that there is a broad social consensus around the idea of sustainability. However, this does not mean that all interests and stakeholders will automatically agree to how the costs and benefits of sustainability should be distributed. To date there has been no comprehensive assessment of the likely costs of introducing sustainability planning on a large scale. Most analysis present a uniformly positive assessment of benefits. However, these assessments frequently include some valuation of nature resources or other non-market goods. In reality these benefits do not present themselves in a clear monetary fashion and non-technical individuals often have difficulty understanding how and why they have been monetized. Without these benefits, sustainability may not present as appealing a business case. Furthermore, it is inevitable that in some place sustainability will require that some individuals receive less benefits and high costs than others. As basic economics tells us, scarcity is inevitable (i.e., everyone cannot have everything they want) and choices must be made. These choices will benefit some stakeholders over others at least some of the time (e.g., permanent win-win solutions are not available all the time). For example, sustainability in Green World may mean that individuals cannot use personnel gasoline vehicles in urban areas, expect state or local government to maintain roads to extremely low density rural areas, and discouraging suburban growth and large homes.

Furthermore, considering the pluralist and open nature of American society, even a broad

28 Green World is an example of a “strong” TBL policy system; a “weak” TBL is characterized by considering all three bottom lines (people, planet, profit) as more or less equal capital (Turner, Gudmussen).
consensus will not be shared by some people. Undoubtedly some individuals would “drop-out” of the sustainability consensus and insist that they have a right to continue to live in “pre-sustainable” outposts (e.g., use older gasoline powered vehicles, live in larger, less dense, car-based communities). Thus, even though the Research Team assumed broad support for sustainability under Green World, individual stakeholders will still need to be “sold” and persuaded as to the benefits of specific sustainability programs. As such, Green World may require substantial consensus building efforts to develop support for specific sustainability measures.

8.3 FUNCTIONAL IMPLICATIONS UNDER EACH SCENARIO

Table 50 shows key requirements for high-level transportation functions performed in a TBL society under the different scenarios—assuming our society will eventually evolve to embrace TBL as an organizing principle. As can be seen, the basic functions need to be performed to support the requirements of a TBL end state, regardless of the future scenario. The main effects the various scenarios will have on the high-level functions are that the opportunities and challenges presented to transportation (in performing the functions) will likely arise in distinctly different scenario-specific ways along the following scenario features:

- Political and demographic landscape and rate of change
- Demand (and ability to pay) for available modal transportation services
- Outlook for energy availability and cost
- Pressure on the health of the environment
- Age and health of infrastructure
- Priorities and needs of society.

When TBL is assumed as an end state and the challenges are viewed holistically, a number of key themes and needs become clear. The following themes will play a very large part in achieving and managing TBL:

- **Sustainability metrics and management systems**: TBL requires the development of credible sustainability metrics and management systems to maintain a TBL policy system. There have been excellent advances in this area (most focused on environmental sustainability), but there is still no clear vision on what TBL systems would look like or how they could be widely applied and accepted as credible enough to drive major decisions or tradeoff solutions.

- **Public participation**: Under any scenario (the likely exception may be Crisis World), a strong framework for communication, public participation, and outreach will be needed. TBL will require not only communication but also multisector engagement. Transportation agencies will need to consider building a stronger engagement
framework around current needs development and planning processes to prepare for the evolution of a TBL policy system.

- **Prioritization and accounting for full costs**: Total cost accounting will be a necessary feature in TBL to support realistic decisions in coming years. In fact, it is already a pressing need for agencies as they consider present-day sustainability investments and project or program risk sharing with the private sector.

- **Culture change**: Agencies will need to facilitate internal culture change from traditional planning and transportation biases and (sometimes narrow) focus on environmental sustainability toward TBL as a goal. Internal education, a clarified vision on long-term sustainability (and TBL) objectives, a “code of TBL ethics,” and celebration of TBL team and individual behavior may be good ways to begin a general culture change.

### Table 50: Functional Implications under Each Scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Response of Transportation Agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEVELOPING CONSENSUS ON NEEDS AND GOALS</strong></td>
<td></td>
</tr>
<tr>
<td>Crisis World</td>
<td>- Crisis driven—identify resources needed and work with experts and key stakeholders to identify key resources for sustainability</td>
</tr>
</tbody>
</table>
| Mega World     | - Need new mechanisms to coordinate needs assessment and develop consensus on goals at a megaregional level  
                 | - Decisionmakers and stakeholders work proactively together creating goals and plans to support transportation needs sustainably. Developing consensus is a major goal. Active outreach and consensus building |
| Suburban World | - Radically decentralized society provides opportunities for public participation and direct democracy in decisionmaking  
                 | - Decisionmakers and stakeholders work proactively together creating goals and plans to support transportation needs sustainably. Developing consensus is a major goal. Active outreach and consensus building |
| Wonder World   | - New technologies provide opportunities for public participation and direct democracy in decisionmaking  
<pre><code>             | - Decisionmakers and stakeholders work proactively together creating goals and plans to support transportation needs sustainably. Developing consensus is a major goal. Active outreach and consensus building |
</code></pre>
<p>| Green World    | - Decisionmakers and stakeholders work proactively together creating goals and plans to support transportation needs sustainably. Developing consensus is a major goal. Active outreach and consensus building |
| <strong>PLANNING AND PROGRAMMING</strong>                                                                                   |
| Crisis World   | - Focus on prioritizing key assets and developing policies to manage crisis and lead to sustainability |</p>
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Response of Transportation Agencies</th>
</tr>
</thead>
</table>
| **Mega World**| - Need to develop megaregional planning and programming mechanism with the authority to work with state and local governments to implement megaregional initiatives  
                 - Emphasize flexibility, accessibility, connectivity, and quality (closer, better)  
                 - Emphasize multimodal and connections between modes  
                 - Manage transportation and mobility demand  
                 - Emphasize integrated planning combining transportation (all modes) with other relevant areas (environment, demographic trends, cultural resources) and levels of government  
                 - Use analysis to interrupt and reverse trends (predict and prevent)  
                 - Work from preferred vision to planning and provision (deliberate and decide) — build scenarios, backcast, deliberate, and decide  
                 - Flexible regional focus engages multiple jurisdictions  
                 - Planning and investment decisions are driven by reliable and up-to-date data that reflects full range of impacts from investing in transportation |
| **Suburban World** | - Need to develop mechanisms to coordinate decentralized programs  
                           - Emphasize flexibility, accessibility, connectivity, and quality (closer, better)  
                           - Emphasize multimodal and connections between modes  
                           - Manage transportation and mobility demand  
                           - Emphasize integrated planning combining transportation (all modes) with other relevant areas (environment, demographic trends, cultural resources) and levels of government  
                           - Use analysis to interrupt and reverse trends (predict and prevent)  
                           - Work from preferred vision to planning and provision (deliberate and decide) — build scenarios, backcast, deliberate, and decide  
                           - Flexible regional focus engages multiple jurisdictions  
                           - Planning and investment decisions are driven by reliable and up-to-date data that reflects full range of impacts from investing in transportation |
| **Wonder World** | - New technology provides ability to model and design programs with much more accuracy and fidelity  
                           - Emphasize flexibility, accessibility, connectivity, and quality (closer, better)  
                           - Emphasize multimodal and connections between modes  
                           - Manage transportation and mobility demand  
                           - Emphasize integrated planning combining transportation (all modes) with other relevant areas (environment, demographic trends, cultural resources) and levels of government  
                           - Use analysis to interrupt and reverse trends (predict and prevent)  
                           - Work from preferred vision to planning and provision (deliberate and decide) — build scenarios, backcast, deliberate, and decide  
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                           - Planning and investment decisions are driven by reliable and up-to-date data that reflects full range of impacts from investing in transportation |
<table>
<thead>
<tr>
<th>Scenario</th>
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• Emphasize multimodal and connections between modes  
• Manage transportation and mobility demand  
• Emphasize integrated planning combining transportation (all modes) with other relevant areas (environment, demographic trends, cultural resources) and levels of government  
• Use analysis to interrupt and reverse trends (predict and prevent)  
• Work from preferred vision to planning and provision (deliberate and decide) — build scenarios, backcast, deliberate, and decide  
• Flexible regional focus engages multiple jurisdictions  
• Planning and investment decisions are driven by reliable and up-to-date data that reflects full range of impacts from investing in transportation |
| Crisis World    | • Focus on prioritization and identifying and funding basic needs for sustainability  
• Identify how non-core functions can be shifted to other partners  
• Identify the ability of government to support the long-term cost of investments from a fiscal and TBL point of view |
| Mega World      | • Need to develop megaregional mechanisms to budget and fund interstate and inter-locality megaregion-wide projects  
• Use integrated and cooperative budget process  
• Incorporate full social, environmental, fiscal, economic, and other costs into planning and provision — use full cost accounting  
• Flexible — funds flow to program areas, regions, and modes where they will make the biggest impact on societal sustainability  
• Independence — consistent funds provided by dedicated transportation funds with long-term commitment to TBL priorities |
| Suburban World  | • Use integrated and cooperative budget process  
• Incorporate full social, environmental, fiscal, economic and other costs into planning and provision — use full cost accounting  
• Flexible — funds flow to program areas, regions, and modes where they will make the biggest impact on societal sustainability  
• Independence — consistent funds provided by dedicated transportation funds with long-term commitment to TBL priorities |
| Wonder World    | • New technology provides ability to manage funding and track spending with much more accuracy and fidelity  
• Use integrated and cooperative budget process  
• Incorporate full social, environmental, fiscal, economic, and other costs into planning and provision — use full cost accounting  
• Flexible — funds flow to program areas, regions, and modes where they will make the biggest impact on societal sustainability  
• Independence — consistent funds provided by dedicated transportation funds with long-term commitment to TBL priorities |
<table>
<thead>
<tr>
<th>Scenario</th>
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</tr>
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| **Green World**  | • Use integrated and cooperative budget process  
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                   • Flexible—funds flow to program areas, regions, and modes where they will make the biggest impact on societal sustainability  
                   • Independence—consistent funds provided by dedicated transportation funds with long-term commitment to TBL priorities |
| **RULEMAKING AND REGULATION** |                                                                                                      |
| Crisis World     | • Reduced public participation as a result of crisis situation and increased ad hoc regulation         |
| Mega World       | • Public-expert partnership in developing regulation and rules—experts invite and encourage public participation  
                   • Bias for flexible, voluntary regulation  
                   • Open to a wide plurality of interests, stakeholders, and activists  
                   • Involve public substantially during the entire rulemaking process  
                   • Cooperative and consultative  
                   • Emphasize voluntary regulation |
| Suburban World   | • Public-expert partnership in developing regulation and rules—experts invite and encourage public participation  
                   • Bias for flexible, voluntary regulation  
                   • Open to a wide plurality of interests, stakeholders, and activists  
                   • Involve public substantially during the entire rulemaking process  
                   • Cooperative and consultative  
                   • Emphasize voluntary regulation |
| Wonder World     | • Public-expert partnership in developing regulation and rules—experts invite and encourage public participation  
                   • Bias for flexible, voluntary regulation  
                   • Open to a wide plurality of interests, stakeholders, and activists  
                   • Involve public substantially during the entire rulemaking process  
                   • Cooperative and consultative  
                   • Emphasize voluntary regulation |
| Green World      | • Public-expert partnership in developing regulation and rules—experts invite and encourage public participation  
                   • Strong regulatory system—clear tradeoffs between TBL  
                   • Open to a wide plurality of interests, stakeholders, and activists  
                   • Involve public substantially during the entire rulemaking process |
| **SERVICE AND PROJECT DELIVERY** |                                                                                                      |
| Crisis World     | • Focus on limited service delivery, transferring non-key functions to other entities                  |
| Mega World       | • Sustainability embedded in all business processes (e.g., procurement, O&M)  
                   • Sustainability performance measured and reported for continual improvement |
| Suburban World   | • Sustainability embedded in all business processes (e.g., procurement, O&M)  
                   • Sustainability performance measured and reported for continual improvement |
## Scenario | Response of Transportation Agencies
--- | ---
**Wonder World**  
- New technology provides ability to manage programs and transportation events and trends in real time with much more accuracy and fidelity  
- Sustainability embedded in all business processes (e.g., procurement, O&M)  
- Sustainability performance measured and reported for continual improvement

**Green World**  
- Sustainability embedded in all business processes (e.g., procurement, O&M)  
- Sustainability performance measured and reported for continual improvement

### COMPLIANCE AND DISPUTE RESOLUTION

**Crisis World**  
- Emergency decisionmaking — more hierarchical, less democratic

**Mega World**  
- Minimize politics  
- Emphasize “deliberate and decide”  
- Avoid law and courts

**Suburban World**  
- Minimize politics  
- Emphasize “deliberate and decide”  
- Avoid law and courts

**Wonder World**  
- Minimize politics  
- Emphasize “deliberate and decide”

**Green World**  
- Minimize politics  
- Emphasize “deliberate and decide”

### EDUCATION AND CULTURAL DEVELOPMENT

**Crisis World**  
- Internal education focus on crisis-related issues and development of a “survival sustainability” culture

**Mega World**  
- Focus on multidisciplinary workforce — acceptance of flexible standards  
- Commit to sustainability education, training, and internal incentives to be sustainable  
- Culture of sustainability and stewardship  
- Performance standards and incentives associated with sustainability

**Suburban World**  
- Focus on multidisciplinary workforce — acceptance of flexible standards  
- Commit to sustainability education, training, and internal incentives to be sustainable  
- Culture of sustainability and stewardship  
- Performance standards and incentives associated with sustainability

**Wonder World**  
- Focus on multidisciplinary workforce — acceptance of flexible standards  
- Commit to sustainability education, training, and internal incentives to be sustainable  
- Culture of sustainability and stewardship  
- Performance standards and incentives associated with sustainability

**Green World**  
- Focus on multidisciplinary workforce — acceptance of flexible standards  
- Commit to sustainability education, training, and internal incentives to be sustainable  
- Culture of sustainability and stewardship  
- Performance standards and incentives associated with sustainability
### OUTREACH AND COMMUNICATION

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Response of Transportation Agencies</th>
</tr>
</thead>
</table>
| Crisis World   | - Focus on explaining to the public the rationale behind emergency measures, rebuilding, and need to move toward sustainability  
                 - Build support for initiatives and programs that require reduced mobility and fewer services                                                                                                                                 |
| Mega World     | - Focus on explaining to the public the rationale for megaregional planning and the importance of dealing with issues outside the megaregion                                                                                                    |
| Suburban World | - Focus on explaining to the public the responsibilities of a rapidly decentralizing system and dealing with challenges of managing sustainability in a decentralized network                                                                |
| Wonder World   | - Focus on explaining to the public the rationale behind different technology selections and rebuilding transportation infrastructure to address new technology issues and sustainability  
                 - Build support for initiatives and programs that require a move to new technologies and greater sustainability                                                                                     |
| Green World    | - Focus on explaining to the public the rationale behind green measures and rebuilding transportation infrastructure to address green issues and sustainability  
                 - Build support for initiatives and programs that require reduced mobility to support sustainability                                                                                           |
9. NEAR-TERM TOOLS AND STRATEGIES TO CONSIDER

Transportation agencies are considering strategies to prepare for a future in which transportation could best support a sustainable TBL policy system. Those strategies depend on understanding the challenges and opportunities to be found in the envisioned TBL policy system and the gaps—where do agencies need to go from here? This chapter recaps the research on where transportation agencies are now in relation to a TBL policy system; what the key issues are for evolution to a new TBL policy system; followed by what agencies can reasonably do to assess, prepare for, and participate effectively in that evolution. Figure 25 below is an overview (presented earlier) of key characteristics of transportation policy systems, evolving from history to a future sustainable TBL system.

