2010 TRANSPORTATION RESEARCH BOARD ENVIRONMENT AND ENERGY RESEARCH CONFERENCE

Research Needs Workshop White Papers on

Climate Change, Sustainability, Energy, and Livability

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* See accompanying documents "Research Matrix – Completed" and "Research Matrix – In Progress" for a list of research included in this paper.

INTRODUCTION

The Transportation Research Board's (TRB) 2010 Environment and Energy Workshop: *Better Delivery of Better Solutions*, which will be held June 6-10, 2010 in Raleigh, North Carolina, will commence with a session to discuss research needs in the **workshop's focus area topics: climate change, sustainability, energy, and livability**. These four topic areas play an important role in shaping and delivering transportation solutions for the future. The four white papers included in this document are intended to inform the opening session by providing a synthesis representing views from select TRB Committees regarding ongoing and completed research related to the workshop's focus topics and future research needs in those cross-cutting topic areas. This is a compilation only and is to be used as a tool for further discussions.

These papers were developed in coordination with the participating TRB Committees listed below and representatives from FHWA's STEP and the American Association of State Highway and Transportation Officials (AASHTO). Each of the four papers is organized into four sections. Each section is tailored to a specific set of TRB Committees and highlights the relationship between these Committee's technical areas and the cross-cutting focus areas introduced above. The TRB Committees represented in these white papers are grouped as follows:

White Paper 1
ADC10 Environmental Analysis in Transportation
ADD20 Social and Economic Factors of Transportation
ADD30 Transportation and Land Development

White Paper 2
ADA60 Public Involvement in Transportation
ADC30 Ecology and Transportation
ADC50 Historic and Archeological Preservation in Transportation

White Paper 3
ADC20 Transportation and Air Quality
ADC40 Transportation-Related Noise and Vibration
ADC60 Waste Management and Resource Efficiency

White Paper 4
ADC70 Transportation Energy
ADC80 Alternative Transportation Fuels and Technologies
ADD40 Transportation and Sustainability
ADD50 Environmental Justice in Transportation

Each of the four white papers described above identify critical project areas that the group of Committees have selected, given their strong relationship to the cross-cutting focus area topics: climate change, sustainability, energy, and livability. For each of the critical project areas selected, information is provided on the current research needs and opportunities for further linking these project areas to the cross-cutting areas. Research included in these white papers is from 2007 to present. A summary of the ongoing and completed research related to the critical project areas, as it relates to climate change, sustainability, energy, and livability, is provided here and is also listed in a separate matrix. A website

link is included for the research results and publications that are available online. Finally, where available, information is provided on the effectiveness of the outreach to promote existing research.

WHITE PAPER 1

BACKGROUND

This white paper, the first in a series of four, is intended to inform the opening session by providing a synthesis representing views from select TRB Committees regarding ongoing and completed research related to the workshop's focus area topics and future research needs in those cross-cutting topic areas. The paper also discusses the effectiveness of outreach efforts on the completed research.

Subject matter experts from the following TRB Committees contributed to this white paper:

- ***ADC10 Environmental Analysis in Transportation*** — This committee considers issues relating to the environmental impacts of transportation projects and systems, with emphasis on planning, decisionmaking, and mitigation strategies, policies, and processes, as well as multidisciplinary impact considerations.

- ***ADD20 Social and Economic Factors of Transportation*** — This committee considers all direct and indirect social and economic effects of transportation systems both within the transportation corridor and within the larger regions affected, including those bearing on present and future transportation needs and services.

- ***ADD30 Transportation and Land Development*** — This committee explores the interrelationships between transportation and land development, the effects of urban form on transportation systems and levels of service, and the effects of changing public goals and aspirations, land use planning and control, and environmental and life-style considerations on transportation needs, form, and requirements.

The white paper team also gathered opinions from members of AASHTO and FHWA. To gather input for the research white paper, the team convened a telephone conference with the TRB Committee co-chairs and subject matter experts who were available to participate. Three questions guided the conversation:

1. What research has been or is being conducted in the interest areas?
2. How effective has outreach on that research been?
3. What research gaps or needs currently exist?

Afterwards, one representative polled research subcommittee members to solicit additional suggestions for research opportunities, while the white paper team followed up individually with those unable to join the conference call. Information gathered on the call was also supplemented with materials emailed to the white paper team after the conference call. Furthermore, there was an investigation of all leads that the TRB Committee points of contact provided as well as library and Internet searches for academic and professional literature. The group acknowledged that this information is a summary of existing work and is not an exhaustive list.

CRITICAL PROJECT AREAS

The subject matter experts identified a number of broad areas related to the cross-cutting focus area topics that are of interest to their committees. The research areas identified are:

- Transportation Network and Climate Change Adaptation
- Integrating Transportation Planning with Land Use, Environmental, and Natural Resource Planning
- Mitigation of Human and Natural Environmental Impacts
- Travel Behavior and the Built Environment
- Transportation, Physical Activity, and Health
- Greenhouse Gas (GHG) Reduction, Sustainability, and Performance Measures
- Social and Economic Impacts of Transportation
- Land Use and Community Impacts of Rail/Transit

I. Transportation Network and Climate Change Adaptation

Focus areas: Climate Change, Sustainability

A. Research needs and opportunities

There are several issues related to transportation network design relevant to the four cross-cutting focus area topics of this paper (climate change, sustainability, energy, and livability). Changes in urban form can impact network design and materials, traveler behavior, and residential and business communities. Network design can also further impact the natural environment in ways related to species habitat, emissions from the construction and paving materials, and stormwater drainage. Several research needs and opportunities related to transportation network design were noted:

- Developing metrics and establishing thresholds for implementing Adaptive Management programs to address climate change impacts on infrastructure
- Developing climate change scenarios as part of transportation planning
- Integrating adaptive management practices into the transportation planning and National Environmental Policy Act (NEPA) project development processes

B. Ongoing and completed research

- **Transportation Adaptation to Global Climate Change**. (2009). This white paper was commissioned to identify the policy options available to support proactive measures for addressing climate change adaptation in transportation. It is intended to inform Congress and other policymakers about policy options at the Federal level. www.bipartisanpolicy.org/sites/default/files/Transportation%20Adaptation%20%283%29.pdf

- **Design Standards for U.S. Transportation Infrastructure: The Implication of Climate Change**. *Georgia Institute of Technology* (2008). This paper, commissioned to help develop the TRB Special Report 290, examines the changes to engineering design practice that might occur given climate-induced changes in environmental factors.

- **Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study**. *U.S. Climate Change Science Program* (2008). This multiyear research program studied how short- and long-term changes in climate could affect transportation systems in the U.S. central Gulf Coast region and how transportation decision makers could address possible impacts. Included in the analysis are the effects on roads, airports, rail, transit systems, and ports. www.climatescience.gov/Library/sap/sap4-7/final-report/sap4-7-final-all.pdf
- **Potential Impacts of Climate Change on U.S. Transportation**. *Transportation Research Board Special Report 290* (2008). The study considers the potential impacts of climate change on the transportation system. http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf
- **The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure** (2008). The study uses multiple data sources to identify the potential impact of sea level rise on land and transportation infrastructure along the Atlantic coast from Florida to New York. www.bv.transports.gouv.qc.ca/mono/0965210.pdf
- **Potential Impacts of Climate Change On Surface Transportation Infrastructure Design**. *Commission Briefing Paper 4D-01* (2007). This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the Commission's final report. http://www.transportationfortomorrow.org/final_report/pdf/volume_3/technical_issue_papers/paper4d_01.pdf

II. Integrating Transportation Planning with Land Use, Environmental, and Natural Resource Planning

Focus areas: Livability, Sustainability, Energy, Climate Change

A. Research needs and opportunities

There are ongoing needs and opportunities for research regarding integrated transportation and land use planning. These include: considerations of watershed and ecosystem mapping; impacts of transportation infrastructure on residential and business communities; population and housing distribution, traveler behavior, and resulting impacts on climate change. The committees identified specific needs, including:

- Researching the implications of linking transportation infrastructure investment to development (e.g. adequate public facilities requirements)
- Considering the impacts and needs of goods movement on transportation and land use planning
- Identifying techniques for integrating local comprehensive plans into regional transportation planning processes

- Promoting model city/county ordinances that support a vibrant pedestrian network
- Identifying the tools and resources necessary to integrate pedestrian trips into transportation models

B. Ongoing and completed research

- **Environment and Sustainability: Assembly Bill 32 and Senate Bill 375**. *California State Polytechnic University, Pomona* (In progress). This project develops decision support protocol and related GIS computer applications for strategic compliance with the new transportation and land use planning mandates of California SB 375. SB 375 is a statute designed to help slow global warming (and incidentally to reduce air pollution and urban sprawl) by promoting comprehensive urban development approaches that are expected to reduce passenger miles driven. This mandate, which affects local agencies and MPOs, requires far more integration of land use planning with transportation planning and far more geospatial analysis than was previously necessary. http://rip.trb.org/browse/dproject.asp?n=24524

- **Effective Organizational Structures and Management Practices for Achieving Environmental Stewardship and Streamlining in Transportation Agencies**. *NCHRP Project 25-25, Task 37, National Cooperative Highway Research Program, TRB* (2009). This NCHRP study focused on identifying and describing effective organization structures and management practices to achieve a high level of environmental stewardship and environmental streamlining. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(37)_FR.pdf

- **Integrating Climate Change into Transportation Decisionmaking**. *USDOT's Center for Climate Change and Environmental Forecasting (CCCEF), FHWA – STEP* (2009). This report is part of ongoing work to highlight innovative actions and initiatives that States, metropolitan planning organizations (MPOs), and local areas have undertaken to incorporate climate change considerations as part of the transportation planning process. These initiatives represent innovative attempts to use the planning process to manage and reduce GHG emissions from the transportation sector within corresponding States, metropolitan areas, and local jurisdictions. http://climate.dot.gov/state-local/integration/planning_process.html

- **Near Source Modeling of Transportation Emissions in Built Environments Surrounding Major Arterials - Phase II**. *University of California, Berkeley Transportation Center* (2009). The model accounts for the effects of the micro-environment on pollutant transport. It will simulate the effects of: 1. Alternative land development strategies (e.g. varying building height and setback requirements, infill patterns, zoning) 2. Alternative transport policies (e.g. idling time reduction, stoplight synchronization, truck traffic scheduling and rerouting). The research addresses incorporating arterials into the environmental planning programs of resource, land use, and transportation agencies. http://rip.trb.org/browse/dproject.asp?n=20340