Figure 25: Policy System Spectrum Related to Sustainability Capability and Initiatives

This research, along with other work (including the NCHRP 20-83 series, and NCHRP 08-74), has and continues to assemble a considerable body of information and opinion to support practical deliberation on the strategies needed. In referring to “transportation agencies” in this discussion, the report addresses a large and variable audience of government agencies at all levels in the transportation community; therefore, all of the research results will not necessarily
interest or resonate with the entire audience in the same way. However, it is clear that a viable TBL policy system will require close collaboration and strategic consensus at all levels of government, as well as with the private and institutional sectors.

There is a growing sense indicated in the literature and by the experts interviewed by the research team that evolution to a TBL policy system would bring significant changes to the way that transportation agencies will need to work, think, and make investment decisions.

Modal transportation infrastructures each engage specific technical disciplines, operational requirements, structures, geographic aspects, and user service expectations. As a result, transportation agencies will most likely always have a distinct, modally-oriented, core mission to deliver safe and efficient service, and to preserve infrastructure, with the least possible secondary impact on society’s other interests in quality of life, environmental preservation, and economic well-being. This modal infrastructure stewardship and service delivery core mission is not likely to diminish or change significantly in a TBL policy system (although methods and processes might).

What is likely to change very significantly under a TBL policy system is primarily in goal-setting, planning, and in program funding investment decisions. For example, given the three TBL dimensions for society to address, balance, or optimize in a particular region, it is not hard imagine (practical or not in today’s structures) regional funding capacity being pooled from all sources, with social, economic, and environmental needs being considered against TBL-based ROI model. High-level planning decisions would be made for a mix of new investments in social, economic development, and environmental management programs. Transportation funding for all modes would flow from these decisions, along with specific goals for contributions to the overall ROI expectation. This is a top-down logic framework, to be sure, but it need not necessarily be an autocratic process. It could be very democratic, involving other agencies and private sector entities to deliberate and decide -- given credible ROI models, with a decisionmaking framework and guiding principles. While this kind of scenario is unlikely in the near term, it is a conceivable long term direction under the TBL policy system. This concept may be the source of some of the discomfort with the TBL, which the research team observed during the interview process.

Success or failure of a TBL policy system will be highly dependent upon having effective and very credible and authoritative methods and tools to assess and value ROI along the three dimensions of TBL. For transportation agencies to prepare well for a sustainable future, it will

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29 Dedicated funding sources may be impediment to this concept, but that could change over time also, if for example, user fees were pooled and combined with taxes and other sources to pay for sustainable TBL, rather than just for transportation infrastructure and service needs.
be very important to develop, test, refine, (and put into practice) an ROI logic framework and models to inform internal and external decisionmakers on goal-setting, planning, and programming. This logic framework will have to explicitly address the economy, environment, and social needs of the region. There are significant challenges to support such a decision support framework and model. Needs include:

- Cost/benefit algorithms linking multi-modal mobility and safety to TBL;
- Cost/benefit algorithms linking transportation projects to TBL;
- Standards of measure for transportation needs and performance;
- Situational data and rating systems to inform regional TBL needs;
- TBL-based assessment and rating standards for project selection;
- Models for planning and programming tradeoff decisions; and
- Accumulated case data to validate the models.

The research presented in Chapters 3 and 4 of this report suggest that many state transportation agencies have evolved from a Level 1 policy system (“Compliant Transportation”) to a Level 2 policy system (“Green Transportation”) over the past decade. The research also suggests that overall, urban local agencies are slightly ahead on this scale, and that federal agencies are behind in terms of current capabilities and initiatives.

It is logical that a new transportation policy system related to the environment, with economic and social implications, would emerge and evolve at the local level and would build momentum from there. At the local level, consensus can be developed around a narrower set of specific issues, and land-use decisions usually are made or strongly influenced locally. This local influence is not necessarily operative for the development of other policy systems built around other concerns or needs. For example, consider the speed and effect of the policy system built around transportation security following the events of 9/11. Figure 26 (first seen in Chapter 3 as Figure 7) is a comparative illustration of the top-down and bottom-up policy system development processes.

The top-down and bottom-up policy development processes are not mutually exclusive. As (and if) support builds for sustainable TBL initiatives, and as larger investment decisions are needed, a top-down process may play a stronger role to accelerate progress.
Figure 26: Policy System Development—Top-Down, Bottom-Up

Top-Down Executive Led Approach to Building Sustainability

State Leaders and key stakeholders begin sustainable initiatives

Demonstrate ROI, show benefits

Increase support, build coalitions in favor of change

New Legislation or Executive Orders

DOT changes policies, programs and process

Program Implemented

Program produces benefits

Public
Stakeholders
Major interest groups
Economic Interests

Bottom-Up Locality Led Approach to Building Sustainability

Local transportation challenges create catalyst for change

City government leaders develop sustainability program in response to local challenges

Demonstrate ROI, show benefits

Increase support, build coalitions in favor of change

Success builds support

Local DOT changes policies, programs and process

Program Implemented

Program produces benefits

Public
Stakeholders
Major interest groups
Economic Interests

The following sections of Chapter 9 present for consideration strategies for moving forward, first at a general level, followed by more function-specific approaches.
9.1 **GENERAL STRATEGIES**

A mature sustainable TBL policy system may be far off, but effort to prepare for that eventuality by implementing practical elements of the concept in transportation decisionmaking seems worthwhile, according to many of the thought-leaders interviewed by the research team. Nevertheless, many noted that decisions to invest an agency’s focus, funds, and political capital are difficult to make toward what could be a distant objective – particularly with existing funding constraints. To inform agency leaders on TBL-related trends, continuous assessment of evolving TBL, both regional and national, is worthwhile to consider.

Although research shows that significant activity and momentum has been built toward green transportation and context-sensitive development, there is as yet no experience with sustainable TBL that conclusively shows that it is a practical system. The situational assessment should provide a continuing barometer for making decisions on priorities, level of commitment, and potential ROI. Some general strategy development actions for agency consideration (in addition to tracking relevant legislation and rulemaking) include:

- Establish and/or participate in a national dialogue on evolution of a TBL policy system, including all levels of government and the private sector;
- Monitor and assess the development and spread of sustainability rating systems and measures, particularly those sponsored by independent rating bodies;
- Monitor and assess the development and adoption of measurement and certification standards, particularly those that deal with two or more elements of the TBL;
- Monitor and assess the deployment of sustainability tools and methods, particularly those adopted by several peer agencies, focusing on those that involve two or more elements of the TBL; and
- Conduct periodic discussions with stakeholders and agency constituents to take stock of the outlook for sustainable TBL (e.g., timing could be triggered by significant events, rulemaking, or trend changes in the factors monitored).

Voluntary adoption and use of measurement and rating standards by agencies and the private sector is a strong indicator of both utility and credibility within the community or market, which is why the measurement and rating are the focus of several of the monitoring activities.

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30 In this case, the team is not referring to what is known as “strong” TBL, which treats the environment as fixed capital and makes tradeoff choices at the expense of economic and social values. “Strong” TBL is not far from the policy system of today, where such tradeoffs are made frequently. Rather, the team is referring to the “weak” TBL concept, in which all three bottom lines—environment, economics, social values—are traded off, balanced, and optimized.
listed above. Rapid spread and voluntary use of the LEED rating in the building industry is a good example of a rating system which has influenced the private sector focus on best practices in improved environmental design, materials, and energy use. In addition to the aforementioned tools, there are tools and methods that agencies can adapt, develop, and use broadly to support high-level agency functions. Such tools include:

- Self-assessment tools to continuously gauge the “TBL maturity” and capability of the agency to prepare for the next phase of development of the sustainability policy system, which will help focus on near-term actions to improve or strengthen focus, if needed;
- Adoption and adaptation of appropriate sustainability-related ROI assessment tools, which could support communications and decisionmaking for many agency functions;
- Surveys and scans to follow up on current or previous sustainability initiatives and decisions to confirm or calibrate logic and assumptions.

The actions suggested above could be implemented at relatively low expense by transportation agencies today. They are easily reversible, “no-or-low regrets” actions, producing strategic information that provides insight into future demands and benefits.

The following section outlines near-term strategies for consideration, organized around the functional framework used in this research.

9.2 DEVELOPING CONSENSUS ON FUTURE VISION, GOALS, OBJECTIVES, AND NEEDS

The general process for this function is currently well-established for most state agencies. Several aspects of this process present challenges in dealing with sustainability, particularly when moving out of the discussion on transportation and environment and moving into the discussion of transportation and TBL. The research team suggests that the following areas will be complicated by the TBL:

- Achieving agreement from stakeholders and partners on a definition of sustainability, a definition that is built on the TBL and also accounts for state and regional needs and priorities
- Mapping agency goals to the proposed definition on sustainability
- Developing associated measurable objectives to track agencies’ progress in addressing needs and achieving progress in meeting goals
- Developing performance measures tied to the proposed objectives and for each focus area.

These processes likely will become routine when a TBL policy system has developed and matured, when appropriate ROI models and performance measures will presumably exist. An
ROI model that can function on a macro-level (pre-project planning and selection) could be useful in the near term to test and incorporate public expectations for TBL outcomes. This challenge is magnified with the need to address the needs of multiple civil agencies as the TBL policy system evolves. Agencies would be well served in the near term to explore alternative ROI models that could serve both present and future needs. Future research will initiate this exploration in support of the tools and methods treatments needed for Interim Report #2.

Given that future TBL-related policy systems likely will require much more public, interagency, and inter-sector engagement than previous decades, agencies may find it useful to test the various choice-facilitation models that already have been developed. These models are interactive, and can encourage multiple stakeholders to engage in decisionmaking by analyzing responses to many issues that involve choices, producing weightings, rankings, and other data to facilitate negotiation and consensus. Expert Choice™ is an example of such a model/tool.

9.3 PLANNING AND PROGRAMMING

Transportation agencies can select from numerous tools to improve sustainability planning and programming. For example, California has developed the Regional Blueprint Planning Program. The California legislature established this process in 2005 as a two-year program, and has since expanded it. Regional blueprints are collaborative planning processes that engage residents of a region in articulating a vision for the long-term future of their region. The regional vision is developed from residents’ values and priorities, and informed by advanced GIS modeling and visualization tools that demonstrate the potential impacts of growth and planning decisions. The process leads to the development of alternative growth scenarios for the region, and, through a public process, to selection of a preferred growth scenario that can then guide regional and local land-use and transportation decisions for a future that is sustainable, while also meeting residents’ needs and providing a high quality of life for all.

Caltrans publishes regular reports on the success and progress of the plan. For example, the 2010 California Regional Progress Report presents a framework for measuring sustainability based on 20 integrated, place-based, quality-of-life regional indicators. Regional-scale issues, such as air quality, housing affordability, vehicle miles traveled, and electricity use, form the basis for assessing the combined impact of regional outcomes on the state’s sustainability. Data needs are highlighted for important regional-scale indicators that currently lack widespread or accurate measurements, including tracking new development, combined housing and transportation costs, and equity. The report calls for dialogue among state, regional, and local

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governments to share strategies, address disparities, define sustainability, and improve sustainability measurement.

The planning and programming function is particularly in need of improved ROI tools and approaches for estimating sustainability. These tools can be used to select specific projects and to communicate the business case for sustainability to stakeholders. There are a many such tools currently being used in the U.S. and other countries. There also are a number of firms that have developed these tools and offer them as part of their services. For example, HDR and IBM both have developed ROI sustainability tools for transportation and local communities. While these tools are sold as being suitable for assessing sustainable transportation projects, they largely focus on the operational impacts of transportation investments. For example, HDR’s tool estimates the capital and operating costs of different investment decisions, the benefits to the environment of reductions in energy use (e.g., reduced water contamination, reductions in GHG and criteria pollutants), and safety and improvements in health (Williams, Larocque, & Vilain, 2011). However, the target of the methodology is a transportation facility, such as a bus station or a transit garage. While this is an important part of estimating the sustainability benefits of transportation investments, the methodology is not flexible enough to address the broader environmental, economic, and social impacts of an entire transportation system.

Some tools do address these broader impacts, such as the New Zealand Land Transport’s Economic Evaluation Manual (Volume 2). These tools estimate the benefits of sustainable transportation projects. It breaks down sustainability benefits into a variety of environmental, economic, and social benefits. Benefits are estimated based on the mode choice changes, such as reduced congestion, reduced idling, and other changes that are intended to occur as a result of sustainability. Environmental benefits are associated with GHG, criteria air pollutants, water, and other environmental factors. Social benefits are associated with reduced injuries and accidents, improved health (from encouraging mode use shift to walking and biking), and economic benefits include benefits associated with the value of time and the value of freight delays. The methodology is supported by a number of default values that all towns and cities use to estimate the monetized benefit of factors such as “decongestion” (i.e., reducing congestion). The methodology also includes the facility-based measures discussed above (e.g., reduction in energy use due to the construction of a new bus station) and is packaged into a series of spreadsheets for easy analysis.

Tools used in the U.S. address many of the same indicators. For example, Caltrans has maintained a simple ROI spreadsheet model for more than a decade that estimates the costs and benefits of highway projects. This simple tool guides users through the development of cost estimates and also estimates project benefits in terms of time saved from reducing congestion, reduction in accidents (monetized as reduced morbidity and mortality and reduced cost of responding to accidents), and environmental benefits (e.g., GHG reductions). With minor changes, these tools can be easily modified to become sustainability ROI tools.

There also are many other tools, most of which reflect the project (e.g., HDR’s sustainable ROI tool) and program (e.g., CalB/C) split. In general, the main challenge is to ensure that these tools are more widely used and that users are provided with appropriate guidance and training to use them properly.

### 9.4 Budgeting and Resource Allocation

Looking forward, these functions may need to undergo changes to accommodate new business models that require greater flexibility to enable transfers and shifts of budgets across agency organization units and between agencies as decisions and risks are shared to a greater extent than today. However, such changes likely will occur only after those new business models are developed; no specific changes in typical agency budgeting processes have been identified for the near term.

TCA will be a necessary feature in TBL management to support realistic decisions in coming years, as addressed in Chapters 3 and 8. TCA accounting systems must be well-understood and tested before going “live” because they will directly affect virtually all parts of the enterprise. TCA will affect and probably simplify the top-level account structure for budgeting, although not necessarily the detail level. That, in turn, should facilitate budgeting and resource allocation processes.