- **Integrating Climate Change into the Transportation Planning Process**. *FHWA - STEP (2008).* The objective of this study is to advance the practice and application of transportation planning among local, State, and regional transportation planning agencies

to successfully meet growing concerns about the relationship between transportation and climate change. www.fhwa.dot.gov/hep/climatechange/index.htm

- **Linking Environmental Resource and Transportation Planning**. *NCHRP Project 25-25, Task 32, National Cooperative Highway Research Program, TRB* (2008). This research showed that transportation as well as conservation agencies are actively engaged in building interdisciplinary, collaborative approaches to planning and project development. Planners and researchers in both disciplines are seeking more efficient and effective processes to achieve transportation objectives and environmental stewardship. Moreover, they recognize the potential benefits of integrated planning to foster creative solutions to difficult environmental and mobility challenges. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(32)_FR.pdf
- **Using the Planning and Environment Linkages Umbrella Approach to Streamline Transportation Decisionmaking**. *FHWA - STEP, published in the Journal of the Transportation Research Board* (2008). The Planning and Environment Linkages (PEL) umbrella approach is designed to streamline the process of project development and environmental review by encouraging agencies to take an integrated, systems perspective to support transportation, environment, and community goals. The PEL approach provides strategies, practices, processes, and analytical tools that encompass related Federal activities including linking planning and NEPA, ecological and context-sensitive solutions, corridor planning, and integrated planning. http://trb.metapress.com/content/v116037622168054/

III. Mitigation of Human and Natural Environmental Impacts

Focus areas: Livability, Climate Change

A. Research needs and opportunities

Transportation projects are required to mitigate adverse environmental impacts that cannot be avoided. One research need is to further explore the effectiveness of mitigation in addressing impacts on communities, including both pre- and post-project assessments of effectiveness. There have been almost two decades of projects that have included avoidance or mitigation measures due to an assessment of high and disproportionate impacts during environmental review. However, there has been limited assessment of the success of those mitigation activities to reduce the impacts below the high and disproportionate level. Another relevant issue is the use and effectiveness of consolidated or regional mitigation banking and associated impacts on land use and travel behavior. These issues may encourage the development of performance measures to help assess the effectiveness of mitigation efforts.

B. Ongoing and completed research

- **Development of a Model to Predict and Mitigate Environmental and Public Health Impacts of Traffic Flows and Traffic Management Policies in Urban Transportation Microenvironments**. *Portland State University* (2010). The major scientific innovations offered by this project are: 1) Integration of detailed and real-time exposure/emissions with a real-time traffic measurement approach 2) Development of an integrated emissions

and transportation model that combines traffic characteristics, emissions, built environment configuration, mode of travel, and predicted health impacts. http://otrec.us/project/345

- **Asset Management of Environmental Mitigation Features**. *NCHRP Project 25-25, Task 51* (2009). The objective of NCHRP 25-25/51 was to identify successful practices that DOTs use to manage environmental assets post-construction.
- **Compendium of Best Practices for Incorporating Environmental Commitments into Transportation Construction and Maintenance Contract Documents**. *NCHRP Project 25-25, Task 47* (2009). This study highlights best practices of State DOTs incorporating environmental commitments into transportation construction documents.
- **Implementation of Community and Cultural Resource Commitments**. *NCHRP 25-25, Task 41* (2009). State DOTs make commitments as they plan transportation projects. The tracking of commitments is a necessary component to ensure adequate implementation. This study analyzed the practices and methods that State DOTs use to track and enforce the implementation of community and cultural resource commitments. http://onlinepubs.trb.org/onlinepubs/archive/notesdocs/25-25(41)_FR.pdf
- **Water Quality Banking**. *City College of City University of New York.* (Ongoing) Current stormwater regulations outline specific processes by which an applicant must evaluate and propose mitigation to offset impacts to water quality, groundwater recharge, and peak runoff resulting from the addition of impervious surfaces. The rules address impacts of individual projects and have no provisions for addressing impacts of multiple projects or "banking" of impacts; building separate, onsite mitigation features for each project can result in inefficient and nominally effective results, and also delay implementation schedules. Many of these issues are similar to wetland regulation and mitigation, which also began with project-specific mitigation and led to the creation of wetland banking; wetland banking has now been in place for over two decades. Since it is often difficult to find appropriate vacant property and unconstrained physical space adjacent to individual projects to mitigate impacts, there is a clear need to establish a watershed-based banking process, which can be used as a feasible alternative solution.

IV. Travel Behavior and the Built Environment

Focus areas: Livability, Sustainability, Energy, Climate Change

A. Research needs and opportunities

Land use decisions affect traveler behavior in terms of the distances people travel, the times when they travel, and the modes that they choose. All of these factors have implications for quality of life, local economy, and the environment. The committees identified specific research needs, including:

- Understanding perceptions of the built environment and time use, travel choice, location, and the ability for perceptions and behaviors to change
- Differences in revealed travel behavior related to the built environment at a disaggregate level (i.e. at the locations where travel takes place)
- Parking strategies to reduce environmental impacts and conform to community goals

- The impacts of location and travel decisions of the baby boomer generation on future transportation and land use decisions
- Reconsidering definitions of levels of service, for all modes

B. Ongoing and completed research

- **Vehicle-Miles-of-Travel-Based Traffic Impact Assessment Methodology.** *Center for Multimodal Solutions for Congestion Mitigation, University of Florida* (In progress). This research will develop methodologies for measuring transportation impact using vehicle miles of travel and travel time. The vehicle miles of travel methodology would more closely reflect the impacts of specific types of land uses and their location within the region and complementary proximity to complementary 'indicator' land uses, such as major employers, grocery stores, home improvement stores, and schools. It will also provide incentives for development that increase internal capture and non-automobile travel, reduce trip length and travel time, and reduce the overall impact of development on major arterials, the State highway system, and the Strategic Intermodal System (SIS) especially at peak travel times. http://cms.ce.ufl.edu/research/Steiner%20Project.php
- **Enhancing Internal Trip Capture Estimation for Mixed-Use Developments. NCHRP Project 08-51 (2010). The objective of this two-phase project is to produce a** methodology for enhancing internal trip capture estimates that includes (1) a classification system of mixed-use developments that identifies the site characteristics, features, and context that are likely to influence internally captured trips and (2) a data-collection framework for quantifying the magnitude of internal travel to and around mixed-use developments to determine the appropriate reduction rates. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=927
- **Driving and the Built Environment, the Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions - Special Report 298**. *The National Research Council* (2009). The report examines the relationship between land development patterns and vehicle miles traveled (VMT) in the U.S. to assess whether petroleum use, and by extension GHG emissions, could be reduced by changes in the design of development patterns. The report estimates the contributions that changes in residential and mixed-use development patterns and transit investments could make in reducing VMT by 2030 and 2050, and the impact that this could have in meeting future transportation-related GHG reduction goals. http://www.nap.edu/catalog.php?record_id=12747
- **Estimating the Effects of Car Sharing on Household Travel and Parking Demand**. *Columbia University* (2009). Car sharing has the potential to be an important means to provide viable transportation alternatives that preserve mobility benefits from automobiles while lowering transportation costs, reducing the amount of land devoted to parking and limiting overall auto travel. In crowded regions like New York, such alternatives are complementary to transit, taxis, and walking. http://www.utrc2.org/research/actproj.php?viewid=183
- **Trip-Generation Rates for Transportation Impact Analyses of Infill Developments**. *NCHRP Project 08-66* (2008). The objective of this research is to develop an easily applied methodology to prepare and review site-specific transportation impact analyses of

infill development projects located within existing higher-density urban and suburban areas. For the purposes of this study, "methodology" refers to trip-generation, modal split, and parking generation. The methodology will address both daily and peak-hour demand for all travel modes. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1616

- **The Built Environment and Travel Behavior: Making the Connection**. *Transportation: Planning, Policy, Research, Practice, Volume 34, Issue 5* (2007). This annual special issue of "Transportation" comprises selected papers presented at the Annual Meeting of the TRB in January 2007. These papers all address the interrelationship between the built environment and travel behavior. Specifically, they provide insight into several important aspects of this topic, including: residential self-selection; interaction between long-, medium-, and short-term choices; the long-term perspective on the influence of the built environment; and a focus on the physically active mode of bicycling. https://commerce.metapress.com/content/j52204623344243t/resource-secured/?target=fulltext.pdf&sid=yzrm40454azzi1mavdkotj55&sh=www.springerlink.com

V. Transportation, Physical Activity, and Health

Focus areas: Livability, Sustainability, Energy Use

A. Research needs and opportunities

A growing interest and focus in the transportation and public health communities relates to the connection between the built environment, traveler behavior, physical activity, and health. There are ongoing efforts to better understand the impacts of transportation investments on physical activity behavior, and associated impacts on rates of obesity and disease. While the association between physical activity and health is substantial, there has been less research linking the built environment and provision of non-motorized facilities to noticeable changes in mode choice and improved health outcomes. There is also a need for continued research and discussion related to the best provision of multimodal facilities. The committees have identified some of the research needs, including:

- Multimodal design to create complete streets
- Design to accommodate multimodal users at major intersections
- Public involvement related to planning for bicycle and pedestrian facilities
- Evaluation of Safe Routes to School programs
- Development of a methodology to evaluate the impacts of constructing missing sidewalks

B. Ongoing and completed research

- **Estimating Bicycling and Walking for Planning and Project Development**. *NCHRP 08-78*. The objective of this research is to prepare a guidebook for practitioners on estimating and forecasting bicycling and walking activity. The guidebook will include transferable methods for practitioners working on regional-, corridor-, and project-level analysis to estimate and forecast bicycling and walking activity in relation to transportation infrastructure characteristics, land use, topography, weather/climate, and

socio-demographic characteristics. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2707

- **A Study of the Interrelationship between Parent's and Children's Physical Activity Participation Frequency**. *University of Texas, Austin* (In progress). This research will study how the daily frequency of physical activity participations of parents and children are interrelated, and how they are affected by urban form design and the built environment. http://swutc.tamu.edu/projectdescriptions/161020.htm
- **Implementation of Active Living Policies by Transportation Agencies and Departments**. *Portland State University* (2009). This project examines how and why some public agencies adopt policies that are intended to create a built environment that supports physical activity and active living. The project focuses on transportation agencies, including city and county DOTs and public works, congestion management agencies, MPOs, other regional transportation agencies, and State DOTs. http://www.cts.pdx.edu/research/activelivingpolicies.php
- **Stepping Towards Causation: Do Built Environments or Neighborhood and Travel Preferences Explain Physical Activity, Driving, and Obesity?** *Social Science and Medicine, Volume 65, Issue 9* (2007). This study controls for neighborhood selection and preference and isolates the effect of the built environment on walking, car use, and obesity. http://tris.trb.org/view.aspx?id=840384

VI. Greenhouse Gas Reduction, Sustainability, and Performance Measures

Focus areas: Climate Change, Energy, Sustainability

A. *Research needs and opportunities*

As GHG reduction becomes more of a national and international priority, there is an increasing need for examining the tangible and forecasted benefits, costs, and risks associated with implementing a national program of GHG reduction measures (and other green techniques) to control climate change.

B. *Ongoing and completed research*

- **Greenhouse Gas Emissions Reduction Strategies for Surface Transportation: A Mitigation Guidebook.** *FHWA - STEP* (In progress). This research will review and analyze a variety of transportation strategies that could be undertaken by State and local transportation agencies to reduce GHG emissions from the transportation sector. A Web-based "Guidebook" will be developed that will describe the strategies, estimate potential range of GHG reductions, estimate costs, identify barriers to implementation, identify example projects, and describe any associated co-benefits or disadvantages.
- **Incorporating Greenhouse Gas Emissions into the Collaborative Decisionmaking Process**. *Strategic Highway Research Program 2 (SHRP 2)* (In progress). The objectives of this project are to: (1) develop a strategy or strategies for addressing GHG emissions at relevant key decision points in the Collaborative Decisionmaking Framework (CDMF); (2) identify relevant material already produced by the normal planning process and the gaps that exist for GHG analysis, (3) prepare materials and methods to address the gaps

and integrate them into the CDMF; (4) prepare a freestanding Practitioner's Handbook. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2348

- **Operations Strategies to Reduce Greenhouse Gas Emissions.** *FHWA – STEP* (In progress). This research will further investigate the GHG reduction potential of highway operation and management strategies. Building on the information developed for the *Moving Cooler* report, USDOT's Report to Congress and others, FHWA will model travel behavior changes from operational strategies to identify changes in overall vehicle use and miles traveled, traffic flow, speed, etc. and forecast long term changes in GHG emissions.
- **Sustainability Performance Measures for State Departments of Transportation and Other Transportation Agencies**. *NCHRP 08-74* (In progress). The objective of this project is to develop a guide for State DOTs and other transportation agencies to use in order to measure the sustainability of their networks, systems, facilities, projects, and activities, at the appropriate scales, stages (i.e. long-range planning, programming, project development, design, construction, maintenance, operations), and timeframes. The project will clearly describe the underlying principles of sustainability as they apply to transportation agencies. The guide will (1) support agency decisionmaking processes at various management levels; (2) enable agencies to develop appropriate sustainability goals, objectives, and associated performance measures, and methods for conducting performance measurement and monitoring; and (3) describe computation methods for these measures and possible data sources. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2500
- **Implications of Performance Standards, Conformity-Style Approaches, and Other Mechanisms for Assessing Greenhouse Gas Reduction Strategies and Integrating GHG Objectives into Transportation Decisionmaking**. *NCHRP 20-24, Task 64* (2010). This project provides a factual basis for judging the merits of alternative methods that State DOTs and MPOs can use for managing GHG emissions from transportation. The project will help policymakers to understand (a) how these alternative approaches to GHG emissions would affect States and metropolitan areas, (b) what approaches may be most effective for evaluating mobile-source GHG emission-management strategies, and (c) what particular tools are available to support implementation of these alternative approaches. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2481
- **Moving Cooler, An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions**. *Collaborative Strategies Group* (2009). The intent of the Moving Cooler study is to assess the potential effectiveness of a broad variety of transportation strategies under a wide range of different assumptions in order to reduce GHG emissions. This study was not intended to result in any specific recommendations about the direction of transportation and climate change policies. Therefore, the report does not purport to provide any interpretations about the implications of the Moving Cooler findings. http://www.movingcooler.info/
- **Climate Change: Action by States to Address Greenhouse Gas Emissions**. *Congressional Research Service* (2007). In the absence of a Federal climate change program, a number of States have taken actions that directly address GHGs. States' efforts cover a wide range of policies. Although much of the early activity was largely symbolic, the more recent State actions have been more aggressive. Twenty-three States have joined

one of the three regional partnerships that would require GHG (or just carbon dioxide) emission reductions. http://tris.trb.org/view.aspx?type=MO&id=870544

- **Growing Cooler: The Evidence on Urban Development and Climate Change**. *Urban Land Institute* (2007). This book (available online) concludes that urban development is both a key contributor to climate change and an essential factor in combating it. The authors make the case that one of the best ways to reduce vehicle travel is compact development, and recommend changes that can be made to make green neighborhoods more available and more affordable. http://postcarboncities.net/files/SGA_GrowingCooler9-18-07small.pdf
- **Public Transportation's Contribution to U.S. Greenhouse Gas Reduction**. *American Public Transportation Association* (2007). This report addresses four questions: 1. How much net CO2 is public transportation saving in the U.S. from the current level of services being offered? 2. How much additional CO2 savings are possible if incremental public transportation passenger loads are increased? 3. What is the significance of non-public transportation commuter use at a household level and what can households do to save additional CO2? 4. Are there favorable land use impacts to which public transportation contributes that result in positive environmental and social benefits? Answers to these questions show that public transportation is a highly valuable asset for reducing global warming. http://tris.trb.org/view.aspx?type=MO&id=870544

VII. Social and Economic Impacts of Transportation

Focus areas: Livability, Sustainability, Climate Change, Energy Use

A. Research needs and opportunities

Transportation projects affect local communities and have economic impacts on nearby property values as well as local businesses. For example, increased accessibility may increase the number of customers that can reach commercial areas and increase property values. On the other hand, nuisance effects (e.g. noise, congestion, pollution, etc.) may decrease property values. The committees identified the following research needs related to social and economic impacts:

- Approaches for assessing the comprehensive economic impacts of transportation decisions on specific populations and communities, including cumulative effects on household location, employment, and cost of transportation as well as indirect effects on the cost of goods and services
- Social and economic impacts of mega projects
- Community impacts from reconstruction of projects that generated substantial impacts at initial construction
- Impacts of transportation projects on property values, including categorizing transportation projects by mode and type of facility (e.g. various cross-sections, greenways) and/or surrounding land use (e.g. residential vs. commercial, typical suburban vs. neotraditional, etc.)

B. Ongoing and completed research

- **Defining Community Context in Transportation Project Planning and Development Process**. *NCHRP 25-25, Task 69* (In progress). This project will inventory and evaluate the effectiveness of community context tools and techniques that are used as part of the project planning and development processes. These tools should assist with understanding community interests and needs (i.e. visions and goals for improved quality of life) for the benefit of effective and efficient decisionmaking that leads to community-valued transportation projects. The research will also identify future needs in the area of context tool development.
http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2847

- **Impacts of Proposed Federal Greenhouse Gas Mitigation Legislation on Texas' Transportation Economy**. *University of Texas, Austin* (In progress). This project will entail a full discussion of impacts on the Texas transportation sector's overall liability and opportunity under a national GHG reduction plan. Understanding the ramifications of regulating carbon as part of a sound environmental stewardship is critical for sustaining economic growth and trade. http://swutc.tamu.edu/projectdescriptions/161021.htm

- **Interactions between Transportation Capacity, Economic Systems, and Land Use Merged with Integrating Economic Considerations Project Development**. *SHRP 2 CO3* (2010). The project objectives are to provide a resource to help determine the net changes in the economic systems of an area impacted by a transportation capacity investment. This includes impacts on the local economy, land use, and the environment.
http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2162

- **The Economic Impact of Upgrading Roads**. *University of Minnesota and Minnesota DOT* (2009). Improvements to transportation networks, especially those in growing areas, tend to have impacts on local land markets. In principle, an improvement to a link in the network will confer economic benefits to adjacent and nearby properties by increasing the utility that the network provides. Traditional methods of economic analysis for highway improvement projects have focused primarily on user benefits and sought to quantify them through the estimation of reductions in travel delay or user cost. However, it should also be possible to estimate the value of the benefits from a highway project based on the response of local land markets to the improvement. This report explores the nature and magnitude of benefits accruing to nearby properties that arise from major highway construction or reconstruction projects, more precisely those that add capacity to an existing highway.
http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1804

- **Relocation Assistance Retrospective Study.** *FHWA- STEP, Office of Real Estate Services* (2009). The purpose of this research is to determine the economic impact of transportation projects by performing an in-depth retrospective survey of the actual costs that business incur as a result of being required to relocate from the project area and determine the percentage of businesses that remain in operation for at least two years after their relocation. The information gathered will be utilized to develop quantitative and qualitative data which can be used to assess the adequacy of benefit levels established in the Uniform Act and provided to impacted business community.
http://www.fhwa.dot.gov/hep/step/fy09rp.htm

- **Improved Methods for Assessing Social, Cultural, and Economic Effects of Transportation Projects**. *NCHRP Project 08-36, Task 66* (2008). This project reviews practices in State DOTs and MPOs that are using information about the human environment earlier in the transportation planning process and synthesizes effective approaches. It also identifies existing or emerging community and social impact assessment practices to develop indicators of quality of life that will be employed in the community impact assessment process. These cross-cutting indicators should include information about the human environment, such as: community cohesion, impacts to housing and employment, cultural resources, aesthetic values, and the availability or access to public facilities and services. http://www.statewideplanning.org/_resources/234_NCHRP-8-36-66.pdf
- **Recurring Community Impacts**. *NCHRP 25-25, Task 36* (2008). This reference document is intended for practitioners in transportation and resource agencies to provide a common understanding of requirements and approaches that are available to improve the analysis, documentation, and mitigation of recurring community impacts. Recurring community impacts, as explained in this guide, are a subset of cumulative community impacts that focus on the past and current actions affecting a community. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(36)_FR.pdf
- **Public Transportation: Benefits for the 21st Century**. *American Public Transportation Association* (2007). This report presents an overview of the benefits of public transit to people and their communities, and to this country as a whole. Some topics covered include: the different types of public transit available (ferry, fixed guideway, bus and highway vehicles); economic impacts and benefits; impact on energy conservation and dependence on oil; reduction of traffic congestion; environmental protection, health benefits, and improvement of air quality; utilization of public transit during emergencies and disasters; mobility for rural and small urban areas; benefits to real estate values and development; access for all ages; human service and essential health care delivery. http://www.apta.com

VIII. Land Use and Community Impacts of Rail and Transit

Focus areas: Livability, Sustainability, Climate Change, Energy Use

A. Research needs and opportunities

As national attention on developing high-speed rail and general interest in light rail systems grows, it is necessary to consider impacts to land use patterns, the local economy, and the communities near the lines and stations.