The TBL policy system also may affect budgeting and resource allocation by creating the need to make longer-term financial and risk-taking commitments in partnership with other agencies. Both budgeting and resource allocation must be in step with regular funding authorization cycles today. Although those cycles may or may not change in the future, the budget accounting and allocation systems will need rules and processes that allow for recognition and accounting of budget surpluses and deficits that can reasonably be contained and controlled, because funding will fluctuate. Agencies can benefit quickly from TCA by virtue of improved cost

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33 See [www.dot.ca.gov/hq/tpp/offices/ote/benefit.html](http://www.dot.ca.gov/hq/tpp/offices/ote/benefit.html).
tradeoff information, but the need for longer-term budgeting and management of surpluses and deficits, while likely, is not as urgent.

TCA also will improve agency practice by applying one of the key methodologies needed to support sustainability—LCCA—to better estimate the long-term cost of alternative investments. LCCA is a cost-estimating technique to assist practitioners in determining the costs of alternative investment options for a specific project or projects. LCCA is commonly applied to examine new projects and to assess preservation, rehabilitation, or replacement options for existing transportation assets. LCCA includes initial cost, but considers all agency costs, and can be expanded to account for user costs, throughout the life-cycle of alternative projects.

LCCA is supported by readily available software and can be adapted to include monetized estimates of “cost” for impacts that are otherwise qualitative.

In general applications, LCCA typically uses discounting to convert anticipated future costs to present value for alternatives analyses. Note that there is a debate over logic and policy issues with discounting. When public funds are used, it is difficult to assess the real opportunity cost incurred (or the discount rate needed).

The FHWA has provided substantial information on LCCA for more than 10 years. For example, in 1998, FHWA produced Demonstration Project 115, “Life-Cycle Cost Analysis in Pavement Design,” which developed a technical bulletin, an LCCA instructional workshop, and a proof of concept for an LCCA software tool. FHWA Resource Center personnel have presented this workshop to more than 40 states.

FHWA’s sustainability guidebook provides numerous examples of cases where states have successfully used LCCA as part of their sustainability programs. For example, the Illinois Department of Transportation’s (IDOT) LCCA process evaluates alternatives based on the present worth of future capital, maintenance, and operations costs, which enables the agency to compare alternatives that may incur costs at different times during their life-cycles. It also incorporates the interest rate, which is an important consideration in determining discount rates. LCCA helps identify the best value for investment expenditures (i.e., the lowest long-term cost that satisfies the performance objective).

The FHWA’s guidebook on sustainability recommends adapting the LCCA methodology to aid in assessing sustainability. Using this approach, the costs of a proposed project are expanded to

34 For more information on LCCA tools, see http://www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm.
35 For more guidance see Transportation Planning for Sustainability Guidebook, US DOT Federal Highway Administration, 2011.
consider all of the environmental, economic, and social impacts. The decisionmaker then can see the full cost profile of all alternatives and select the alternative with the lowest overall social, economic, and environmental cost. The LCCA methodology, combined with the ROI estimation techniques identified above, would form a powerful tool for long-term sustainability analysis.

**Summary—Budgeting and Resource Allocation**

- Increased flexibility in budgeting may be needed to support risk-sharing within and between agencies, over multiple budget cycles. Agencies should consider long-term budget accounting, and management and control of reserve accounts;
- Consider instituting TCA;
- Consider integrating LCCA tools into the planning and budgeting processes.

### 9.5 RULEMAKING AND REGULATION

Rulemaking by its nature is generally a prescriptive and arduous process. After authorizing legislation is passed, designated agencies are responsible for rulemaking to create regulations, standards for compliance, and regulatory processes. These are vetted with stakeholders through a structured public comment-resolution process.

If the current policy system for transportation evolves toward sustainable TBL, it is inevitable that various forms of legislation will accompany or drive the transition, and the resulting rulemaking can be expected to be complex in terms of the agencies, sectors, scientific content, standards, and process issues that are involved. Throughout the rulemaking process, transportation agencies, other involved agencies, and the private sector will undoubtedly be concerned about their capabilities to comply, and about their costs of performing the business of government and the business of commerce.

As the debate over GHG regulation continues, a similar level of concern from the government and private sectors is apparent. But, despite the challenging scientific issues and the practical concerns over how this regulation can work, there is a widely held public opinion and fear that GHG is a major driver of climate change trends. It seems clear to many that action is needed to avert serious environmental problems. Partly as a result of this public dilemma, several major companies and agencies have been measuring and rating GHG output, carbon footprint, and related factors. This is an example of trying to stay ahead of regulation, and preparing for legislation or rulemaking to occur.

Under the TBL policy system, it is logical to expect a bias in favor of flexible regulations and voluntary compliance with accepted standards as an important component of successful sustainable TBL programs. Without this flexibility, rulemaking can be expected to be an
onerosous task and the rules difficult to comply with. Returning to the GHG example, if voluntary efforts and market effects coalesce into widely accepted guidelines, practical standards of achievement and measures, and rating systems, rulemaking could support or adopt them in a practical form.

Recommendations for agency consideration in this section closely follow the general strategies outlined in Section 9.1, which is to engage in developing methods, standards, and measures for TBL, and to test those methods for practicality under the agency’s specific functional structure and operating environment. This process can include evaluating, testing, and possibly integrating various approaches already in use (e.g., CalTrans, HDR, New Zealand planning support).

Preparing in advance for TBL-related rulemaking likely will require a holistic approach and viewpoint that represents more than one agency’s traditional operating focus. The strategy will need to include and encourage partnering with other agencies, public interests, experts—the regional and local stakeholders and key actors in the TBL. A suggested initial focus for this process includes:

- Common understanding in an agency’s partner and stakeholder community, of shared concerns, issues, and opportunities connected with TBL;
- Ability to assess and express overall ROI for the participants in the collaborative effort (i.e., what is the benefit for each party, and for all parties? What is the potential cost and risk of not acting?);
- Ability to monetize or otherwise reliably quantify the impact of potential regulatory requirements;
- Ability to connect and evaluate regulatory impact to jobs, commerce, and state and local revenues;
- Methods to apply high-level TBL-related planning and decisionmaking concepts;
- Establishment of TBL-related viewpoints, standards, and expectations;
- Consensus on relevant TBL-related measures;
- Agreement of measures of success and TBL rating approaches; and
- Issues with acceptance, adoption, and compliance with TBL requirements.

Engaging the community in this way would no doubt present many challenges as well, and would require significant investment of participants’ time and resources, as well as focus away from other short-range priorities. However, the sustainable TBL policy system may not be too far off in the future in some regions. In many respects, the “strong” TBL policy system is already in evidence in a number of areas. The expanded GreenLITES and the I-LAST examples
(see Section 9.5) reflect some of the TBL dimensions, and the kind of private-public sector collaboration needed.

9.6 **SERVICE AND PROJECT DELIVERY**

Service and project delivery encompass many different elements. One of the major issues stakeholders identified in our interviews was the need for standards and approaches to identify sustainable options and to ensure that the selected materials or systems purchased meet sustainable requirements. There are several standards-based systems for transportation developments that transportation agencies could use in the near term.

For example, the NYSDOT developed GreenLITES (Leadership in Transportation and Environmental Sustainability), a self-certification program that rewards transportation projects and operations based on the extent to which they support sustainability. Although originally an “environment-only” system, the GreenLITES program has been expanded to include all aspects of the TBL. The GreenLITES program is based on the building industry’s Leadership in Energy and Environmental Design® (LEED) system. Each project (e.g., capital projects, O&M projects (on a subregional basis), and region wide investments) is evaluated annually in terms of sustainability practice and is assigned a certification level that recognizes varying sustainability levels. NYSDOT uses this information to measure performance in achieving sustainability goals, identify best practices, detect where improvements are needed, and communicate to the public how NYSDOT is adopting sustainable practices.

Similarly, Illinois developed the *Illinois–Livable and Sustainable Transportation (I-LAST) Rating System and Guide* (issued January 2010). The guide was developed in a cooperative effort with IDOT, the American Council of Engineering Companies–Illinois (ACEC-Illinois), and the Illinois Road and Transportation Builders Association (IRTB). This voluntary guide describes sustainability in terms of transportation and provides a tool for identifying and documenting sustainable practices on highway projects in the state. Specifically, the I-LAST:

- Provides a comprehensive list of practices that have the potential to bring sustainable results to highway projects;
- Establishes a simple and efficient method for evaluating transportation projects with respect to livability, sustainability, and their effect on the natural environment; and
- Records and recognizes the use of sustainable practices in the transportation industry.

The I-LAST identifies the following goals of sustainable projects:

- Minimize impacts on environmental resources;
- Minimize consumption of material resources;
• Minimize energy consumption;
• Preserve or enhance the historic, scenic, and aesthetic context of a highway project;
• Integrate highway projects into the community in a way that helps to preserve and enhance community life;
• Encourage community involvement in the transportation planning process;
• Encourage integration of non-motorized means of transportation into a highway project;
• Find a balance between what is important to the transportation function of the facility, to the community, and to the natural environment, and what is economically sound; and
• Encourage the use of new and innovative approaches in achieving these goals.

The I-LAST includes a checklist-based scorecard for evaluating the sustainable practices included in a highway project, with 17 separate sustainable features in the following eight categories:

• **Planning** — Context-sensitive solutions, land use, community planning;
• **Design** — Alignment selection, context-sensitive design;
• **Environmental** — Protect, enhance, or restore wildlife communities; protect, enhance, restore native plant communities; noise abatement;
• **Water** — Reduce impervious area; stormwater treatment; construction practices to protect water quality;
• **Transportation** — Traffic operations, transit, improve bicycle and pedestrian facilities;
• **Lighting** — Reduce electrical consumption and reduce stray light;
• **Materials**; and
• **Innovation**.

For each of the 17 features, the scorecard lists activities and the points that can be earned for each activity included on a project. It also provides an explanation and lists resources to help users better understand how to implement each of the sustainable features.

These examples also show how rating and measurement systems can influence agency and private sector behavior toward TBL principles. Various rating approaches are used to influence contract selection decisions, and TBL-sensitive project development and delivery.

**Summary: Service and Project Delivery**

• Adopt standards and approaches to identify sustainable options and ensure that selected materials and/or systems purchased meet sustainability requirements, as defined in the development of goals, objectives, and associated performance measures.
• Consider embedding sustainability/TBL-related ratings and standards into all business processes (e.g., project development, letting and selection, quality management).

9.7 EDUCATION AND CULTURAL DEVELOPMENT

Interviews with stakeholders reveal a broad consensus that sustainability will require substantial cultural change within agencies, the private sector, and the public sector. In the current fiscal and economic climate, many agencies lack the resources and support to engage in broad new initiatives. In general, stakeholders believe it will be helpful to promote sustainability as an economy measure and as a more efficient means of delivering service. In particular, a change in the mindset is needed away from focusing on the traditional level of service (LOS) and transportation as an end in itself, to focusing on how transportation can improve community life and meet community needs. Stakeholders expressed a need for new, more holistic ROI tools that could support or clarify the business case for sustainability and communicate its value as a common-benefit initiative.

Sustainable TBL is expected to require a new decisionmaking paradigm to manage TBL-sensitive transportation decisions across multiple modes and jurisdictions.

Several states recently have embarked on bold initiatives to change the culture of DOTs away from the traditional LOS bias. These initiatives can serve as a model for how DOTs can move to greater support for sustainability. For example, in response to a perceived lack of confidence from stakeholders, limited funding, loss of knowledgeable employees, and a push from policymakers to outsource, the Louisiana Department of Transportation and Development (DOTD) initiated a major program of culture change (Bridges, 2008). It adopted a two-prong approach. First, it developed tools to demonstrate the ROI of any proposed change and carefully identified the changes that really would produce a difference in performance and service delivery. Second, it engaged the department head as the chief sponsor of the initiative. The chief sponsor communicated forcefully that this was a “change-or-die” situation and that it required maximum commitment. Multiple communications initiatives were launched to demonstrate the need for change, explain the rationale and proposed changes, and explain how people could be part of the change. The program focused on quick-wins, claiming low-hanging fruit, and building momentum for change (Bridges, 2008).

Some governments have attempted to initiate development of a new culture through extensive public participation programs. The City of Perth, Australia, for example, in 2003, began a broad-based consultation process to create a new vision of the city. This process brought together more than 42 government departments and citizens and business groups to create a vision of Perth in 2030. As part of this exercise, a survey was conducted of more than 1,700 households and a 1-day planning forum was held with more than 1,000 participants. At that forum, participants were broken down into 10-person teams, each given a particular transportation
problem. Each team had to identify solutions and wrestle with the tradeoffs that planners face between sustainability, mobility, and economic growth. The result was a consensus plan known as “Network City,” which was widely supported and endorsed by all major interests, and has as a goal that 60 percent of all new infrastructure and private construction be developed as car-free, sustainable networks (Schiller, Preston; Bruun, Eric C; Kenworthy, Jeffrey R, 2010).

Summary: Education and Cultural Development

- Consider developing a sustainability code of ethics for the agency, focusing on supporting a sustainable society;
- Develop and conduct training activities with internal staff on incorporating sustainability principles into transportation decisionmaking processes;
- Establish employee initiative and performance incentives associated with sustainability;
- Set up and maintain an internal news forum and discussion focusing on sustainable TBL; and
- Support development of sustainability-related coursework in regional education institutions, and encourage and support study by agency personnel.

9.8 Outreach and Communication

Responsibility for supporting, planning, and executing sustainable TBL will extend beyond the traditional jurisdiccional and modal organizational boundaries of national, state, and local agencies. Responsibility also will cut across the various functional, geographic, and operational divisions and departments that usually are part of transportation agencies. As authorities and TBL planning and management process requirements are gradually developed, the agency and inter-agency “lines and boxes” will emerge based on specific needs for oversight, decisionmaking, execution, and compliance. Existing agency functions would necessarily continue, but TBL management could take a matrix form, cutting across not only internal organization units but also across multiple agencies. The private sector and public representative teams could very possibly occupy various places in, or have direct links to, that matrix.

In the meantime, agencies could examine these relationships and gain practical insight by establishing TBL-related coordination and communication processes, both within and outside existing organizational boundaries.

9.8.1 Outreach and Coordination

- Consider establishing interagency coordination on TBL—Several interviewees noted that sustainability appears to be a top down–driven process. However, most land-use and transportation decisions are made at the regional and local levels, and, as indicated earlier, sustainability initiatives make it evident that there is a very important bottom-up
process in motion. Federal Government and state agencies, MPOs, counties, municipalities, and modal agencies all would play significant roles in managing TBL. Establishing a coordination model with these entities could be an effective way to establish an overarching set of acceptable TBL goals and to execute TBL-related planning and decisionmaking functions across a region.

- Establish intra-agency coordination—Sustainability applies to every stage of decisionmaking: planning, design, and implementation of projects and infrastructure, as well as to day-to-day O&M. All agencies interviewed noted that addressing sustainability does not fit neatly into their existing organizational structures. Agencies may consider establishing and chartering a cross-cutting team or teams to coordinate activities supporting sustainability within the agency. Such teams also could play a significant role in developing the interagency linkages needed.