B. Ongoing and completed research

- **Synthesis of Information Related to Transit Problems. Topic SH-12. Impact of "Small Starts" (Streetcars and Trolleys) on Land Development**. *TCRP Synthesis J-07/Topic SH-12* (In progress). The purpose of this synthesis is to document experience with selected streetcar and trolley projects and their relationship with the built environment. The ability of these systems to spur growth and revitalization has not been

adequately documented.
http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2566

- **Regional High-Speed Rail Lines and Small City Mobility: A Spanish Experience**. *TRB Annual Meeting 2009 Paper #09-1854* (2009). This paper presents and analyzes the results of the first study on the impact of the new high-speed rail on Toledo local and interurban mobility. The location of the station, at the edge of the city, directs the urban mobility of the users (tourists and commuters to Madrid) and demands good integration of the various modes of transportation. The research includes a survey to train users, with more than 5,000 valid questionnaires collected during the week of October 22-28, 2007. http://pubsindex.trb.org/view.aspx?id=881401
- **Transforming High-Speed Rail Stations to Major Activity Hubs: Lessons for California**. *TRB Annual Meeting 2009 Paper #09-2757* (2009). The paper reviews the case for high-speed rail as a complement to air and highway systems in addressing congestion and providing needed additional services as the population of the State continues to grow. Review of domestic and international experiences reveals that well-planned station-area developments can result in desirable impacts on the communities served. http://pubsindex.trb.org/view.aspx?id=881904
- **Transportation, Social, and Economic Impacts of Light and Commuter Rail**. *Texas Transportation Institute, Texas DOT, FHWA* (2009). Rail systems expand mobility and reduce household investment in transportation. However, as regions implement rail systems, they must consider the full range of rider impacts so that environmental justice issues do not emerge. The largest body of research relates to the economic impact of rail. These impacts are strongest in station areas, as access to rail increases property value on nearby property. However, the positive impact of rail on property values does not hold true for property directly adjacent to the rail line. State DOTs have played a variety of roles in rail development, ranging from funding initial planning to operating services. http://tris.trb.org/view.aspx?type=MO&id=902294
- **The Impact of High-Speed Training on Socioeconomic Activity**. *World Conference on Transport Research Society* (2007). This paper reports on work undertaken for the South East England Development Agency (SEEDA) that was designed to determine the impact of the London-Paris-Brussels-Amsterdam-Cologne high-speed rail network on socioeconomic development. http://tris.trb.org/view.aspx?id=883827

WHITE PAPER 2

BACKGROUND

This white paper, the second in a series of four, is intended to inform the opening session by providing a synthesis representing views from select Transportation Research Board (TRB) Committees regarding ongoing and completed research related to the workshop's focus topics and future research needs in those cross-cutting topic areas. The paper also discusses the effectiveness of outreach efforts on the completed research.

Subject matter experts from the following TRB Committees contributed to this white paper:

- ***ADA60 Public Involvement in Transportation*** — This committee enhances the understanding and practice of public involvement in the development and implementation of transportation policy, as well as in transportation project and systems planning, development, design, construction, operations, and maintenance.

- ***ADC30 Ecology and Transportation*** — This committee stimulates, engages in, and performs outreach for research on the integration of sound ecological principles and designs into the transportation planning, decisionmaking, and design processes.

- ***ADC50 Historic and Archeological Preservation in Transportation*** — This committee identifies emerging cultural resource and historic preservation issues in transportation, defines associated research needs, advances those research needs to TRB and others for funding, and disseminates information on completed research through programs and publications.

The white paper team also gathered opinions from members of AASHTO and FHWA. To gather input for the research white paper, the team first convened a telephone conference with the TRB Committee co-chairs and subject matter experts who were available to participate. Three questions guided the conversation:

1. What research has been or is being conducted in the interest areas?
2. How effective has outreach on that research been?
3. What research gaps or needs currently exist?

Afterwards, two representatives polled their respective committees to solicit additional suggestions for research opportunities, while the white paper team followed-up individually with those unable to join the conference call. Information gathered on the call was supplemented with an investigation of all proposed research, databases, and authors that the TRB Committee points of contact provided to the white paper team, and library and Internet searches for academic and professional literature.

CRITICAL PROJECT AREAS

Four cross-cutting needs emerged through a discussion of the four focus area topics (climate change, sustainability, energy, and livability). These needs are:

- To develop a clearer, shared definition of climate change, sustainability, livability, and energy, and to develop methods for communicating with other agencies and the public about these topics
- To employ more strategies for coordinating actions that address climate change, sustainability, livability, and energy at multiple geographic scales and levels of government
- To establish short-term and long-term planning and mitigation strategies to respond to the impacts of climate change and sustainability as well as energy and livability programs and policies
- To more effectively define and disseminate the outcomes of research projects on climate change, sustainability, energy, and livability

The existing research, research opportunities, and research needs related to these needs can be best explored by examining each focus area topic separately. It should be noted that due to the volume of research in each of the focus area topics, this paper focuses on resources that subject matter experts have provided as well as resources found in databases that the working group identified, published in 2008 or later. Databases searched include: the NCHRP 25-25 database, the TERI database, the TRIS database, and the RiP database.

I. Climate Change

A. Research needs and opportunities

The white paper contributors emphasized that their work on climate change focuses on two separate but related goals: (1) Understand the likely environmental impacts of climate change that will take place over the next 20-30 years and how to modify environmental analysis and project design to address these impacts, and (2) Develop mitigation measures that minimize transportation's contribution to climate change. Both of these goals must be met at different geographic and ecological scales as well as at different levels of government.

Research needs and opportunities related to the first goal include:

- An understanding of climate change impacts to date in order to help predict future climate impacts on human activities. This research would be especially useful if examined in a variety of locations so that transportation professionals can plan for potential future climate impacts.

- An identification of modifications that should be made to the transportation planning and design processes to cope with the environmental impacts of climate change.

- A better understanding and dissemination of information on the GHG emissions contributions of transportation and other human activities.

- More information on the effects of climate change on invasive species and how to study the potential impacts of climate change on invasive vegetation and aquatic species.

Research needs and opportunities related to the second goal include:

- Better guidance on methods to communicate information on climate change impacts to the community and on the role of the community in mitigating climate change impacts. Because climate change is a controversial issue in some areas of the country, information on ways to explain the impacts of climate change and what the community can do to mitigate negative impacts would be useful.

- A clearer explanation of each State's top priorities for dealing with climate change. Thirty-five out of fifty States have climate action plans completed or in progress, according to the Pew Center on Global Climate Change. Additional research should specifically focus on transportation's role in State climate action plans.

- More information on the project-level implications of GHG emissions, stemming from better tools, models, and formulas that monitor the fluctuation of emission levels. These tools should either explain the implications of GHG reduction initiatives or show changes in a manner that is appropriate for NEPA analysis. This type of information could define the aspects of a project that should trigger a climate mitigation requirement.

B. Ongoing and completed research

- **Scenario Planning for Greenhouse Gas Mitigation and Climate Change Adaptation**. *FHWA - STEP* (In progress). This project will develop and implement several workshops for State DOTs and MPOs to assist them in incorporating climate change considerations into their scenario planning process. The project will document the workshops and develop a "Guide" for State DOTs and MPOs to use when incorporating climate change considerations into scenario planning, and provide an Action Plan to help the selected DOTs and MPOs move forward with the process.

- **Adapting to Climate Change: The Public Policy Response – Public Infrastructure**. *Resources for the Future* (2009). This paper uses a threats-and-needs assessment approach to evaluate the issues facing public infrastructure in the U.S. and then examines the adaptive capacity for responding to these threats and needs from multiple sectors. http://ntl.bts.gov/lib/31000/31900/31975/RFF-Rpt-Adaptation-NeumannPrice.pdf

- **Public Understanding of Climate Change and the Gaps between Knowledge, Attitudes, and Travel Behavior**. *TRB* (2009). Public awareness of the relationship between transportation and climate change appears to be at a high level. Moreover, there appears to be a high degree of concern on environmental issues. These findings are not reflected in corresponding lifestyle choices, which implies an attitude-behavior gap. This paper attempts to increase public awareness of climatic issues and to encourage the public to recognize the impacts of their behavior on climate change and to make lifestyle choices that minimize these impacts. http://ntl.bts.gov/lib/32000/32200/32265/32265.htm

- **The Impact of Climate Change and Weather on Transport: An Overview of Empirical Findings**. *Transportation Research Part D: Transport and Environment 14:3* (2009). This paper presents a survey of the empirical literature on the effects of climate change and weather conditions on the transport sector. http://ntl.bts.gov/lib/32000/32200/32263/32263.htm

- **The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public**. *Columbia University Center for Research on Environmental Decisions* (2009). This guide examines the biases and barriers to scientific communication about climate change impacts and offers strategies for effective communication about this complex topic. Strategies for effective communication include: narrative storytelling, the incorporation of imagery, and the use of trusted messengers to communicate. http://www.cred.columbia.edu/guide/pdfs/CREDguide_full-res.pdf
- **Transportation Adaptation to Global Climate Change**. (2009). This white paper was commissioned to identify policy options that support proactive measures for addressing climate change adaptation in transportation. It is intended to inform Congress and other policymakers about policy options at the Federal level that will help increase the national transportation system's resilience to climate impacts such as rising sea levels and weather variability, thereby reducing long-term costs. www.bipartisanpolicy.org/sites/default/files/Transportation%20Adaptation%20%283%29.pdf
- **Integrating Climate Change into the Transportation Planning Process**. *FHWA – STEP* (2008). This study aims to advance transportation planning among local, State, and regional transportation planning agencies to meet growing concerns about the relationship between transportation and climate change. www.fhwa.dot.gov/hep/climatechange/index.htm
- **TRB Special Report 290**. *National Research Council* (2008). This report explores the consequences of climate change for U.S. transportation infrastructure and operations. www.trb.org/news/blurb_detail.asp?ID=8794
- **Growing Cooler: The Evidence on Urban Development and Climate Change**. *Urban Land Institute* (2007). This book (available online) concludes that urban development is both a key contributor to climate change and an essential factor in combating it. The authors make the case that one of the best ways to reduce vehicle travel is compact development and they recommend changes that can be made to make green neighborhoods more available and more affordable. http://postcarboncities.net/files/SGA_GrowingCooler9-18-07small.pdf

II. Sustainability

A. Research needs and opportunities

Sustainability lacks a clear, widely accepted definition and most audiences do not understand what elements compose it on both a conceptual and practical level. Almost every member of the working group emphasized the need to develop a concrete, reasonable definition of sustainability that could then be incorporated throughout transportation policies and practices. Such a definition needs to support the overarching goals of the transportation community, while at the same time acknowledge regional and individual perspectives. Some progress has been made on this front through the Strategic Highway Research Program (SHRP 2), but more work is necessary.

In practice, the inclusive nature of sustainability as a concept means that a very diverse group of research needs and opportunities falls under the sustainability heading. These needs include:

- More extensive research on and documentation of dialogues between the public and policymakers centered on the subject of sustainability. There has been little documented research on explicit communication between the public and government agencies developing sustainable solutions to reduce the environmental impacts of global climate change.

- Comprehensive guidance derived from past public participation processes that aims to reduce the ecological footprint of transportation programs and projects. Many agencies have recently dealt with sustainability concepts as they relate to reducing a carbon footprint. In turn, examining concepts such as community-based planning, urban planning, urban design, and Context-Sensitive Solutions (CSS) could provide a wealth of information.

- Information on the relationship between sustainability, social equity, and public involvement, focusing on the promotion of social equity through sustainability programs.

- Research on best practices in the measurement and mitigation of non-point source pollution that is negatively impacting the health of ecosystems and communities.

- A comprehensive assessment of the impact of transportation projects on the sustainability of wildlife habitats. Developing a better understanding of wildlife crossings and better mapping of wildlife paths may improve the safety of wildlife and drivers.

B. Ongoing and completed research

- **Best Practices in Addressing NPDES and Other Water Quality Issues in Highway System Management: Results of a U.S. Domestic Scan Tour**. *AASHTO Standing Committee on Highways* (2009). This interdisciplinary domestic scan, undertaken by the AASHTO Standing Committee on Highways, brought transportation and environmental professionals together to examine State DOT stormwater management practices. http://www.cte.ncsu.edu/CTE/TechTransfer/Teleconferences/2010schedule.asp#after
- **NCHRP Synthesis 400: New Approaches to Ecological Surveys**. *TRB* (2009). This synthesis report surveyed transportation and natural resource professionals to identify ecological survey needs for transportation activities and the technologies, techniques, and innovative methods to fulfill those needs. The identified approaches to fulfilling those needs include data collection, data analysis and data delivery, as well as uses for data in planning, operations, and cooperative working relations. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_400.pdf
- **NCHRP 25-25, Task 32: Linking Environmental Resource and Transportation Planning – The Current State of Practice**. (2009). Increasingly, NEPA documents for major transportation projects indicate that dispersed land development is likely to be a

secondary environmental impact. Dispersed development can contribute to air and water degradation, habitat loss, and a decline in ecosystem functions. This study developed a handbook of techniques used to predict, control, or mitigate land development impacts on transportation projects.
http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1540

- **NCHRP 25-25, Task 53: Stormwater Treatment with Vegetated Buffers**. *Texas Transportation Institute* (2009). This research incorporated a literature review and a review of States' guidance to determine how highway stormwater treatment is modeled throughout the country, share best practices, and develop guidance for effective stormwater treatment on rural highways.
http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP25-25%2853%29_FR.pdf

- **Sustainability Reporting by the Public Sector: Practice, Uptake, and Form**. *Global Reporting Initiative* (2009). This article discusses sustainability reporting in public sector agencies at the local, regional, State, and Federal levels according to Global Reporting Initiative (GRI) guidelines. Also, it explores the importance and obstacles to more extensive reporting from all levels of government.
http://www.globalreporting.org/NR/rdonlyres/FAFD9A06-702A-4AA8-988C-979DBCCBC948/0/LeesonEtAlSustReortingByPublicSector.pdf

- **NCHRP 25-25, Task 36: Recurring Community Impacts**. (2008). Community impact assessment is a critical part of the NEPA process that builds trust between the public and government agencies; however measuring cumulative impacts on communities has proven problematic. Given the dynamics of community growth and development, it can be difficult to measure the cumulative impact. The objective of this study was to develop guidelines for State DOTs on how best to address recurring community impacts in NEPA documents. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2836%29_FR.pdf

- **Making Sustainable Transport Politically and Publicly Acceptable.** *D. Banister, J. Pucher, and M. Lee-Gosselin, Institutions and Sustainable Transport: Regulatory Reform in Advanced Economies* (2007). This paper uses case studies from the U.S., the EU, and Canada to explore the case of political and public acceptability for increasing the sustainability of passenger transportation. It contains guidelines for action.
http://policy.rutgers.edu/faculty/pucher/Acceptability%20EU%20CAN%20USA.pdf

- **Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects**. *FHWA* (2006). Developed by a team of representatives from eight Federal agencies and the Departments of Transportation for four States, Eco-Logical articulates a vision of how infrastructure development and ecosystem conservation can be integrated to harmonize economic, environmental, and social needs and objectives.
http://www.environment.fhwa.dot.gov/ecological/eco_index.asp

III. Energy

A. *Research needs and opportunities*

Of the four focus topic areas, the working group observed the fewest connections between energy and their TRB committees. Research needs at the intersection of energy, transportation, and the topic areas addressed by ADA60, ADC30, and ADC50 primarily deal with the use of the ROW. Primary research needs included:

- New research on the potential for alternative energy generation in highway ROW. Alternative energy generation may include the installation of solar panels or wind power generation.

- Additional research on the ecological implications of carbon sequestration performed in ROW. This research should examine the different types of plants used to sequester carbon in this setting and the potential for generating carbon offsets.

B. *Ongoing and completed research*

- **Carbon Sequestration Pilot Program: Implementation and Next Steps**. *FHWA – STEP* (2009). This report outlines lessons learned from the New Mexico Department of Transportation's pilot carbon sequestration program and documents the elements likely required to implement a carbon sequestration process tailored to State DOTs. http://climate.dot.gov/documents/FINAL_C-Seq_Report_021109.pdf

- **Changing the Way America Moves: Creating a More Robust Economy, a Smaller Carbon Footprint, and Energy Independence**. *American Public Transportation Association* (2009). This report examines the potential benefits of investments in public transportation for achieving energy independence and mitigating climate change. http://www.apta.com/resources/reportsandpublications/Documents/america_moves_09.pdf

- **Identification of Emerging Practices and Issues for Alternative Fuel Technologies and Energy Facilities in the Right of Way**. *FHWA- STEP, Office of Real Estate Services* (2009). The purpose of this research is to explore new technologies and potential applications and to develop appropriate guidance that supports right-of-way innovation by our stakeholders. As policy initiatives emerge to reduce and combat greenhouse gas emissions, a number of emerging opportunities are being identified regarding the use of highway right-of-way as part of the solution. Potential solutions include right-of-way accommodation of alternative power generation sources (energy facilities) and accommodation of infrastructure for renewable and alternative fuels (alternative fuel technologies). The information gathered and lessons learned from stakeholders and literature review carried out as part of this research will provide a source of information that will be used to promote and further the integration of transportation and land use decision making that would support FHWA's strategic goals and policy initiatives to support green house gas reduction.

- **Wind-Powered Electrical Systems: Highway Rest Areas, Weigh Stations, and Team Section Buildings**. *Illinois Center for Transportation* (2009). This research project

examined wind to energy in order to provide electrical power to the Illinois Department of Transportation highway rest areas, weigh stations, and team section buildings. The goal of the project was to determine the extent to which wind power could offset electricity costs, provide a reasonable return on investment, offset energy use, and provide educational opportunities. http://ntl.bts.gov/lib/31000/31000/31022/ICT-09-034.pdf

- **Spatial Development and Energy Consumption**. *Resources for the Future* (2007). This research paper discusses the potential effectiveness of urban policies at improving energy efficiency. It uses models of realistic transportation and land-use policies to examine whether those policies are likely to reduce energy consumption in the urban context. http://www.rff.org/RFF/Documents/RFF-DP-07-51.pdf

IV. Livability

A. Research needs and opportunities

Livability, like sustainability, is a concept with complex boundaries. A more specific definition in order of livability would help in creating new policy and processes. The DOT-HUD-EPA Partnership for Sustainable Communities has used six livability principles to define the goals of the partnership: 1. Provide more transportation choices 2. Promote equitable, affordable housing 3. Enhance economic competitiveness 4. Support existing communities 5. Coordinate policies and leverage investment 6. Value communities and neighborhoods.

Research needs related to livability include:

- A firm understanding of what livability means to residents of different areas of the country. Residents of rural and urban areas may define a livable community very differently. Therefore, a definition that favors one type of built form or transportation mode over another may lead to conflict or may not be accurate in all settings. Conducting additional research on public perceptions of livability may tease out common principles applicable nationwide.

- Further assessments of the indirect and direct impacts of transportation investments on land use and sprawl. This may lead to new methods of preventing GHG increases from transportation investments through land use regulation.

- Best practices for sound barrier design in historic areas that prevent sound barriers from reducing the scenic or livable qualities of historic areas and existing communities.

- Best practices for prioritizing the rehabilitation of historic bridges and understanding the most effective means of preservation for different types of bridges as they relate to livable communities.

- Additional research on the impacts of CSS on historic preservation. CSS has been an important approach for incorporating environmental considerations into the transportation development process and may prove equally successful for historic preservation.