9.8.2 Communication

- Most stakeholders agree that better and ongoing communication is needed to describe an agency’s progress in achieving sustainability goals, objectives, and policies.
- Transportation agencies must communicate with internal and external stakeholders about TBL through transparent indices, numbers, tables, graphs, scorecards, dashboards, and other information formats.
- Communications on TBL-related issues would be most productive at this stage of TBL evolution—as a two-way process engaging a broad set of stakeholders—focused primarily on decisionmakers and thought leaders, including public sector representatives, trade and professional organizations, federal, state, and local agencies, and the private sector. The FDOT’s Corridor of the Future program provides useful practical experience for such an effort (Lee).

9.8.3 Summary: Outreach and Communications

- Establish interagency and intra-agency coordination on TBL issues;
- Conduct regular communication and information exchange activities with trade and professional groups, the private sector, and the public;
- Ensure outreach and communication activities stay ahead of the evolution of the TBL policy system; and
- Support overall outreach activities with relevant facts and figures as sustainable TBL initiatives progress.

The research has shown that the principle gaps between today’s policy systems and sustainable TBL are found in the needs development, policymaking, and planning functions of transportation agencies. These functions will need to engage shared objectives and shared risk-taking among many stakeholder agencies in a region, as well as private sector actors. The institutional structures needed will form slowly, as stakeholders grasp the commonality of
mission needs an benefits under the TBL system. Tools and methods to inform, assist, test the TBL concept, and assess needed risk-sharing between stakeholders – are the most useful path for agencies to follow in the near term, pending what these tools and methods reveal about the practicality of wide-spread management of the TBL. It can be seen that many of our near term action recommendations address tools, methods, and TBL assessment framework development.

Some focus on situational assessment, and self-assessment to match real trends with the right agency capabilities to anticipate incremental changes and respond to them. A third category of recommendations deals with outreach, training, and educational programs to build professional capacity, and share knowledge for the future.

9.9 **Next Steps**

In conclusion, there a number of tools and methods development and integration initiatives that can be pursued by agencies in the near term to prepare agencies and stakeholders for the transition to sustainability. These initiatives will be valuable no matter what the future brings and can add value to agencies at almost any policy system stage. Table 51 shows some of these initiatives organized by:

- Initiatives where there are multiple available tools that can be adapted or modified to fit the requirements of transportation agencies at relatively low cost;
- Initiatives that are needed but additional consensus building needs to occur among transportation agencies before a widely usable tool can be deployed; and
- Initiatives that are needed in the near-term but additional work needs to be undertaken before these tools can be deployed to a wide audience.

<table>
<thead>
<tr>
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<th>Deployment Status</th>
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<td></td>
<td>Ready with minimal adaptation</td>
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<tr>
<td>Guidance on communicating the value proposition of TBL sustainability to key stakeholders</td>
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<td>LCCA Tools and Guidance</td>
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<td>Generic sustainability performance measures system (including guidance and data sources)</td>
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<td>Sustainability needs assessment and goal development system tools</td>
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<tr>
<td>Sustainable transportation standards and rating systems (e.g., GreenLITES)</td>
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In the next report (i.e., Interim Report #2), the team will research and assess tools, practices, and models that can be adopted by transportation agencies that fit into Group 1 (existing tools). In addition, the team will identify the requirements for Group 2 and 3 (tools, practices and models requiring additional research or consensus building) and provide guidance on next steps for developing these tools, practices and models. Concepts for integrating these tools, and examples of adaptation for agency use will be offered, as well as assessment of the value proposition for wide adoption of key tools and methods. Particular attention will be focused on assessing alternative approaches and models to determining TBL ROI in transportation goal-setting and planning processes.
## ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
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<td>Alternative Fuel Vehicle</td>
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<td>American Association of State Highway and Transportation Officials</td>
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<td>ITRC</td>
</tr>
<tr>
<td>Leadership in Energy and Environmental Design</td>
<td>LEED</td>
</tr>
<tr>
<td>Level of Service</td>
<td>LOS</td>
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<tr>
<td>Life-Cycle Cost Analysis</td>
<td>LCCA</td>
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<tr>
<td>Life-Cycle Cost Environmental Accounting</td>
<td>LCEA</td>
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<td>Life-Cycle Costing</td>
<td>LCC</td>
</tr>
<tr>
<td>Light Rail Transit</td>
<td>LRT</td>
</tr>
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<td>Louisiana Department of Transportation and Development</td>
<td>DOTD</td>
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<tr>
<td>Macroeconomic Activity Module (part of NEMS)</td>
<td>MAM</td>
</tr>
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<td>Maryland DOT</td>
<td>MDSHA</td>
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<tr>
<td>Metropolitan Area Express</td>
<td>MAX</td>
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<td>Metropolitan Planning Organization</td>
<td>MPO</td>
</tr>
<tr>
<td>Metropolitan Transit Authority</td>
<td>MTA</td>
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<tr>
<td>Minnesota’s Department of Transportation</td>
<td>MDOT</td>
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</table>

213
<table>
<thead>
<tr>
<th>Term</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphological Analysis</td>
<td>MA</td>
</tr>
<tr>
<td>Mountain Top Removal</td>
<td>MTR</td>
</tr>
<tr>
<td>National Association of Stock Car Auto Racing</td>
<td>NASCAR</td>
</tr>
<tr>
<td>National Cooperative Highway Research Program</td>
<td>NCHRP</td>
</tr>
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<td>National Energy Modeling System</td>
<td>NEMS</td>
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<td>National Environmental Policy Act</td>
<td>NEPA</td>
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<tr>
<td>National Health Service</td>
<td>NHS</td>
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<tr>
<td>National Round Table on the Environment and the Economy (Canada)</td>
<td>NRTEE</td>
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<tr>
<td>Natural Resources Defense Council</td>
<td>NRDC</td>
</tr>
<tr>
<td>New York City’s multidimensional, inter-agency plan</td>
<td>PlaNYC</td>
</tr>
<tr>
<td>New York State Department of Transportation</td>
<td>NYSDOT</td>
</tr>
<tr>
<td>New Zealand Dollar</td>
<td>NZ$</td>
</tr>
<tr>
<td>New Zealand Major Events</td>
<td>NZME</td>
</tr>
<tr>
<td>New Zealand Transport Strategy</td>
<td>NZTS</td>
</tr>
<tr>
<td>Not-in-My-System</td>
<td>NIMS</td>
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<tr>
<td>Office of Management and Budget</td>
<td>OMB</td>
</tr>
<tr>
<td>Ontario Round Table on Environment and Economy</td>
<td>ORTEE</td>
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<tr>
<td>Operations and Maintenance</td>
<td>O&amp;M</td>
</tr>
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<td>Oregon Department of Energy</td>
<td>ODOE</td>
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<tr>
<td>Oregon Department of Transportation</td>
<td>ODOT</td>
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<tr>
<td>Oregon Progress Board</td>
<td>OPB</td>
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<tr>
<td>Oregon Sustainable Transportation Initiative</td>
<td>OSTI</td>
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<tr>
<td>Oregon’s Department of Environmental Quality</td>
<td>DEQ</td>
</tr>
<tr>
<td>Organization of Economic Co-operation and Development</td>
<td>OECD</td>
</tr>
<tr>
<td>Organization of Petroleum Exporting Countries</td>
<td>OPEC</td>
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<td>Performance Programming Process</td>
<td>P3</td>
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<td>PLAN-Boulder County</td>
<td>PBC</td>
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<td>Portland’s Metropolitan Planning Organization</td>
<td>Metro</td>
</tr>
<tr>
<td>Regional Plan Association</td>
<td>RPA</td>
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<td>Regional Planning Affiliations</td>
<td>RPA</td>
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<tr>
<td>Regional Planning Organization</td>
<td>RPO</td>
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<tr>
<td>Regional Transportation Planning Organizations</td>
<td>RTPO</td>
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<tr>
<td>Regional Vulnerability Assessment</td>
<td>ReVA</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>ROI</td>
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<tr>
<td>San Francisco Metropolitan Transportation Authority</td>
<td>SFMTA</td>
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<tr>
<td>Science and Technology Policy Institute</td>
<td>STPI</td>
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<tr>
<td>Senate Bill</td>
<td>SB</td>
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<tr>
<td>Single Occupancy Vehicle</td>
<td>SOV</td>
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<tr>
<td>Term</td>
<td>Abbreviation</td>
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<td>----------------------------------------------------------------------</td>
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<tr>
<td>Smart Mobility Framework</td>
<td>SMF</td>
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<tr>
<td>Subject Matter Expert</td>
<td>SME</td>
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<tr>
<td>Surface Mining Control and Reclamation Act of 1977</td>
<td>SMCRA</td>
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<td>Sustainability Impact Assessments</td>
<td>SIA</td>
</tr>
<tr>
<td>Sustainability Life-Cycle Accounting</td>
<td>SLCA</td>
</tr>
<tr>
<td>Sustainable Management Approaches and Revitalization Tools – electronic</td>
<td>SMARTe</td>
</tr>
<tr>
<td>Target-Base Budgeting</td>
<td>TBB</td>
</tr>
<tr>
<td>Texas Department of Transportation</td>
<td>TxDOT</td>
</tr>
<tr>
<td>Total Cost Accounting</td>
<td>TCA</td>
</tr>
<tr>
<td>Transit-Oriented development</td>
<td>TOD</td>
</tr>
<tr>
<td>Transportation Association of Canada</td>
<td>TAC</td>
</tr>
<tr>
<td>Transport and Environment Reporting Mechanism</td>
<td>TERM</td>
</tr>
<tr>
<td>Transportation Investment Generating Economic Recovery</td>
<td>TIGER</td>
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<td>Transportation Master Plan</td>
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</tr>
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<td>Transportation Research Board</td>
<td>TRB</td>
</tr>
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<td>Tribal Transportation Planning Organization</td>
<td>TTPO</td>
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<tr>
<td>Triple Bottom Line</td>
<td>TBL</td>
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<tr>
<td>U.S. Green Building Council</td>
<td>USGBC</td>
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<tr>
<td>United Kingdom</td>
<td>UK</td>
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<tr>
<td>United Nations Division for Sustainable Development</td>
<td>DSD</td>
</tr>
<tr>
<td>Vehicle Mile Traveled</td>
<td>VMT</td>
</tr>
<tr>
<td>Vehicle-To-Grid</td>
<td>V2G</td>
</tr>
<tr>
<td>Victoria Transport Policy Institute</td>
<td>VTPI</td>
</tr>
<tr>
<td>Washington State Department of Transportation</td>
<td>WSDOT</td>
</tr>
<tr>
<td>Waste Reduction Model</td>
<td>WARM</td>
</tr>
<tr>
<td>World Commission on Environment and Development</td>
<td>WCED</td>
</tr>
<tr>
<td>World Health Organization</td>
<td>WHO</td>
</tr>
<tr>
<td>Zero-Base Budgeting</td>
<td>ZZB</td>
</tr>
</tbody>
</table>
APPENDIX 1: DETAILED DESCRIPTIONS OF DRIVERS

Driver: Demographic factors (population size, characteristics, and magnitude)

Description: This driver involves the size, distribution, and characteristics (e.g., age, sex, and ethnicity) of the U.S. population.

Significance: The size, geographic distribution, and characteristics of the U.S. population are likely to be a major factor influencing the resources available to state transportation agencies, transportation demand, and the opportunities and challenges facing state transportation agencies.

Trends: The U.S. Census Bureau provides detailed projections of the U.S. population between 2000 and 2050. Figure 27 shows the overall projection. As shown in the figure, the U.S. Census Bureau projects that the U.S. population will increase from approximately 282 million in 2000 to approximately 419 million in 2050. With the population currently estimated to be 308 million in 2010, this means that approximately 111 million people will be added between 2010 and 2050.

Figure 27: U.S. Census Bureau population projections 2000–2050

From: (U.S. Census Bureau, 2000)
These population projections were made using the cohort-component method, which makes assumptions about the components of population change (e.g., fertility, mortality, and international migration) to project population by age and sex (U.S. Census Bureau, 2000). The following describes these assumptions briefly.

**Fertility Assumptions**

The fertility assumptions use a total fertility rate (average number of lifetime births per 1,000 women implied by age-specific fertility rates) of 2,048 in 1999; 2,207 in 2025; and 2,219 in 2050 (Note: fertility increases largely as a result of immigration, because immigrants tend to be younger and have larger families) (U.S. Census Bureau, 2000).

**Mortality Assumptions**

The mortality values assume that average life expectancy at birth will increase gradually from the 1999 values of 74.1 years for the male population and 79.8 years for the female population to the 2050 values of 81.2 years for the male population and 86.7 years for the female population (U.S. Census Bureau, 2000).

**Migration Assumptions**

The basic international migration assumptions made by the U.S. Census Bureau include assumptions about levels of immigration (both legal and illegal immigration) of foreigners to the United States and about rates of emigration from the United States. Annual net immigration (i.e., immigration minus emigration) is estimated to be 996,000 in 2025 and 1,097,000 in 2050.

In terms of the age distribution of the population, the U.S. Census Bureau predicts that the population will age over the period 2000 to 2050. As Figure 28 and Table 52 show, the population over 60 is expected to increase from 16 percent to 26 percent between 2000 and 2050.

---

Figure 28: United States Census Bureau Population Projections—Age Structure
A major uncertainty in these population estimates is the distribution of population within the United States. The following section discusses this issue.

**DISTRIBUTION OF POPULATION WITHIN THE UNITED STATES**

In terms of the distribution of population throughout the United States, there are a number of alternative scenarios. One of the most common assumptions about the distribution of the future population is the so-called “megaregion” model. Under this model, analysts note that if current economic and population trends continue, by 2050, more than 80 percent of the nation’s population, economic activity, and jobs will be centered in megaregions (Regional Plan Association, 2006).

A megaregion is a geographically clustered network of cities and suburban areas that are brought together via shared infrastructure, economic interests, settlement and land-use patterns, and a common environmental, geographical, and topographical focus (Regional Plan Association, 2006). Megaregions are not megacities (i.e., a city with a population of greater than 10 million) or single uninterrupted urban areas (Anonymous, 2006). In fact, a megaregion may contain a number of cities and a mixture of different land uses (e.g., densely populated urban centers, suburban sprawl, exurban communities, small towns, and even rural areas). As an example, the northeast megaregion normally extends from Boston, Massachusetts, to Washington, DC., or Richmond, Virginia. Within that region, there are many cities, towns, suburbs, and rural areas, but they can be considered a single region because they rely on key elements of common infrastructure and economic interests. In this case, the I-95 corridor, parallel rail networks, the electricity grid, and trade flows between the cities and towns tightly connect the people and environment of this megaregion.

The existence of megaregions in some of our scenarios does not mean that cities and regions not included in the megaregions will decline or cease to exist. In all of our developed scenarios for the future, megaregions are not expected to “take” more population from other parts of the United States, but, as magnets for trade and economic growth, they are likely to become richer and more interconnected at a faster rate than other areas. These ideas are consistent with the literature, which predicts that numerous cities and small towns outside the megaregions will continue to grow and maintain vibrant economies.
There is dispute about the number and location of megaregions in the United States. Virginia Tech’s Metropolitan Institute and the Regional Plan Association (RPA) conducted the most well-known efforts to describe and define the megaregions using slightly different methods (Regional Plan Association, 2006). Figure 29 shows the megaregions identified by the RPA; Figure 30 shows megaregions identified by the Metropolitan Institute. As can be seen, there is a close correspondence between the megaregions identified by the two groups.