B. Ongoing and completed research

- **Considering Cultural Resources in Transportation Planning, Project Development, and Construction**. *TRB* (2009). This report contains strategies for effectively considering cultural resources during the transportation planning and project development processes. It is important for transportation decision makers to consider cultural resources as they may lead to better planning decisions and avoid potential delays and costs associated with the discovery of cultural resources after a project is underway. http://onlinepubs.trb.org/onlinepubs/millennium/00025.pdf
- **Minnesota's Preservation of State-Owned Historic Bridges for Long-Term Transportation Use**. *Proceedings of the 2009 Structures Congress* (2009). The Minnesota Department of Transportation (Mn/DOT) identified certain inefficiencies in managing historic bridges including time-consuming, inefficient, and costly processes. Hoping to streamline historic bridge management, Mn/DOT worked with Mead & Hunt and HNTB to develop management plans for selected historic bridges that would incorporate a new collaborative approach by the Mn/DOT historian and the engineer. http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=ASCECP0003410410310000350000001&idtype=cvips&gifs=yes&ref=no
- **NCHRP 25-25, Task 49: Effective Practices for Considering Historic Preservation in Transportation Planning and Early Project Development** (2009). This report examined the best practices of State DOTs for considering historic preservation factors during transportation systems planning and project development. The report also examines how State DOTs engage tribes and historic preservation agencies during the planning and project development processes. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2849%29_FR.pdf
- **Strengthening Interjurisdictional Coordination on Transportation and Related Land Use – A Guidebook for Practitioners**. *Rudin Center for Transportation Policy and Management* (2008). The guidebook is drawn from research on the jurisdictional barriers that have had an impact on greater integration of land use and transportation planning in a variety of recent planning studies. It provides training matrices, including key success factors for interjurisdictional coordination. http://wagner.nyu.edu/rudincenter/research/Guide%20Book%20Revised%20Cover2008%20FIN.pdf
- **NCHRP 25-25, Task 22: Forecasting Indirect Land Use Effects of Transportation Projects** (2007). This report provides updates on recent research findings on indirect land use effects of transportation projects and presents several important emergent areas of practice not addressed in the previous literature. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25%2822%29_FR.pdf

EFFECTIVENESS OF OUTREACH FOR CURRENT RESEARCH

The working group identified several current barriers to outreach for TRB research and methods and determined ways to reduce these barriers and improve communication. The methods for reducing inadequate or inconsistent research outreach include:

- *Develop opportunities for interactive, multidisciplinary communication about new research:* After research or reports are completed, members of the transportation community often review them by reading the document(s) alone, without any discussion. This results in a one-way communication process that can limit the reader's understanding of the information. Interactive review would create a dialogue between the researcher and the reader, leading to a better understanding of the findings. Recently FHWA, through STEP, has been offering webinars presenting recent research where members of the transportation community can learn about the research in the author's own words and can ask personalized questions.

- *Develop stronger partnerships between national and State research efforts:* It is important that research results reach practitioners at all levels – local, State, tribal and Federal. Stronger partnerships between the national cooperative research programs and State research programs, such as the co-sponsoring of events and webinars, could facilitate a wider dissemination of research results.

- *Incorporate communication plans and strategies into requests for proposals (RFPs) for TRB research:* All RFPs for TRB-funded research should require the contractor or agency completing the research to develop and implement a communication plan or strategy. This would create a broader audience for TRB research efforts and ensure that interest lasts well beyond the moment of a report's publication.

- *Require quantifiable deliverables in all RFPs to further enhance TRB research quality:* RFPs for TRB research should require quantifiable deliverables. For example, a specified number of responses should be required for any survey; estimated time commitments are an alternative option. These quantifiable deliverables would ensure a higher quality for all TRB research, increasing TRB's capacity for outreach.

- *Require respondents to RFPs in order to identify research team members to present research at scholarly events:* Research funding applications do not request applicants to indicate if a member of the research team has presentation capabilities. This would be helpful in ensuring that TRB-funded research is well-represented and presented at conferences.

WHITE PAPER 3

BACKGROUND

This white paper, the third in a series of four, is intended to inform the opening session by providing a synthesis of representative views from select Transportation Research Board (TRB) Committees regarding ongoing and completed research related to the workshop's focus topics and future research needs in those cross-cutting focus area topics. The paper also discusses the effectiveness of outreach efforts on the completed research.

Subject matter experts from the following TRB Committees contributed to this white paper:

- ***ADC20 Transportation and Air Quality*** — This committee examines the full range of relationships between transportation and air quality, including: regulatory and policy considerations, modeling practices, health effects, new technologies, and transportation management strategies.

- ***ADC40 Transportation-Related Noise and Vibration*** — This committee examines transportation-related noise and vibration and evaluates alternative strategies and control techniques for reducing noise and vibration levels and for testing their environmental impact.

- ***ADC60 Waste Management and Resource Efficiency*** — This committee examines systems-based solutions and research associated with resource efficiency- and contamination-related technical areas, such as: toxic and hazardous materials tracking, pollution prevention, product substitution and green designs, recycling and reuse of materials, advances in environmental site assessment technologies and methodologies, and brownfields programs.

- ***AV030 Environmental Impacts of Aviation*** – This committee examines environmental issues central to airport planning, design, construction and operation, as well as to related aviation system and aviation technology development issues. The mission of this committee is to promote innovation and progress in identifying, evaluating, mitigating and preventing the environmental impacts of aviation, through research and collaboration.

To gather input for the white paper, the team first convened a Web-based meeting with the TRB Committee chairs and subject matter experts who were available to participate. The group engaged in a moderated discussion and was asked to share details about specific research areas, projects, researchers, and papers that pertain to the four cross-cutting focus area topics. Information gathered on the call was supplemented with (1) materials emailed to the team after the Web meeting, (2) an investigation of all leads that the TRB Committee points of contact provided, and (3) library and Internet searches for academic and professional literature.

Many of the sources reviewed for this paper are academic or professional research papers. In most cases, these are peer-reviewed journal articles. In some cases, however, the team has included special reports and papers issued by industry associations, consulting groups, and other entities; these may not be peer-reviewed or published by academic institutions or professional associations. Several criteria limited the number of sources that are included in this document:

- Publication date – Generally, the research team included only those sources that were published or released since 2007. In some special cases, an older source was thought to be particularly useful and is therefore included.
- Relationship to the four cross-cutting topics – For the most part, the research team included only those sources that address the four topics at a high level (rather than at a detailed technical level).
- Reputable source – In general, the research team included papers or articles from sources that are considered reputable throughout the transportation industry. The team has noted instances where special interest groups or uncommon sources have produced the reports.

CRITICAL PROJECT AREAS

The subject matter experts identified a number of broad areas related to the cross-cutting focus area topics that are of interest to their committees. The research areas identified are:

- Mode Choice and Climate Change
- Health Effects of Non-Motorized Transportation
- Health Impacts from Air Pollution
- Roadside Barriers to Mitigate Air and Noise Pollution Affecting Livability (including natural, vegetative, and artificial barriers)
- Life Cycle Assessment of Roadway Materials and Operations
- Urban Heat Island Effect
- Environmental Management Programs
- Analysis of Greenhouse Gas (GHG) Emissions and Carbon Sequestration
- Alternative Energy Sources

I. Mode Choice and Climate Change

Focus areas: Climate Change, Livability

A. Research needs and opportunities

More information is needed on the effect of mode shifts from motorized to non-motorized transportation on climate change. This research overlaps with studies that investigate the effects of land use in reducing GHG emissions, which contribute to climate change.

B. Ongoing and completed research

- **Seasonal Impacts on Bicycle Transport**. *University of Vermont (UVM)* (In progress).This project, in tandem with several similar UVM research projects, seeks to document factors that influence choice of bicycling as a transportation mode for commuting to work in a northern climate. This project is ongoing and it is expected that results will contribute to methods for estimating demand for these services. Companion studies address pedestrian activity. www.uvm.edu/~transctr/devsite/?Page=022304.html&SM=_researchmenu.html

- **Air Quality Impacts of Transportation and Land Use Policies: A Case Study in Austin, Texas**. *University of Texas, Austin* (2010). The impacts of land use and transportation policies on emissions, ozone concentrations, and a metric for population exposure were examined for Austin, Texas. Three distinct transportation and land use scenarios were investigated using a gravity-based land use model and a standard travel demand model: a business-as-usual scenario, a road pricing policy that included a flat-rate carbon-based tax and congestion pricing of all Austin area freeways, and an urban growth boundary policy. Emissions of ozone precursors decreased markedly for all 2030 scenarios due to the implementation of more stringent Federal motor vehicle emission control programs, but transportation and land use policies were predicted to lead to even greater reductions of emissions of both ozone precursors relative to the business as usual scenario. The impacts of such policies on ozone concentrations and population exposure suggested varying effects. Lower exposure was typically predicted for the road pricing scenarios, but a penalty appeared to exist with relatively higher values of exposure predicted for the urban growth boundary on some episode days. The results of this analysis indicate the potential complexity of planning for urban growth and equity and the need for integrated modeling and policy evaluation efforts. http://tris.trb.org/view.aspx?id=909572

- **The Travel Behavior Intentions of Young People in the Context of Climate Change**. *University of the West of England* (2010). This article examines the factors influencing the future travel behavior intentions of British young people between the ages of 11-18. Specifically, it gives attention to how climate change considerations affect this age group. The researchers found that a desire to drive dominated the participants' travel behavior intentions and that their values relating to identity, self-image, and social recognition as well as their affective attitudes towards transport modes, are key influences on this and at the expense of their environmental values. Although the researchers found that the young people in the study are aware of climate change, their understanding of the link between transport and climate change was weak. www.transport.uwe.ac.uk/research/briefings/BS017-Young%20people%20and%20travel.pdf

- **Analysis of Real-World Lead Vehicle Operation for Integration of Model Emissions and Traffic Simulation Models**. *University of Connecticut* (2009). New models and data are needed in microscopic traffic simulation tools to allow effective use with newer modal tailpipe emissions models. Traffic simulation models offer the ability to simulate large second-by-second vehicle operation datasets as input for emissions models. However, more data is needed to improve simulation of second-by-second vehicle speed. This research analyzes and models the vehicle dynamics of unconstrained drivers in real-world driving situations based on road geometry. Vehicle dynamics data were collected using an instrumented vehicle driven by 22 volunteers, over a 17-mile predetermined test route. The objective of this research was to analyze and model the non-random speed variations in unconstrained lead drivers. The results of this study suggest horizontal and vertical curvatures have a significant impact on the second-by-second operation of an unconstrained lead vehicle. Furthermore, these nonrandom changes in speed are important considerations since they can produce considerable variations in the level of tailpipe emissions. http://www.uvm.edu/~transctr/publications/TRB_2010/10-2370.pdf

- **Moving Cooler. Collaborative Strategies Group** (2009). This paper assesses a variety of strategies to reduce GHG emissions from motorized transportation. Land use changes, localized pricing strategies, and integration of non-motorized transit facilities were recommended as part of a multifaceted approach. www.movingcooler.info/
- **Seeking and Valuing Win-Win Built Environment Investments for Healthy and Sustainable Travel.** *University of Wisconsin, Madison* (2009). This study aims to identify and evaluate win-win built environment improvement strategies that would simultaneously promote sustainable and healthy travel behavior. Specifically, the paper describes an econometric analysis framework capable of differentiating the built environment elements that result in a substantive effect compared to those that lead to complementary or synergistic effects. http://pubsindex.trb.org/view.aspx?id=882333
- **Growing Cooler: The Evidence on Urban Development and Climate Change**. *Urban Land Institute* (2007). This paper examines impacts of land use patterns on VMT and GHG emissions. Accounting for predicted increase in fuel efficiency, the paper shows that GHG will continue to rise. The reason for this increase in GHG is due to a surge in VMT as a result of lower-density land use patterns and suburban sprawl. http://postcarboncities.net/files/SGA_GrowingCooler9-18-07small.pdf

II. Health Effects of Non-Motorized Transportation

Focus area: Livability

A. Research needs and opportunities

Research has been conducted on the respective health effects of walking and biking in regards to obesity and cardiovascular health as well as the negative health impacts of automobile emissions. More research is needed to examine both the positive and negative impacts of walking and biking in urbanized areas.