**Figure 29: RPA Megaregions in 2050**
A potential counter trend is that technology advances and sociocultural preference may lead to greater decentralization (Kotkin, 2010). Under this scenario, population growth will occur in small towns, suburbs, and secondary cities outside the megaregions. This scenario notes specifically that despite recent increases in central city population over the past 20 years, most of the growth in the United States has been in the suburbs that surround the growing cities of the South and West—in places that followed the Los Angeles sprawl model of urban planning, such as Houston, Texas, and Phoenix, Arizona. Similarly, rural areas and small towns will continue to grow as technology allows people greater freedom in deciding where they live. Given that Americans have consistently shown a preference for single-family homes, ample yard space, and the suburban lifestyle (i.e., people seeking a more family-friendly environment with less congestion and crime than in inner cities, lower property prices, and decentralization of economic life), if technology and the economy allow people the freedom to continue this behavior, they likely will. In addition, the demand for biofuels, as well as for solar and wind energy will make rural areas economically viable, presenting new opportunities for economic development outside the megaregions.

Using these two scenarios, the research team identified two potential paths forward for the United States:

---
• **Megaregion Future**: Population and economic activity continue to concentrate in megaregions that are bound together with increasing infrastructure and economic ties.

• **Decentralized Future**: Population is distributed more evenly across the nation, with a revival in suburbs, small towns, and medium-size cities as technology allows people to live and work where they want.

Combining these ideas with our projections of population growth, the research team created a matrix that shows different potential outcomes of different population growth and distribution trends (Table 53) and describes how each potential outcome might look and the factors related to that outcome.

### Table 53: Potential Outcomes Related to Population

<table>
<thead>
<tr>
<th>Size of Population by 2050</th>
<th>Population Distribution</th>
<th>Megaregions</th>
<th>Decentralized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (399 million)³⁷</td>
<td></td>
<td>Low economic growth in the United States relative to other countries leads to lower net migration.</td>
<td>Low economic growth in the United States relative to other countries leads to lower net migration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Population continues to follow current spatial distribution tendencies, with population concentrated in megaregions.</td>
<td>Technology allows increased freedom for individuals to live and work where they wish, leading to rapid decentralization and growth in small towns, smaller cities, and suburbs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increased investment in rural industries (e.g., biofuels, extractive industries) leads to increased growth in rural areas.</td>
</tr>
</tbody>
</table>

## Size of Population by 2050

<table>
<thead>
<tr>
<th>Size of Population by 2050</th>
<th>Population Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium (419 million)</strong></td>
<td>♦ Economic growth continues along anticipated lines, causing net migration to follow anticipated patterns.</td>
</tr>
<tr>
<td></td>
<td>♦ Fertility and mortality patterns follow expected trends.</td>
</tr>
<tr>
<td></td>
<td>♦ Population continues to follow current tendencies with population concentrated in megaregions.</td>
</tr>
<tr>
<td><strong>High (458 million)</strong></td>
<td>♦ Economic growth continues along anticipated lines causing net migration to follow anticipated patterns.</td>
</tr>
<tr>
<td></td>
<td>♦ Fertility and mortality patterns follow expected trends.</td>
</tr>
<tr>
<td></td>
<td>♦ Technology allows increased freedom for individuals to live and work where they wish, leading to rapid decentralization and growth in small towns, smaller cities, and suburbs.</td>
</tr>
<tr>
<td></td>
<td>♦ Increased investment in rural industries (e.g., biofuels, extractive industries) leads to increased growth in rural areas.</td>
</tr>
</tbody>
</table>

### Driver: Economic growth and public sector spending on transportation

**Description:** This driver involves the future patterns of economic growth (e.g., GDP, inflation, investment, employment, income growth) and public sector spending (e.g., federal, state, and local) on transportation.

**Significance:** The broad increase in U.S. GDP is generally considered to be a major determinant of the resources that will be available to address the major challenges that federal, state, and local transportation agencies will face between 2010 and 2050. Based on the record of the last century, rapid economic growth has transformed American society and culture, and radically defined our ability to address major societal challenges (Lindsey, 2007).
**Trends:** Based on historical growth in U.S. GDP over the past century and half, the U.S. economy has grown at an average rate of more than 3 percent per year (Ridely, 2010). The consistent and robust strength of this trend gives the United States a reasonable starting point for future economic growth predictions. To create a picture of what future economic growth might look like, the research team used the Department of Energy’s (DOE) National Energy Modeling System (NEMS) to develop a series of economic scenarios. The team used NEMS because it made it possible to combine economic projections with energy supply/demand scenarios. The NEMS Macroeconomic Activity Module (MAM) considers a series of macroeconomic indicators, including GDP, disposable income, value of industrial shipments, new housing starts, sales of new light-duty vehicles, interest rates, and employment. Key energy indicators fed back to the MAM include aggregate energy prices and costs. Using NEMS, the DOE created a series of different economic growth cases that can act as a benchmark for developing different future economic performance scenarios:

- **High-Growth Case:** Under this case, high growth rates for population (1.3 percent per year, compatible with the U.S. Census Bureau’s “high-population” estimate) and labor productivity (2.4 percent per year, representing a relatively rapid improvement in technology) result in higher non-farm employment (1.2 percent per year) and low unemployment. With higher productivity gains and employment growth, inflation and interest rates remain low, and consequently economic output grows at a higher rate (3.0 percent per year) than in the reference case (2.4 percent). Disposable income per capita increases by 1.82 percent per year. Figure 31 shows this case along with the moderate- and low-growth cases.

- **Moderate-Growth Case:** This case builds projections from current anticipated economic conditions (compatible with the most recent U.S. OMB and Congressional Budget Office forecasts) that include the current recession and the prospects for a return to normal economic growth in the middle of the current decade. Under this case, non-farm employment increases by 0.8 percent per year, and labor productivity by 2.0 percent per year. Economic output, as measured by real GDP, increases by 2.4 percent per year, and growth in real disposable income per capita averages 1.8 percent per year (see Figure 31).
Low-Growth Case: The low economic growth rate case expresses a non-crisis scenario with overall depressed growth. This case assumes lower growth rates for population (compatible with low estimates from U.S. Census Bureau projections) and labor productivity (1.5 percent per year, representing a relatively slow improvement in technology), resulting in lower nonfarm employment (0.4 percent per year), higher prices and interest rates, and lower growth in industrial output. In the low economic growth case, economic output, as measured by real GDP, increases by 1.8 percent per year, and growth in real disposable income per capita averages 1.7 percent per year (see Figure 31).

These projections are by no means the only visions of future GDP. There is a broad body of literature that presents both more optimistic and more pessimistic scenarios. At the negative extreme, numerous scenarios predict a future of ongoing depression or economic collapse (Levine, 2008). Specifically, resource exhaustion (e.g., peak oil), increasing environmental pressures, and/or failure to deal with long-term economic and social problems may lead to lower than expected growth and recurrent recessions. However, there is little hard analysis of the impact of these drivers. The analysis that does exist depends on numerous assumptions. For example, the Stern Report, developed by former World Bank chief economist Nicholas Stern and undertaken on behalf of the United Kingdom (UK) government, estimates the cost of climate change could range from 5 percent to 20 percent of global GDP by 2050; however, stabilization at 500 to 550 parts per million (ppm) carbon dioxide equivalents (CO2e, a measure of the contribution of six key GHGs) will cost the global community approximately 1 percent of

![Figure 31: High, Low, and Medium Economic Growth Case from NEMS](billions of 2008 dollars)
GDP by 2050 (Stern, 2006). More recent analyses of the impact of geography and population distribution have estimated it to be on the order of 1.7 percent to 3 percent of GDP by 2050 (Nordhaus, 2006). These analyses, however, consider only one major crisis—the impact of climate change. For example, one analysis of the impact of a peak oil reduction of 30 percent between 2006 and 2050 predicts an 11-percent decline in U.S. per capita GDP (Chefurka, 2007).

All these analyses differ in terms of their methodology, assumptions, and drivers; however, to include a credible worst case, the research team plotted a series of potential outcomes, ranging from a 1-percent to 20-percent reduction from a “low” growth in 2050 (assuming projected low growth to 2020), and then averaged these scenarios to create a worst-case outcome (approximately 8 percent). For comparison, at the depth of the current recession, GDP fell by 6.1 percent. This outcome suggests a decade-long economic recession in which every year is worse than the previous year.

It should be stressed that a trend of this magnitude has never been seen in any developed country. Even depressions in emerging economies rarely experience long-term GDP declines, and they rarely last longer than 10 to 20 years. More typically, emerging economies experience rapid cycles of booms and busts (Federal Reserve Bank of Minneapolis, 2007). Thus, despite the widespread negative and pessimistic literature, the worst-case outcome here is unprecedented; nothing in U.S. history or the broader history of the industrialized world is remotely like this outcome.

Figure 32 presents these projections. As shown, these projections show an initial decline as the United States continues to experience effects from the financial crisis of 2008, and then a return to growth, which is subsequently interrupted by a range of challenges, from climate change to resource shortages.
Alternatively, there are other visions where economic growth increases dramatically. For example, current world economic growth has created a situation in which world wealth (adjusted for inflation) doubles every 15 years (Hanson, 2008). Given current trends in technology (e.g., developments in artificial intelligence, computer processing speed, nanotechnology, robotics, biotechnology, and automation), some futurists predict that society is on the verge of a great jump forward or rapid acceleration in economic growth (analogous to the Industrial or even the Agricultural Revolutions). This phenomenon, known in the literature as “the singularity,” predicts an increase in technology-driven economic growth such that world wealth would double every 5 years, or possibly every 2 weeks. Although it is possible such phenomena may occur, the team does not include them in the outcome analysis because the various expert reviews the team conducted considered them too extreme and impractical for the analysis.
GDP and personal income are only one measure of the resources that will be available to state transportation agencies. Another measure is the level of resources that will be devoted to public-sector activities, including transportation.

Figure 33 summarizes federal, state, and local spending on transportation between 1960 and 2015 (projected) in nominal dollars and as a percentage of GDP (Note: total figures include statutory federal transfers such as Medicare and Social Security). Table 54 summarizes the percentage of GDP for each level of government invested in transportation between 1960 and 2015. As shown, despite numerous fluctuations, the proportion of U.S. GDP invested in transportation has remained relatively stable at 1.95 percent (never more than 2.4 percent; never less than 1.67 percent). Given the long-term nature of this trend and assuming that transportation remains in the same position relative to other public sector priorities, it is likely that this trend will continue into the future. Appendix 2 provides detailed backup data and assumptions related to this analysis.

Table 54: Average Percent of GDP Invested in Transportation from All Levels of Government, 1960 to 2015 (estimated)

<table>
<thead>
<tr>
<th>Level of Government</th>
<th>Percent of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Government</td>
<td>0.62%</td>
</tr>
<tr>
<td>State Government</td>
<td>0.84%</td>
</tr>
<tr>
<td>Local Government</td>
<td>0.84%</td>
</tr>
<tr>
<td>Total (removes federal transfers to state and local governments)</td>
<td>1.95%</td>
</tr>
</tbody>
</table>
Figure 33: Transportation Spending from Federal, State, and Local Governments, 1960 to 2015 (estimated)

Figure 34 illustrates the impact of applying the constant 1.95 percent of federal, state, and local spending to low, moderate, and high economic growth cases.

Several experts on the research team interviewed for the project suggested that past trends for federal, state, and local transportation spending are not useful predictors of future spending patterns. Specifically, they cited that a shift to user fees and congestion pricing mechanisms would transform the funding positions for state and local governments. This assumes that there will be public and political support for a shift to user fees. It is possible that this may occur; however, it is equally possible that public resistance to user fees and congestion pricing may prevent a shift to this form of transportation funding. It is also possible that user fees and congestion pricing will only offset the losses experienced by federal and state governments in collecting gas taxes from increasingly more fuel-efficient vehicles.
Based on this analysis, the research team identified potential outcomes and trends for the period 2010 to 2050, as shown in Table 55.

Source: Bloomberggoverment.com
Table 55: Potential Economic Growth and Transportation Spending Outcomes, 2010 to 2050

<table>
<thead>
<tr>
<th>Potential Outcome</th>
<th>Growth of GDP</th>
<th>Spending on Transportation</th>
<th>User Fees and Congestion Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Decline Case</td>
<td>After 2020, GDP falls by 8 percent over the next 30 years over the low-growth projected case.</td>
<td>Spending on transportation for federal, state, and local governments stays at the historic average of 1.95 percent of GDP (including federal transfers), with the Federal Government gradually reducing its role over time.</td>
<td>Public and political acceptance of user fees and congestion pricing leads to a system where funding gaps are filled by user fees. Public and political rejection of user fees and congestion pricing prevents the emergence of a system where user fees cover funding gaps.</td>
</tr>
<tr>
<td>Low-Growth Case</td>
<td>Economic output, as measured by real GDP, increases by 1.8 percent per year.</td>
<td>Spending on transportation for federal, state, and local governments stays at the historic average of 1.95 percent of GDP (including federal transfers), with the Federal Government gradually reducing its role over time.</td>
<td>Public and political acceptance of user fees and congestion pricing leads to a system where funding gaps are filled by user fees. Public and political rejection of user fees and congestion pricing prevents the emergence of a system where user fees cover funding gaps.</td>
</tr>
<tr>
<td>Moderate-Growth Case</td>
<td>Economic output, as measured by real GDP, increases by 2.4 percent per year.</td>
<td>Spending on transportation for federal, state, and local governments stays at the historic average of 1.95 percent of GDP (including federal transfers).</td>
<td>Public and political acceptance of user fees and congestion pricing leads to a system where funding gaps are filled by user fees. Public and political rejection of user fees and congestion pricing prevents the emergence of a system where user fees cover funding gaps.</td>
</tr>
<tr>
<td>High-Growth Case</td>
<td>Economic output increases by an average of 3.8 percent per year.</td>
<td>Spending on transportation for federal, state, and local governments stays at the historic average of 1.95 percent of GDP (including federal transfers).</td>
<td>Public and political acceptance of user fees and congestion pricing leads to a system where funding gaps are filled by user fees. Public and political rejection of user fees and congestion pricing prevents the emergence of a system where user fees cover funding gaps.</td>
</tr>
</tbody>
</table>
Driver: Energy (Includes Transportation Energy Uses and Fuel Prices)

Description: This driver involves the future patterns of energy use and future transportation fuel prices.

Significance: The availability of traditional and new fuels is believed to be one of the most important factors in the future viability of the U.S. economy and the options open to U.S. transportation planners (Spiegel, McArthur, & Norton, 2009) (Paul, 2009).

The Energy Information Administration (EIA), every year, uses the NEMS model to produce a series of forecasts of energy use to the year 2035. These outcomes seem relatively conservative, but they present a dramatic range. The research team has extended these forecasts out to 2050 using the NEMS model, and modified them based on interviews with SMEs and several SME panels. Based on these trends, the team have identified a series of outcomes that represent different levels of GDP, population, technology development, and energy choices and assumptions concerning the energy market. The research team used these parameters to develop low, medium, and high outcomes. Appendix 2 shows the data behind each outcome in detail (i.e., production, import, export, and fuel usage) for the period 2010 to 2050.\(^{38}\) In addition, the research team used NEMS to develop an additional set of outcomes based on:

- Low-technology versus high-technology growth (technology assessments are consistent with those based on preliminary information available from 20-83(04) Effects of Changing Transportation Energy Supplies and Alternative Fuel Sources on Transportation)
- Low-oil price versus high-oil price growth.

\(^{38}\) See “U.S. Energy Information Administration / Annual Energy Outlook 2010” Department of Energy for a full discussion of the assumptions in this section.
For the high and low oil prices over this period, NEMS produced the following estimates of future prices given our GDP scenarios and DOE assumptions about future oil availability:

- **Moderate-Growth Case:** Assumes world light, sweet crude oil prices are about $133 per barrel (2008 dollars) in 2035.
- **High Oil-Price Case:** More pessimistic assumptions for economic access to non-OPEC resources and for OPEC behavior. Under this case, world light, sweet crude oil prices are about $210 per barrel (2008 dollars) in 2035.
- **Low Oil-Price Case:** More optimistic assumptions for economic access to non-OPEC resources and for OPEC behavior. Under this case, world light, sweet crude oil prices are $51 per barrel in 2035 (2008 dollars).

Figure 35 combines all cases to show the different range of gas prices per gallon under these different outcomes. The high-technology and low-technology fuel-use patterns closely resembled those generated in the high-GDP and low-GDP growth patterns. *Economic growth appears to be a more important determinant of energy use than technology.* Thus, we show only the different GDP cases and oil price cases in Figure 35 to reduce confusion. As shown, depending on the assumptions made, predicted gasoline prices per gallon in 2050 vary from $1.89 (low oil price) to $9.23 (high oil price) in 2008 dollars. Note: these prices assume a tax structure similar to that of today.

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39 Gasoline prices per gallon were calculated by the research team using the methodology described in (Hamilton, 2007).
Booz Allen SMEs and external academics reviewed these trends and projections. Based on their inputs, Table 56 was created to show a number of plausible energy outcomes related to the transportation sector and energy price projections.

<table>
<thead>
<tr>
<th>Potential Outcomes</th>
<th>Energy Usage</th>
<th>Fuel Price (using price of gasoline as indicator)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Growth</td>
<td>Petroleum and carbon fuel remain the most important sources of fuel.</td>
<td>Gasoline prices are somewhat depressed, but world demand continues to push them to more than $6 per gallon.</td>
</tr>
<tr>
<td></td>
<td>Alternative fuels account for less than 16 percent of the transportation market.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electricity is a major energy source for surface transportation, but most still comes from coal and related fuels.</td>
<td></td>
</tr>
<tr>
<td>Moderate Growth</td>
<td>Petroleum and carbon fuel remain important sources of fuel, but alternative fuels account for 18 percent of the transportation market.</td>
<td>Gasoline prices close to $7 per gallon.</td>
</tr>
<tr>
<td></td>
<td>Electricity is a major energy source for surface transportation. Some electricity still comes from clean coal and non-carbon sources.</td>
<td></td>
</tr>
</tbody>
</table>
### Potential Outcomes

<table>
<thead>
<tr>
<th>Potential Outcomes</th>
<th>Energy Usage</th>
<th>Fuel Price (using price of gasoline as indicator)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Growth</td>
<td>Petroleum and carbon fuel remain important sources of fuel, but alternative fuels account for 20 percent of the transportation market. Electricity is a major energy source for surface transportation. Most electricity comes from clean coal and non-carbon sources.</td>
<td>Gasoline prices close to $7 per gallon.</td>
</tr>
<tr>
<td>High Oil Price</td>
<td>Petroleum and carbon fuel remain the most important sources of fuel. Alternative fuels account for 20 percent of the transportation market. Electricity is a major energy source for surface transportation, and some comes from clean coal and non-carbon sources.</td>
<td>Gasoline prices close to $9 per gallon.</td>
</tr>
</tbody>
</table>

### Driver: Climate Change, Environment, and Resource Use

**Description:** This driver involves future changes in the environment, specifically, climate change, impact of commerce and industry, related phenomena, other environmental changes, and resource availability and resource use.

**Significance:** Climate change, environmental change, and resource availability are critical determinants of the ability of the economy to grow and flourish in the 21st century. In particular, the state of the environment will be a critical determinant of the challenges and opportunities that state transportation agencies face in supporting a sustainable transportation system and a sustainable society (Matsushita & Helten, 2001). These are serious challenges, but from the point of view of this project they are important only in the degree to which they might affect the ability of state transportation agencies to support sustainable transportation and a sustainable society. Based on the research team’s analysis of the literature, most of these challenges have relatively limited direct impacts, but substantial indirect impacts, on transportation

### Other TRB Reports Relevant to this Driver

This section provides an overview of climate change issues. Another TRB Report, 20-83(05) Climate Change and the Highway System: Impacts and Adaptation Approaches, provides a detailed discussion of climate change issues. At the time of this writing, the scenarios developed as part of this project were not available to the research team. This driver addresses broader environmental and resource use changes. Readers should note that this section focuses on general environmental and resource use trends rather than on a detailed analysis of transportation and climate change.
and state transportation agencies. For example, climate change directly affects transportation systems in a number of ways (see the forthcoming report 20-83(05) *Climate Change and the Highway System: Impacts and Adaptation Approaches*). Transportation also affects the environment, which in turn places additional demands on society’s ability to manage and respond to transportation requirements. Figure 36 provides an overview of this relationship. Thus, while there are numerous environmental challenges, the research team focused on the environmental challenges and trends that are most likely to affect state transportation agencies’ ability to support a sustainable society.

**Figure 36: Relationship between Transportation Systems and the Environment**

**Trends:** The literature on environmental trends in the first half of the 21st century is wide and extremely diverse. The research team reviewed hundreds of books, reports, blogs, and articles that address this issue. On the basis of this literature review, the research team determined that views about the future of the environment and resources vary along two dimensions: the degree of management/planning and the degree to which the overall outlook is positive or negative (see Figure 37).
Figure 37: The Environmental Management Quadrant: Dimensions of Environmental and Resource Change in Futurist Environmental/Resource and Scientific and Technical Literature

- **Positive Outlook**: As shown in Figure 37, futurist, scientific, and technical literature vary in their orientation toward the speed and extent of environmental change in the first half of the 21st century:
  - **Positive Outlook**: One view is that environmental conditions have been improving since the 1950s, as societies have become richer and technologically better able to deal with environmental problems. Based on this view, and what proponents claim to be scientific consensus, it is argued that environmental and resource change will be relatively gradual in the first half of the 21st century and that a variety of market,
technological, and regulatory responses will be able to manage these changes successfully.  

- **Negative Outlook:** A more radical view is that the current scientific consensus underestimates the speed and magnitude of change and that increasing resource shortages (e.g., water, oil, rare metals, and soil depletion), rapid environmental change, and a worsening environment in most areas will characterize the first half of the 21st century.

- **Managed Change versus Radical Reorganization:** A second axis or dimension addresses the degree to which current institutions (i.e., political, economic, social, and institutional) are able to adapt and address these changes:

  - **Managed Change:** One view holds that the current political, economic, and social system will be able to manage environmental and resource availability changes. Some analysts believe that climate change will be dramatic and more rapid than is currently foreseen and that the current system will be sorely tested; however, these analysts believe that the current institutional and economic system will able to meet the challenges posed by the environment and resource usage in the next few decades. Typically, these analysts envision that an emerging environmental or resource crisis will lead to a technological or sociocultural response that will generate a new consensus and new tools within current political and social institutions to deal with environmental problems over the second half of the 21st century, as change eventually overwhelms the current system.

  - **Radical Reorganization:** A more radical view holds that only a radical reorganization of society and the economy around sustainability and environmental protection can stave off collapse. In some cases, this change occurs only after environmental and resource crises have demonstrated that the current system can no longer manage global change; in other cases, change occurs before the crisis and heads off the crisis (Kahn, 2010).

Using this framework, the research team developed a series of alternative possible outcomes for use in developing scenarios. Table 57 shows these outcomes.

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40 For analyses that support or reflect this vision, see: (1) (Lomborg, The Skeptical Environmentalist: Measuring the Real State of the Environment, 1998); (2) (Smith, 2010); (3) (Lomborg, Global Crises, Global Solutions, 2009); (4) (Ridely, 2010), (Romer, 2010)

41 For an example of this view, see: (Hansen, 2010); (McKibben, 2010)

42 For an overview of these challenges, see: (Nature Editorial Staff, 2009)

43 For an example of this view, see: (Martenson, 2011); (Jackson, 2009)
**Table 57: Potential Future Outcomes of Environmental Trends, Resource Use, and Societal Response**

<table>
<thead>
<tr>
<th>Future of the Environment and Resource Use</th>
<th>Societal Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Managed Response</td>
</tr>
<tr>
<td>Positive Vision of Environmental and Resource Use Trends</td>
<td>Under this vision, environmental change is slow and manageable. Thus, while there will be significant stress from growing population and development, optimistic analysis of future environmental trends notes that most of these challenges are most likely to occur in developing countries. While these are serious challenges, optimistic analysts stress that efforts are already underway to address them and that as these societies develop, they will follow a pattern similar to that of currently developed societies. Analysts who support this vision argue that while environmental challenges will continue to exist, the United States and other nations will be able to manage these challenges through a mixture of regulation and technological fixes.</td>
</tr>
</tbody>
</table>
| Negative Vision of Environmental and Resource Use Trends | Under this vision, environmental change is rapid and threatens to overwhelm the ability of the current system to manage change. Challenges include stratospheric ozone layer depletion; uncontrolled land-use changes; atmospheric aerosol pollution; chemical contamination of air, water, and soil by long-lasting chemical compounds; water shortages; disruption of the phosphorus and nitrogen cycles; loss of biodiversity; and climate change. Analysts who support this vision frequently also claim that environmental degradation will be combined with serious resource depletion (e.g., peak oil, water shortages) that will require substantial technology and regulatory changes for an effective response. | Under this vision, environmental change is rapid and overwhelms the current system to manage change. In response, there is a partial collapse of the global system, leading to an increase in sub-national and international conflicts. In the United States, there are major environmental disasters (e.g., rapid, dramatic sea level rise, prolonged droughts in the Southwest and Midwest) and limited social or economic collapse in some areas (e.g., region-wide emergencies caused by repeated hits within a single season of major hurricanes or super-storms in vulnerable locations). Typically, these visions also combine a view of dramatic environmental change with rapid resource depletion. Ultimately, these challenges can be addressed only via a radical reorganization of global society. In the absence of this reorganization, U.S. society may face a major collapse in...
The Future of Environment and Resource Use

<table>
<thead>
<tr>
<th>Driver: Transportation technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> This driver involves potential technical developments in vehicle-based communications, vehicle materials, power systems, and infrastructure.</td>
</tr>
<tr>
<td><strong>Significance:</strong> The development and adoption of transportation technologies will affect travelers’ mobility options and the fuels needed to power these options.</td>
</tr>
<tr>
<td><strong>Trends:</strong> Transportation technologies of the future likely will vary substantially from what the team are familiar with currently. The team expects to see changes in communications and information technologies that affect our vehicles and how they interact with infrastructure, changes in materials that affect vehicles and infrastructure, potential changes in both fuels and in engines that use a variety of fuels, and changes in the infrastructure itself.</td>
</tr>
</tbody>
</table>

Information and communications technologies may affect how drivers and passengers interact with vehicles and how the vehicle interacts with other vehicles and the infrastructure itself. Drivers are already familiar with in-vehicle systems such as OnStar and Sync, which provide drivers with information about their vehicles and with access to vehicle diagnostics and entertainment systems. Many vehicle technologies increase safety by alerting drivers to local obstacles. The U.S. DOT is performing research related to connected vehicle systems that will allow vehicles to autonomously communicate with each other and with the infrastructure. Advances in communication with the infrastructure (e.g., current electronic toll tags) could allow for toll payments and roadway user fees, in addition to obtaining data for traffic management systems.

<table>
<thead>
<tr>
<th>Other TRB Reports Relevant to this Driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>This section provides an overview of transportation technology trends. Another TRB Report, <em>20-83(02) Expediting Future Technologies for Enhancing Transportation System Performance</em>, provides a detailed discussion of transportation technology. At the time of this writing, the scenarios developed as part of the 20-83 (02) project were not available to the research team. Note: the discussion of this driver is not intended to be a comprehensive discussion of the factors affecting transportation technology. Rather, it is intended to identify the major trends and issues that could be relevant to surface transportation technology over the next 30 to 40 years and the factors that may affect adoption of the technology.</td>
</tr>
</tbody>
</table>
There is the potential for change in both vehicle and infrastructure materials. Vehicles may be made out of lightweight materials that provide both energy and safety benefits. There are already many different transportation vehicles that use a variety of transportation fuels. Different fuels (e.g., diesel, gas, electric, hybrid, E85, biofuel, fuel cell) require different types of engines. Current engines are likely to become more efficient, leading to more power with less fuel.

The research suggests that pavements and other infrastructure facilities may be eventually made out of longer-lasting and potentially recyclable materials that will better withstand environmental and weather impacts. Some pavements will allow for better drainage, which should reduce the detrimental effects on ecosystems.

Other advances could make the infrastructure “smarter”; transportation systems of the future may have automated guideways within cities and between cities. For example, there may be personal rapid transit vehicles on fixed guideways within cities that allow users to punch in destinations, analogous to GPS devices in current vehicles. Eventually, the United States may eventually have automated highways that take control of vehicles to get travelers to the next cities. As described above, technology changes may also lead to new guideways for vehicles and transportation systems that could facilitate travel between cities (e.g., automated highways) or within cities (e.g., personal rapid transit networks).

Technology over the next 40 years likely will vary according to both research and development (R&D) investment and technology adoption rates. Both technology development and technology adoption will need to occur before transportation technology has a large impact on the system:

- **Technology development**: Many of the technologies envisioned today can be developed for the right price. Development in this case refers to both the feasibility and possibility of developing a technology that can be implemented and the development of ways to manufacture the technology so that the price is attractive to users.

- **Technology adoption**: Technology adoption occurs for a variety of reasons. In general, the technology must do something different and must be at a price that is reasonable. There may be other reasons to adopt technology, however, such as government mandates or environmental pressures. As described above, some technologies require public infrastructure to be used fully. In early adoption, only some locations will have available the infrastructure required by that technology. We also expect that most technologies will exhibit economies of scale; that is, as they become more widely adopted, they will be produced more cheaply. Figure 38 provides an S-curve of technology adoption.
Using this framework, the research team developed a series of alternative possible outcomes to be used to develop scenarios. Table 58 shows these outcomes.