B. *Ongoing and completed research*

- **Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects**. *Health Effects Institute* (2010). This report is a comprehensive and systematic review to date of the scientific literature on emissions, exposure, and health effects from traffic-related air pollution. It includes conclusions about the populations exposed around major roads, the associations between exposure to air pollution from traffic and human health, and important remaining data gaps. The report focuses on areas 300-500 feet away from highways and reports an increase in asthma among people living within proximity to a highway. http://pubs.healtheffects.org/view.php?id=334
- **Economic analyses of transport infrastructure and policies including health effects related to cycling and walking: A systematic review**. *World Health Organization* (2009). A compendium of published and unpublished studies that presented the findings of an economic valuation of an aspect of transport infrastructure or policy, and included data on walking and/or cycling and health effects in the valuation. There is a wide variation in the approaches taken for including the health effects of physical activity in economic analyses of transport projects. This is not helped by a lack of transparency of

methods in many studies. A more standardized approach is called for, including a clearer description of the applied methods and assumptions taken. http://linkinghub.elsevier.com/retrieve/pii/S0967070X08000450

- **Effects of long-term exposure to traffic-related air pollution on respiratory and cardiovascular mortality in the Netherlands: the NLCS-AIR study**. *Utrecht University* (2009). Evidence is increasing that long-term exposure to ambient air pollution is associated with deaths from cardiopulmonary diseases. In a 2002 pilot study, we reported clear indications that traffic-related air pollution, especially at the local scale, was related to cardiopulmonary mortality in a randomly selected sub cohort of 5000 older adults participating in the ongoing Netherlands Cohort Study (NLCS) on diet and cancer. In the current study, referred to as NLCS-AIR, our objective was to obtain more precise estimates of the effects of traffic-related air pollution by analyzing associations with cause-specific mortality, as well as lung cancer incidence, in the full cohort of approximately 120,000 subjects. Cohort members were 55 to 69 years of age at enrollment in 1986. Follow-up was from 1987 through 1996 for mortality (17,674 deaths) and from late 1986 through 1997 for lung cancer incidence (2,234 cases). Though relative risks were generally small in the current study, long-term average concentrations of black smoke, NO2, and PM2.5 were related to mortality, and associations of black smoke and NO2 exposure with natural-cause and respiratory mortality were statistically significant. Traffic intensity near the home was also related to natural-cause mortality. The highest relative risks associated with background air pollution and traffic variables were for respiratory mortality. http://www.ncbi.nlm.nih.gov/pubmed/19554969
- **Health effects of real-world exposure to diesel exhaust in persons with asthma**. *University of Medicine and Dentistry of New Jersey-School of Public Health* (2009). Many people, including people with asthma, experience short-term exposure to diesel exhaust (DE) during daily activities. The health effects of such exposures, however, remain poorly understood. The present study utilized a real-world setting to examine whether short-term DE exposure would (1) worsen asthma symptoms, (2) augment airway inflammation, or (3) increase oxidative stress burdens. The study also examined exposure-response relations for several DE components and the contribution of background asthma severity to individuals' respiratory responses to DE exposure. The study found that short-term exposure to urban roadside diesel traffic led to consistent and significant reductions in lung function, accompanied by airway acidification and neutrophilic inflammation. Our findings help to explain the epidemiologic evidence on diesel traffic health effects in persons with asthma. http://www.ncbi.nlm.nih.gov/pubmed/19449765
- **Health Impacts of the School Commute**. (2008). This paper was submitted to TRB and was partly funded by the University of California Traffic Safety Center. There is a number of health implications associated with the choice of commute mode, including traffic safety, exposure to air pollution, and levels of physical activity and obesity, and the risks and benefits of each must be weighed. The paper concludes that there may be some benefit from a public health perspective with regards to air quality and traffic safety. Additionally, physical activity may be higher among walkers than among students who are driven, but it is not known whether this association is causal. Active commuting to school appears unrelated to obesity or being overweight. As of the publication date, the

researchers concluded that they are uncertain about whether an intervention to increase active commuting in children would impact activity-related health outcomes by itself. http://escholarship.org/uc/item/2g612244

- **Respiratory Effects of Exposure to Diesel Traffic in Persons with Asthma**. *Karolinska Institute* (2007). This study examined the effects of short-term exposure to diesel highway traffic on people with asthma. It was found that when individuals walked through the London streets they had much higher exposures to nitrogen dioxide, ultrafine particles, fine particles, and elemental carbon than when they walked through the park. The study explains the epidemiological evidence that associates lung function in people with asthma with the amount of exposure they have to diesel traffic. http://content.nejm.org/cgi/content/short/357/23/2348
- **Commuter Exposure to Respirable Particles inside Buses and by Bicycle**. *Manchester Metropolitan University* (1999). This article evaluates the exposure of bus commuters and a cyclist to respirable particles in the city of Manchester, using personal sampling pumps installed in the cabs of the vehicles and carried by the cyclist. These have provided an estimate of the average exposure of commuters using bus services and cycling in a congested European city. http://linkinghub.elsevier.com/retrieve/pii/S0048969799002478

III. Health Impacts from Air Pollution

Focus areas: Climate Change, Livability

A. Research needs and opportunities

Additional research is needed to examine the range of health impacts from air pollution.

B. Ongoing and completed research

- **Effects of Diesel Exhaust Particles on Angiogenesis.** *Health Effects Institute* (2009). Researchers evaluated whether exposure to diesel engine exhaust affected angiogenesis—the development of new small blood vessels. The researcher implanted ApoE-/- mice subcutaneously with a biodegradable scaffold containing endothelial cells and a growth factor, and exposed the mice to 1mg/m3 diesel exhaust particles or filtered air in a whole body diesel exposure chamber for 6 hours/day for 5 days/week for 2, 5, or 8 weeks. The investigators used histopathology and immunohistology techniques to compare the effects of the different exposures on cell numbers, cell types, and expression of cellular markers and enzymes in the scaffolds and the aorta. http://pubs.healtheffects.org/view.php?id=318
- **Air Pollution and Health: A European and North American Approach (APHENA).** *Health Effects Institute* (2009). This report describes a unique collaboration among investigators from Europe, the United States, and Canada using existing data from three geographic areas and supported by HEI in collaboration with the European Commission. APHENA offered a large and diverse data set with which to address methodological as well as scientific issues about the relationships between PM10, ozone, and mortality and morbidity that were the subject of lively debates at the time the project was launched. The

researchers undertook a rigorous examination of time-series methods used to model the relationship between daily PM10 and ozone concentrations and daily mortality and hospital admissions. They sought to develop a standardized approach to the analysis of time series data at the city and regional level, to assess the consistency between relative rates of mortality and hospital admissions across Europe and North America when estimated using a common analytic protocol, and to explore possible explanations for any remaining variation in the results that analytic differences could not explain. http://pubs.healtheffects.org/view.php?id=327

- **Climate Change, Tropospheric Ozone and Particulate Matter, and Health Impacts.** *ESS, LLC and University of Auckland, New Zealand* (2008). This paper reviews how climate change could affect future concentrations of troposhperic ozone and particulate matter (PM), and what changing concentrations could mean for population health. Researchers reviewed studies projecting the impacts of climate change on air quality, and studies projecting the impacts of these changes on morbidity and mortality. Researchers concluded that additional research is needed to better understand the possible impacts of climate change on air pollution-related health impacts. If approved models continue to project higher ozone concentrations with climate change, then reducing GHG emissions would enhance the health of current and future generations. http://www.scribd.com/doc/7905519/Climate-Change-Tropospheric-Ozone-and-Particulate-Matter-and-Health-Impacts#fullscreen:off

- **Air Quality Impacts of Transportation and Land Use Policies: A Case Study in Austin, Texas.** *University of Texas, Austin* (2010). The impacts of land use and transportation policies on emissions, ozone concentrations, and a metric for population exposure were examined for Austin, Texas. Transportation and land use policies were predicted to have substantial impacts on travel and emissions of ozone precursors. Emissions of ozone precursors decreased markedly for all 2030 scenarios due to the implementation of more stringent federal motor vehicle emission control programs, but transportation and land use policies were predicted to lead to even greater reductions of emissions of both ozone precursors relative to the business as usual scenario. The impacts of such policies on ozone concentrations and population exposure suggested varying effects. Lower exposure was typically predicted for the road pricing scenarios, but a penalty appeared to exist with relatively higher values of exposure predicted for the urban growth boundary on some episode days. The results of this analysis indicate the potential complexity of planning for urban growth and equity and the need for integrated modeling and policy evaluation efforts. http://tris.trb.org/view.aspx?id=909572