**Table 58: Potential Outcomes Related to Transportation Technology**

<table>
<thead>
<tr>
<th>Potential Outcome</th>
<th>Vehicles</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow development, slow adoption</td>
<td>Only limited adoption of new technologies. Cost of the new technology may be prohibitive to the average user.</td>
<td>Only limited demonstrations of new technologies. Reliance on the private sector.</td>
</tr>
<tr>
<td>Medium development, medium adoption</td>
<td>Cost of new technologies may be large for the average person, resulting in uncertain benefits from limited adoption rates. Difficult chicken-and-egg problem between speed of development and adoption versus availability of public support to maximize use of the technology.</td>
<td>Without fast adoption, new types of guideways (for personal rapid transit or high-speed rail) will be limited to only a few locations.</td>
</tr>
<tr>
<td>Fast development, fast adoption</td>
<td>Costs reduced by economies of scale and network effects, which increase adoption rates at accelerating rates. Government mandates or incentives may speed adoption.</td>
<td>New types of vehicles require new guideways. Supported transportation facilities may change. Economies of scale or the recognition of potential network effects and positive spillovers may facilitate public funding for these changes.</td>
</tr>
</tbody>
</table>
Driver: Land Use

Description: Land use is the use and modification of land to support people’s activities.

Significance: In the past, geographical boundaries (e.g., rivers, mountains, and major transportation facilities) helped dictate where people lived, worked, and obtained goods and services. Currently, land-use zoning and urban planning drive the uses of different tracts of land. If political situations change as expected across scenarios, the ability and role of government authorities to organize land-use may differ between the future scenarios.

Trends: Land use is often closely tied to the sustainability of today’s current transportation systems. Building or widening a road provides more capacity in the short term, which results in access to more housing, work locations, or goods and services, resulting in a Catch-22 of additional vehicles that fill this increased capacity, thus increasing congestion once again. In many places in the United States, it is difficult to obtain land to build additional road/rail capacity, which in turn makes building additional capacity a cost-prohibitive and socially disruptive approach to ease congestion. It is relatively easy to agree that this cycle of building capacity, thereby inducing demand, and then responding to the increased capacity, is not sustainable.

In response to the need and desire for work and housing to be co-located, there is a movement in the United States for Smart Growth sites or mixed-land-use areas where housing, work facilities, and retail stores are located close to each other. Such areas are intended to improve quality of life by reducing commute times and the time required to acquire goods and services, such as groceries and dry cleaning. Their intent is to attract people who want resources close by. Some experts predict that these mixed-land-use developments will continue to become more popular in the United States, as people seek alternatives to suburban sprawl and the long commutes to work locations.

As described previously, some urban planning efforts in the United States designate zones and specific land uses for specific geographical areas. Such zoning practices have been used to keep incompatible land uses separated (such as separating areas of heavy industry from housing). They also have been used to preserve the character of neighborhoods or areas. For example, a housing development built under specific zoning requirements cannot include retail operations, such as a grocery store. Increasing the separation of land uses may no longer be ideal, and under some future circumstances, preserving zones and preventing mixed land uses may not be practical or desired.

In extreme cases, people in the future may live in high-density complexes that provide housing, work options, goods, and services. High-density housing, such as the U.S. housing projects of the 1970s and today’s Singaporean apartments, allow for economies of scale in building
materials, access to resources, and utilization of resources, such as electricity and sewage systems, for land uses that in the past, would have been separated by legal requirements.

As in the previous discussions of drivers, note that land-use practices of the future will be managed or unmanaged:

- **Managed:** Like today, managed land use includes zones that separate activities, such as housing and commercial space and move toward mixed-use facilities.
- **Unmanaged:** Some areas do not have zoning regulations that prescribe land uses. Devolution of government authority may lead to unmanaged land use.

Table 59 shows potential outcomes arrayed with the different land-use options.

**Table 59: Potential Outcomes Related to Land Use**

<table>
<thead>
<tr>
<th>Potential Land Use Outcome</th>
<th>Managed</th>
<th>Unmanaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suburban sprawl; low-density land use</td>
<td>Land-use zoning continues to separate agricultural, residential, commercial, and industrial land functions.</td>
<td>Without management, landowners use their land as they please. This may result in random placement of commercial opportunities or multifamily housing.</td>
</tr>
<tr>
<td>Medium-density land use; some mixed-density areas</td>
<td>Zoning is relaxed, which allows some mixed-density (Smart Growth) areas to arise.</td>
<td>Residential and commercial development occurs near attractions (e.g., open space, transportation facilities). Development is largely market-driven.</td>
</tr>
<tr>
<td>High-density land use with mixed-density urban centers</td>
<td>Lack of transportation resources (such as fuel for personal vehicles) or environmentally based decisions require mandates for high-density housing complexes. Ideally, these include commercial functions.</td>
<td>Without management, some commercial and residential facilities may become isolated from others. The market is not able to support transportation needs.</td>
</tr>
</tbody>
</table>

**Driver: Future transportation system funding, operation, and control**

**Description:** This driver considers how future transportation systems will be organized and the role of the different players in the process.

**Significance:** We must consider how transportation will be different in various scenarios so that the team can begin to accommodate the expected changes. Changes likely will affect mobility, safety, and the systems’ ability to be sustainable.
Trends: There is a large body of literature on future transportation patterns. The intent of this project is not to address these issues. Rather, this project focuses on understanding how these changes are likely to affect organizing principles for state and local transportation agencies. Having reviewed this literature, the research team identified three major factors related to state transportation agencies:

- **Funding:** How will the transportation system of the future be funded?
- **Roles of private and public sector actors:** What will be the mix of private and public responsibilities in the future transportation system?
- **Centralization and decentralization:** How will responsibilities be distributed among different levels of government and, in particular, what will be the role of the Federal Government?

Each of these factors is discussed in greater detail below:

### Funding

A critical question for the future organizing principles of state transportation agencies is the source of funding available for transportation. Funding transportation has always been a challenge for state transportation agencies. In fact, funding U.S. surface transportation has been characterized as being in a state of “perpetual crisis” since the 1850s, where revenues have never been sufficient to meet needs and there is constant pressure to identify new funding sources. At present, it is clear that the current national and state gas taxes are not sufficient for maintaining our current infrastructure, let alone for expansion or for new infrastructure. According to the National Surface Transportation Policy and Revenue Commission and the National Transportation Infrastructure Financing Commission, there is a gap between revenues from gas taxes and capital investment and roadway maintenance needs. Furthermore, vehicles are more gas efficient (a trend that is expected to continue, resulting in further decreases in revenue from that source). The federal gas tax has not changed since 1993, so with vehicle efficiencies increasing and buying power decreasing, less infrastructure can be built or

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maintained. Both commissions suggest that sources in addition to gas taxes, such as direct user-based fees (e.g., toll revenues, congestion charges, vehicle miles traveled fees), are needed to better fill the gap.

As resources devoted to transportation become more constrained (either through increased fuel costs or through other crises or because we are not able to identify a replacement funding mechanism), transportation agencies likely will have to make increasing tradeoffs in transportation. This leads to a number of questions, such as: Will they be able to maintain all roads and bridges or will they have to respond to traffic demands or roads and bridges in the worst condition? Will they be able to provide winter maintenance 24/7 or only during some time periods? Can structures be categorized deficient and their use restricted so that limited resources can go to other structures? Should an urban area maintain its freeways or invest more money into its arterials (Zhang & Xu, 2011).

While public and government agencies will be making difficult decisions about what to maintain, private entities may become increasingly involved in transportation systems. For example, private companies may identify roadways that they think they can maintain or enhance using private sources (like tolls) and then offer to operate the roadways at a profit (this is happening in several locations in the United States, including the Indiana Toll Road, Texas State Highway 121, and the Capital Beltway High Occupancy Toll Lanes in Northern Virginia). Local communities also may seek private funding to rebuild roadways or bridges that have been labeled deficient.

**Roles of Private and Public-Sector Actors**

The degree of private ownership of infrastructure will vitally affect the future organizing principles for state transportation agencies. The public and private sectors have played different roles and have operated under a variety of different regulatory regimes in the U.S. transportation system. It is likely that there will be continuing change in the balance and responsibilities of the public and private sectors as different pressures and events continue to affect the development of the U.S. transportation system. In particular, difficulties in funding the extant public transportation may lead to greater pressures to share ownership and responsibilities for operations.

For example, private entities may become willing operators of routes that have a greater chance of covering operating costs. There are privately operated car-sharing companies already, such as FlexCar and ZipCar.49 More private companies may enter the markets to provide services,

including mechanisms for ride-sharing for commuters (e.g., the SLUG commuting system in Northern Virginia), people going on trips, older people needing rides to doctor’s offices, and so on. Privatized transit services may increase if current public transportation agencies are unable to sustain their services or if they cut some of their services in response to changes in public transportation funding or national crises.

**CENTRALIZATION AND DECENTRALIZATION**

The degree of centralization and decentralization in the control of the transportation system will be vitally important to the future organizing principles of state transportation agencies. U.S. transportation policy in the 20th century was a story of increasing federal involvement in transportation (Dilger, 2003). Specifically, in the early 20th century, the Federal Government expanded its role into the transportation policy system gradually. Beginning as a provider of expertise and knowledge (i.e., the period of “engineers as problem solvers”) in the early 20th century, and gradually moving into a position of financing and building surface transportation systems in the Great Depression and the Interstate Era, the Federal Government became a major player and funder of the transportation system. Since the peak of its involvement in the 1940s, however, the federal role has declined (although there was federal involvement in urban transit in the 1960s and the Intermodal Surface Transportation Act era) (see Figure 39).

**Figure 39: Federal Spending on Transportation as a Percent of GDP, 1900 to 2015 (estimated)**

![Federal Spending on Transportation as a Percentage of GDP](image-url)
In the future, the Federal Government will face conflicting pressures in terms of its involvement in transportation. On one hand, the pressure for greater sustainability, greater coordination, and maintaining equity between rich and poor regions of the country suggest that the Federal Government should become more involved in transportation. On the other hand, the growing demands on the Federal Government from numerous competing national priorities (e.g., supporting an aging population, dealing with climate change, and addressing deficit and debt issues) and a lack of resources to address these major challenges may mean that the Federal Government must withdraw from many areas and focus on key issues where it plays a vital, irreplaceable role.

In addition to uncertainty about the future of the federal role, there are similar uncertainties regarding the role of state governments. As with the Federal Government, state governments face several challenges, including, but not limited to, the following:

- Resource-demand mismatch (i.e., increasing demands on state governments, but a lack of resources to meet those demands, especially in states with statutory balanced-budget requirements)
- Increased requirements for regional planning, both within states for agencies such as Metropolitan Planning Organizations (MPOs) and among states (e.g., coordination within the Northeast Corridor)
- Need to develop new financing mechanisms based on user fees
- Growing requirements to integrate transportation planning into broader sustainability planning and decisionmaking.

These challenges could lead to a number of responses. On one hand, state transportation agencies and state governments could reassert their role in the transportation system and become the dominant player, acting as a coordinator and manager of the system. On the other hand, state transportation agencies could cede some of the fiscal commitments associated with being heavily involved in transportation, giving some of their authority and responsibilities to sub-state authorities (e.g., MPOs) or super-state authorities (e.g., megaregional planning authorities).

Taking these two variables together, the research team created a few potential alternatives of the extent of centralized and decentralized planning and management (see Figure 40).
Figure 40: Future Federal, State, Local, and Regional Transportation Planning and Management Roles

Taking all of these trends together, the research team created the following matrix which combines these options into a series of potential outcomes (see Table 60).
Table 60: Potential Outcomes Related to Future Transportation Impacts

<table>
<thead>
<tr>
<th>Funding Mechanism</th>
<th>Limited Private Role</th>
<th>Significant Private Role</th>
<th>Limited Private Role</th>
<th>Significant Private Role</th>
<th>Limited Private Role</th>
<th>Significant Private Role</th>
<th>Limited Private Role</th>
<th>Significant Private Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPO and megaregional organizations dominate transportation planning and management</td>
<td>Some roadways and bridges will fall into disrepair. Limited public transportation options. Investment, management, and control focus on megaregions and MPOs. Transportation systems outside megaregions and metropolitan areas decline.</td>
<td>Without new funding mechanisms, only high-demand toll roads will be operated by private entities. Investment, management, and control focus on megaregions and MPOs. Transportation systems outside megaregions and metropolitan areas decline.</td>
<td>Some roadways and bridges will fall into disrepair. Limited public transportation options. Investment, management, and control focus on megaregions and MPOs, with Federal Government focusing on interregional transport.</td>
<td>Without new funding mechanisms, only high-demand toll roads will be privatized. Investment, management, and control focus on megaregions and MPOs, with the Federal Government focusing on interregional transport in cooperation with privatized transportation organizations.</td>
<td>Some roadways and bridges will fall into disrepair. Limited public transportation options. State transportation agencies oversee the planning and management of transportation systems.</td>
<td>Without new funding mechanisms, only high-demand toll roads will be privatized. State transportation agencies oversee the planning and management of transportation systems, with most systems jointly managed by state and private organizations.</td>
<td>Some roadways and bridges will fall into disrepair. Limited public transportation options. Management and planning systems resemble the 1950s and 1960s, with substantial private roles.</td>
<td>Without new funding mechanisms, only high-demand toll roads will be privately operated. Management and planning systems resemble the 1950s and 1960s, with substantial private roles.</td>
</tr>
<tr>
<td>Funding Mechanism</td>
<td>Limited Private Role</td>
<td>Significant Private Role</td>
<td>Limited Private Role</td>
<td>Significant Private Role</td>
<td>Limited Private Role</td>
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<td>Limited Private Role</td>
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<tr>
<td>Some New Funding Mechanism and Sources</td>
<td>Agencies will have to make difficult tradeoffs on what to provide and maintain. Investment, management, and control focus on megaregions and MPOs. Transportation systems outside megaregions and metropolitan areas decline.</td>
<td>Roads and transit may be operated and/or owned privately. Private ownership may lead to great discrepancies in available transportation—richer areas will have better facilities and services. Investment, management, and control focus on megaregions and MPOs.</td>
<td>State transportation agencies dominate transportation planning and management with strong federal cooperation</td>
<td>State transportation agencies dominate transportation planning and management</td>
<td>Federal government dominates transportation planning and management devolving execution and oversight to the states</td>
<td>Roads and transit may be operated and/or owned privately. Private ownership may lead to great discrepancies in available transportation—richer areas will have better facilities and services.</td>
<td>Management and planning systems resemble the 1950s and 1960s, with substantial private roles.</td>
<td>Roads and transit may be operated and/or owned privately. Private ownership may lead to great discrepancies in available transportation—richer areas will have better facilities and services. State transportation agencies oversee the planning and management of transportation systems, with most systems jointly managed by state and private organizations.</td>
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<td>Funding Mechanism</td>
<td>Limited Private Role</td>
<td>Significant Private Role</td>
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<tr>
<td>MPO and megaregional organizations dominate transportation planning and management</td>
<td>MPOs and megaregional organizations dominate transportation planning and management with strong federal cooperation</td>
<td>State transportation agencies dominate transportation planning and management</td>
<td>Federal government dominates transportation planning and management devolving execution and oversight to the states</td>
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| Many New Funding Mechanisms and Sources | Improved transportation (greater frequency; more access and mobility). Investment, management, and control focus on megaregions and MPOs. Transportation systems outside megaregions and metropolitan areas decline or are transferred to private sector control. | Improved transportation (greater frequency; more access and mobility). Investment, management, and control focus on megaregions and MPOs, with the Federal Government focusing on interregional transport. | Improved transportation (greater frequency; more access and mobility). Investment, management, and control focus on megaregions and MPOs, with the Federal Government overseeing the planning and management of transportation systems. | Improved transportation (greater frequency; more access and mobility). State transportation agencies oversee the planning and management of transportation systems, with most systems jointly managed by state and private organizations. | Improved transportation (greater frequency; more access and mobility). State transportation agencies oversee the planning and management of transportation systems, with most systems jointly managed by state and private organizations. | Improved transportation (greater frequency; more access and mobility). Management and planning systems resemble the 1950s and 1960s, with greater user fees. | Improved transportation (greater frequency; more access and mobility). Management and planning systems resemble the 1950s and 1960s, with substantial private roles. |
# APPENDIX 2: FEDERAL, STATE, AND LOCAL SPENDING ON TRANSPORTATION, 1961 TO 2015 (EST.) - NOMINAL BILLIONS OF DOLLARS AS A PERCENT OF GDP

<table>
<thead>
<tr>
<th>Year</th>
<th>U.S. GDP</th>
<th>Federal Spending</th>
<th>State Spending</th>
<th>Local Spending</th>
<th>Federal Transfers to State and Local Governments</th>
<th>Total Federal, State, Local Spending</th>
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<td></td>
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<td>$ billion</td>
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<td>% of GDP</td>
<td>$ billion</td>
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<td>1960</td>
<td>526.4</td>
<td>4.45</td>
<td>a</td>
<td>0.85%</td>
<td>6.15</td>
<td>a</td>
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<tr>
<td>1961</td>
<td>544.8</td>
<td>4.36</td>
<td>a</td>
<td>0.80%</td>
<td>6.33</td>
<td>a</td>
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<tr>
<td>1962</td>
<td>585.7</td>
<td>4.29</td>
<td>a</td>
<td>0.73%</td>
<td>6.73</td>
<td>a</td>
</tr>
<tr>
<td>1963</td>
<td>617.8</td>
<td>4.6</td>
<td>a</td>
<td>0.74%</td>
<td>7.52</td>
<td>a</td>
</tr>
<tr>
<td>1964</td>
<td>663.6</td>
<td>5.24</td>
<td>a</td>
<td>0.79%</td>
<td>7.94</td>
<td>a</td>
</tr>
<tr>
<td>1965</td>
<td>719.1</td>
<td>5.76</td>
<td>a</td>
<td>0.80%</td>
<td>8.31</td>
<td>a</td>
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<tr>
<td>1966</td>
<td>787.7</td>
<td>5.73</td>
<td>a</td>
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<td>8.73</td>
<td>a</td>
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<tr>
<td>1967</td>
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<td>5.94</td>
<td>a</td>
<td>0.71%</td>
<td>9.54</td>
<td>a</td>
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<tr>
<td>1968</td>
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<td>6.32</td>
<td>a</td>
<td>0.69%</td>
<td>9.95</td>
<td>a</td>
</tr>
<tr>
<td>1969</td>
<td>984.4</td>
<td>6.53</td>
<td>a</td>
<td>0.66%</td>
<td>10.59</td>
<td>a</td>
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<tr>
<td>1970</td>
<td>1038.3</td>
<td>7.01</td>
<td>a</td>
<td>0.68%</td>
<td>11.25</td>
<td>a</td>
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<tr>
<td>1971</td>
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<td>8.05</td>
<td>a</td>
<td>0.71%</td>
<td>12.27</td>
<td>i</td>
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<td>1972</td>
<td>1237.9</td>
<td>8.39</td>
<td>a</td>
<td>0.68%</td>
<td>12.84</td>
<td>i</td>
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<td>1382.3</td>
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<td>12.79</td>
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<td>1974</td>
<td>1499.5</td>
<td>9.17</td>
<td>a</td>
<td>0.61%</td>
<td>13.63</td>
<td>i</td>
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<tr>
<td>1975</td>
<td>1637.7</td>
<td>10.92</td>
<td>a</td>
<td>0.67%</td>
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<td>1976</td>
<td>1824.6</td>
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<td>a</td>
<td>0.75%</td>
<td>16.2</td>
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<td>1977</td>
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<td>14.83</td>
<td>a</td>
<td>0.73%</td>
<td>16</td>
<td>i</td>
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<tr>
<td>1978</td>
<td>2293.8</td>
<td>15.52</td>
<td>a</td>
<td>0.68%</td>
<td>16.9</td>
<td>i</td>
</tr>
<tr>
<td>1979</td>
<td>2562.2</td>
<td>18.08</td>
<td>a</td>
<td>0.71%</td>
<td>19.3</td>
<td>i</td>
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<td>a</td>
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<td>22.35</td>
<td>i</td>
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<tr>
<td>1981</td>
<td>3126.8</td>
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<td>a</td>
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<td>i</td>
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<tr>
<td>1982</td>
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<td>23.88</td>
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<td>3534.6</td>
<td>21.33</td>
<td>a</td>
<td>0.60%</td>
<td>25.39</td>
<td>i</td>
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<tr>
<td>1984</td>
<td>3930.9</td>
<td>23.67</td>
<td>a</td>
<td>0.60%</td>
<td>27.2</td>
<td>i</td>
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### Sustainable Transportation Systems and Sustainability as an Organizing Principle for Transportation Agencies

#### Interim Report #1

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<th>State Spending</th>
<th>Local Spending</th>
<th>Federal Transfers to State and Local Governments</th>
<th>Total Federal, State, Local Spending</th>
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<td>$ billion</td>
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<td>30.56</td>
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<td>a</td>
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<td>54.69</td>
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<tr>
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<td>2007</td>
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<td>136.73</td>
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Legend:
- **a** - actual reported
- **i** - interpolated between actual reported values
- **g** - 'guesstimated' projection by usgovernmentspending.com
- **b** - budgeted estimate in United States fy11 budget

Source: USGovernmentspending.com, 2011, Bloomberg Government
APPENDIX 3: NEMS ENERGY FORECASTS FOR UNITED STATES ENERGY CONSUMPTION IN LOW, HIGH, AND MEDIUM ECONOMIC GROWTH CASES

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<td>Production</td>
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<tr>
<td>Crude Oil and Lease Condensate</td>
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</tr>
<tr>
<td>Natural Gas Plant Liquids</td>
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</tr>
<tr>
<td>Dry Natural Gas</td>
<td>28%</td>
</tr>
<tr>
<td>Coal</td>
<td>29%</td>
</tr>
<tr>
<td>Nuclear Power</td>
<td>12%</td>
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<td>Total</td>
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<td>Consumption</td>
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<td>Dry Natural Gas</td>
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</tr>
<tr>
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<tr>
<td>Hydropower</td>
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</tr>
<tr>
<td>Biomass</td>
<td>5%</td>
</tr>
<tr>
<td>Other Renewable Energy</td>
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</tr>
<tr>
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### Imports

<table>
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<tr>
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<tr>
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<tr>
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<tr>
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### Consumption

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<tr>
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</tr>
<tr>
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<tr>
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### HIGH GROWTH CASE

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<td>Dry Natural Gas</td>
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<tr>
<td>Coal</td>
<td>29%</td>
<td>29%</td>
<td>28%</td>
<td>28%</td>
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</tr>
<tr>
<td>Nuclear Power</td>
<td>12%</td>
<td>11%</td>
<td>10%</td>
<td>10%</td>
<td>11%</td>
</tr>
<tr>
<td>Hydropower</td>
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</tr>
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<tr>
<td>Other</td>
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<tr>
<td><strong>Total</strong></td>
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### Imports

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<td>64%</td>
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<tr>
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<td>19%</td>
<td>20%</td>
<td>21%</td>
<td>21%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>13%</td>
<td>13%</td>
<td>12%</td>
<td>10%</td>
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</tr>
<tr>
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<tr>
<td><strong>Total</strong></td>
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### Supply and Disposition

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<td>Exports</td>
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</tr>
<tr>
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<td>55%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>17%</td>
</tr>
<tr>
<td>Coal</td>
<td>28%</td>
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<tr>
<td>Total</td>
<td>100%</td>
</tr>
<tr>
<td>Consumption</td>
<td></td>
</tr>
<tr>
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<td>38%</td>
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<tr>
<td>Natural Gas</td>
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<tr>
<td>Coal</td>
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<tr>
<td>Nuclear Power</td>
<td>9%</td>
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<tr>
<td>Biomass</td>
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## APPENDIX 4: SUBJECT MATTER EXPERTS INTERVIEWED

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<tr>
<th>Organization</th>
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<tr>
<td><strong>Federal</strong></td>
<td></td>
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</tr>
<tr>
<td>EPA</td>
<td>John Thomas</td>
<td>Director, Office of Policy, <em>Former</em> NCHRP 20-83 (07) Panel Member</td>
</tr>
<tr>
<td>FHWA</td>
<td>Mike Culp</td>
<td>Office of Environment and Planning</td>
</tr>
<tr>
<td>USDA National Park Service</td>
<td>Joe Burns</td>
<td>USDA Forest Service, NCHRP 20-83 (07) Panel Member</td>
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<tr>
<td><strong>State DOTs</strong></td>
<td></td>
<td></td>
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<tr>
<td>Alabama DOT</td>
<td>Don Arkle</td>
<td>Assistant Chief Engineer for Policy and Planning, NCHRP 20-83 (07) Panel Member</td>
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<tr>
<td>California Air Resource Board</td>
<td>Lezlie Kimura</td>
<td>Chief, Air Quality and Transportation Planning Branch</td>
</tr>
<tr>
<td>Caltrans</td>
<td>Chris Ratekin</td>
<td>Division of Transportation Planning</td>
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<tr>
<td>Colorado DOT</td>
<td>Yates Oppermann</td>
<td>Environmental Planner, NCHRP 20-83 (07) Panel Member</td>
</tr>
<tr>
<td>Delaware DOT</td>
<td>Michael Strange</td>
<td>Planning Director</td>
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<tr>
<td>Florida DOT</td>
<td>Brian Blanchard</td>
<td>Chief Engineer</td>
</tr>
<tr>
<td>Maryland DOT</td>
<td>Gregory Slater</td>
<td>Director, Transportation Planning, Office of Freight and Multimodalism - Project Manager, Office of Freight and Multimodalism - Project Manager</td>
</tr>
<tr>
<td></td>
<td>Bradley Smith</td>
<td>Transportation Planning, Deputy Director</td>
</tr>
<tr>
<td></td>
<td>Heather Murphy</td>
<td>Transportation Planning, Assistant Deputy Director</td>
</tr>
<tr>
<td></td>
<td>Michelle Martin</td>
<td></td>
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<tr>
<td>Maryland State Highway Administration</td>
<td>Felicia Alexander</td>
<td>Special Assistant to the Director of Planning, NCHRP 20-83 (07) Panel Member</td>
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<tr>
<td>NY DOT</td>
<td>Lynn Weiskopf</td>
<td>Policy and Planning Division, Statewide Policy Bureau, NCHRP 20-83 (07) GreenLITES Project Manager, Policy and Planning Division</td>
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<tr>
<td></td>
<td>Paul Krekeler</td>
<td>Special Assistant for Environmental Concerns to the Operations Division</td>
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<td></td>
<td>Elizabeth Kolb</td>
<td>Environmental Analysis Bureau</td>
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<td></td>
<td>Debra Nelson</td>
<td></td>
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<tr>
<td>Virginia DOT</td>
<td>Constance Sorrell</td>
<td>Chief of System Operations, Administrator, Transportation and Mobility Planning</td>
</tr>
<tr>
<td></td>
<td>Marsha Fiol</td>
<td>Chief Engineer for Program Development</td>
</tr>
<tr>
<td></td>
<td>Malcolm Kerley</td>
<td>Chief of Policy and Environment</td>
</tr>
<tr>
<td></td>
<td>Richard Walton</td>
<td></td>
</tr>
<tr>
<td>Washington DOT</td>
<td>Brian Smith</td>
<td>Director of Strategic Assessment, NCHRP 20-83 (07) Panel Member</td>
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<tr>
<td><strong>Regional, MPOs, and Local Agencies</strong></td>
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<tr>
<td>Contra Costa Transportation Authority</td>
<td>Randy Iwasaki,</td>
<td>Executive Director</td>
</tr>
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<td></td>
<td>Martin Englemann</td>
<td>Planning Director</td>
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<tr>
<td>Delaware Valley Regional Planning Commission (DVRPC)</td>
<td>Michael Boyer, Ryan Gallagher</td>
<td>Director of Planning, Assistant Manager of Special Projects</td>
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### Organization | Name | Office/Title
--- | --- | ---
Hillsboro County MPO | Ray Chiaramonte Beth Alden | Executive Director Transportation Planning and Program Group Leader
Metropolitan Area Planning Council (Boston) | Eric Bourassa | Manager of Transportation Group
Port Authority New York and New Jersey | Susanne DesRoches, Lena DeSantis, Arlyn Purcell | Sustainability Director (Engineering), Office of Policy, Aeronautical Technical Services Transportation Department Supervisor, Environmental Programs, Aviation Department
SANDAG | Muggs Stoll | Planning Director

### Modes
Port of Long Beach | Eric Shen | Director of Planning

### Research Organizations, Academics
American Transportation Research Institute | Dan Murray | Vice President of Research
RAND | Marty Wachs | Senior Fellow, Former Director of Transportation
Rutgers University | Bob Noland | Professor and Director Voorhees Transportation Center
Texas Transportation Institute | Josias Zietsman, Tara Ramani | Principal Investigator, 08-74, Sustainability Performance Measures for State DOTs and other Transportation Agencies
Urban Land Institute | Rachel MacCleery | Managing Director for Infrastructure
University of Massachusetts at Amherst | John Collura | Director, Transportation Center, Civil and Environmental Engineering Department
Victoria Transportation Policy Institute | Todd Litman | Executive Director

### Practitioners and Consultants
Booz Allen | Joel Fetter | Sustainability Project for USDA
Booz Allen | Steve Buchanan, Bradley Decker | Booz Allen's Response to EO 13514, Sustainability for Federal Agencies
Booz Allen | Joe Speaks | Transit Sustainability
CH2M Hill | Nancy Houston | Formerly Florida DOT
Independent Consultant | Bill Ankner | Former Secretary Louisiana DOT, Rhode Island DOT, NJ Office of Policy
Independent Consultants | Bob Dunphy | Former Contractor to Urban Land Institute
Independent Consultant | Wayne Kober | Formerly Pennsylvania and AASHTO, Environmental Compliance, NCHRP 20-83 (07) Panel Member
Independent Consultant | Phil Tarnoff | Former Director of Center for Advanced Transportation Technologies (CATT) Laboratory at University of Maryland
Parsons | David Carlson | Director of Sustainable Development, NCHRP 20-83 (07)
Interviewees by Type of Organization

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This pie chart was provided merely as a visual tool, rounding accounts for the discrepancy.
BIBLIOGRAPHY