- **Health impacts from diesel freight emissions: Development of a geospatial analytical framework for policy evaluation with a case study of Sacramento, CA.** *Rochester Institute of Technology* (2008). Freight transport activity produces a significant amount of airborne particulate matter from diesel exhaust. This poses a health risk to populations living near freight transport routes. Existing methods, including atmospheric dispersion modeling, epidemiology or air quality measurement can estimate the magnitude of harm experienced by populations but these methods often require resources or expertise beyond the reach of some stakeholders. This thesis describes a framework by which health impact estimation can be carried out utilizing readily available models and methodologies. This framework is presented with the intent that significant parts of the

analytic process can be automated by computer scripts or other programmatic structures, further reducing the time, expertise and resource requirements for health impact analyses. These analyses allow policy makers to more effectively evaluate the expected health impacts of transport policy and incorporate public health considerations into other policy making activities. A case study of on-highway truck activity in Sacramento, CA is included. This case study demonstrates the expected action of this framework and also highlights some possible policy directions for transport in the region. http://gradworks.umi.com/14/57/1457521.html

IV. Roadside Barriers and Air Pollution Mitigation, and Noise Pollution Affecting Livability

Focus areas: Climate Change, Livability

A. Research needs and opportunities

B. Noise barriers help mitigate noise pollution that can pose negative impacts on residential areas. These barriers may also mitigate some air pollution. Additional research is needed to examine the range of benefits from highway barriers, in particular, in regard to the effects of Type II noise barrier programs, along with specific design requirements to achieve these benefits. In addition, some on-going research indicates that roadside structures and vegetation may play a role in reducing exposure to near-road air pollutants. Additional research is needed to further the understanding of the effectiveness of roadside structures and vegetation and their impact to near roadway air quality; pollutant transport and dispersion; and other benefits. *Ongoing and completed research*

- **Evaluating Alternative Mowing Regimen and the Use of Native Grasses and Wildflowers on Roadside Right-of-Ways**. *Mississippi State University* (In progress). This three-year project will determine if a limited mowing regimen is sufficient to make ROW maintenance more cost-effective while increasing the beauty of Mississippi's ROWs. It will also identify additional propagules that may be useful in expediting the transition to natural ROWs and ascertaining motorist patience with the transition and perception of a more natural ROW. http://rip.trb.org/browse/dproject.asp?n=23746
- **Not Just a Pretty Face: Roadside Vegetation Plays Practical, Safety, and Economic Roles**. *University of California, Berkeley Transportation Center* (2009). This article describes a novel roadside vegetation management program that saves money, reduces maintenance and carbon emissions, and returns unused areas of ROW to their physical state as of a few hundred years ago. The project is known as the Hoosier Roadside Heritage Program and the Indiana Department of Transportation and a private group called Save the Dunes undertook the project. Specifically, it involves planting wildflower seeds native to the area along U.S. 12. The article also describes a similar partnership between the Mississippi Department of Transportation and the Mississippi State University. http://tris.trb.org/view.aspx?id=890803
- **Diesel Truck Traffic in Low-Income and Minority Communities Adjacent to Ports: Environmental Justice Implications of Near-Roadway Land Use Conflicts**. *University of California, Los Angeles* (2008). This paper discusses the environmental justice implications of truck-related land use conflicts and current planning and emission control strategies to mitigate the local air pollution impacts of increasing port-related truck traffic in these low-income, minority communities. Sound barriers and landscape

buffers may help mitigate pollution, but more research is needed. http://www.lewis.ucla.edu/publications/reports/Diesel%20Truck%20Traffic%20-%20Doug%20Houston.pdf

- **The Influence of a Noise Barrier and Vegetation on Air Quality Near a Roadway**. *Environmental Protection Agency (2007).* This paper integrates results from an air quality modeling assessment and air quality monitoring measurements to identify how noise barriers and vegetation near roads may impact local air quality. This study allowed an assessment of the potential influence of these structures on near-road air quality. These structures influence pollutant transport and dispersion in the near-field (<300 m). Preliminary results suggest that, under some meteorological conditions, noise barriers and vegetation may reduce air pollutant concentration levels downwind of the barrier. http://cedb.asce.org/cgi/WWWdisplay.cgi?163333

V. Life Cycle Assessment of Roadway Materials and Operations, Especially the Use of Innovative Materials and Recycled Materials

Focus areas: Sustainability

A. Research needs and opportunities

Research on life cycle assessment is needed to understand the long-term effects of construction materials and processes. Life cycle assessments may be interpreted differently and it can be difficult to compare materials on this basis. Additionally, a universal catalog of commonly used materials and processes would be beneficial. Specifically, there is a need for more research on recycled products since States and municipalities seek to include them in their projects.

B. Ongoing and completed research

- **A comparative study of the emissions by road maintenance works and the disrupted traffic using life cycle assessment and micro-simulation**. *University of Newcastle Upon Tyne, United Kingdom* (2009). This paper reviews life cycle methodologies and develops a model for assessing the pavement construction and maintenance. After running the model, the team found significant energy/CO2 emissions from disrupted traffic near the construction site that should be included in the life cycle assessment of a maintenance project. http://linkinghub.elsevier.com/retrieve/pii/S1361920908001648

- **Incorporating Sustainability Considerations into the Transportation Asset Management Process**. *Virginia Polytechnic Institute and State University* (2009). The paper investigates life cycle assessment models and proposes that environmental sustainability and social considerations be included in project evaluation. http://pubsindex.trb.org/view.aspx?id=881131

- **Life-Cycle Assessment of Warm Mix Asphalt (WMA): Environmental and Economic Perspectives**. *Louisiana State University, Baton Rouge* (2009). This paper reviews a developed model that quantifies a total life cycle assessment comparison of WMA to hot mix asphalt (HMA) by measuring the energy, material inputs, and emission during aggregate extraction, asphalt binder production, and HMA production and

placement. Overall, WMA use is estimated to provide a 15% reduction on the environmental impacts of HMA. http://pubsindex.trb.org/view.aspx?id=880702

- **New Tool for Minimizing Total Asphalt Pavement Life Cycle Costs**. *University of Belgrade, Serbia* (2009). Description of a Life Cycle Cost Analysis Graph Tool that enables the comparison between base and project alternatives and calculates key project indicators for the specified analysis period. http://144.171.11.40/cmsfeed/ip/paper_detail.asp?paperid=34033
- **Roadway Construction Sustainability Impacts: A Review of Life Cycle Assessment**. *University of Washington* (2009). A review of 14 roadway construction identifies life cycle assessment findings. Among them, materials production accounts for the bulk of energy use/CO2 emissions. Total CO2 emissions are typically 3-7 TJ/lane-mile and the energy expended during construction is roughly equivalent to that from operating traffic on the facility over 1-2 years. http://tris.trb.org/view.aspx?id=910627
- **Simple Procedure to Assess Performance and Cost Benefits of Using Recycled Materials in Pavement Construction**. *Worcester Polytechnic Institute* (2008). This paper showcases a methodology for assessing recycled materials in pavement. A full-scale accelerated pavement test section was built to investigate the performance of different base course materials: Louisiana Class II crushed limestone, foamed-asphalt-treated recycled asphalt concrete, fly-ash-stabilized blended calcium sulfate (BCS), and BCS stabilized with the 120 grade ground granulated blast furnace-slag (GGBFS). GGBFS was found to have the highest strength and stiffness among the tested materials. http://cedb.asce.org/cgi/WWWdisplay.cgi?0810277
- **Environmental Life-Cycle Assessment of Passenger Transportation: A Detailed Methodology for Energy, Greenhouse Gas, and Criteria Pollutant Inventories of Automobiles, Buses, Light Rail, Heavy Rail and Air [Version 1]**. *University of California, Berkeley* (2007). This paper showcases comprehensive life cycle assessment models quantifying the energy inputs and emissions from automobiles, buses, heavy rail, light rail, and air transportation in the U.S. associated with the entire life cycle. It references previous studies, but aims to be a more complete inventory of life cycle assessments covering all modes of transport. This is part of a larger ongoing study. http://tris.trb.org/view.aspx?id=851660

VI. Urban Heat Island Effect

Focus areas: Sustainability, Energy

A. Research needs and opportunities

No information is available at this time.

B. Ongoing and completed research

- **Harvesting Energy from Asphalt Pavements and Reducing the Heat Island Effect**. *Worcester Polytechnic Institute* (2009). A rise in temperature of asphalt pavements contributes to the urban heat island effect, causes problems with air quality, and increases the power requirement for cooling buildings. A high temperature would also lead to the

potential of rutting failure in asphalt pavements. The concept of mining heat from asphalt pavements, utilizing an appropriate fluid flowing in pipes installed within the pavement, has been proposed. Theoretical considerations and results of laboratory testing and modeling simulation have been presented. The results indicate that the concept is feasible, and that the efficiency of heat mining can be improved by selecting appropriate surface layer and aggregates for pavement materials. The use of this proposed method would lead to a significant reduction in pavement and near-surface air temperature, and extension of asphalt pavement life.

- **Strategies for Design and Construction of High-Reflectance Asphalt Pavements**. *National Center for Asphalt Technology* (2009). The occurrence of higher air and surface temperatures in urban areas is known as the urban heat island (UHI) effect. Reducing the UHI effect in urban areas may decrease summer time energy use and improve human and ecological health. The Leadership in Energy and Environmental Design (LEED®) certification system, for some programs, awards up to three points for construction projects that provide any combination of the following cool pavement strategies for up to 75 percent of the site landscape. http://tris.trb.org/view.aspx?type=MO&id=904505
- **The Thermal and Radiative Characteristics of Concrete Pavements in Mitigating Urban Heat Island Effects**. *Arizona State University* (2008). The main objective of this research study was to provide understanding, supporting documentation, and tools on how pavement designs and materials selection contribute to surface and subsurface temperature fluctuations. This objective was achieved through two focus areas that outlined the scope of work of this research: thermal properties and reflectance evaluation, and heat absorption and transfer modeling. The outcome of the two focus areas outlined above are envisioned to play a key role aiding future decision makers and designers when choosing appropriate pavement materials for their particular application. It will provide further awareness of urban heat island and it drives further municipal ordinances and building codes that incorporate environmentally appropriate materials into development and rehabilitation projects. http://tris.trb.org/view.aspx?type=MO&id=876559
- **AR-ACFC Overlays as a Pavement Preservation Strategy for PCCP**. *Arizona State University* (2007). Since the late 1980's, the Arizona Department of Transportation (ADOT) has been placing Asphalt Rubber – Asphalt Concrete Friction Course (AR-ACFC) mixes over existing Portland Cement Concrete Pavements (PCCP). The initial intent of the overlay was to restore smoothness and assist in the redevelopment of skid resistance of the riding surface. By adding an additional, easily maintained layer or "blanket" over the PCCP, the underlying material will experience higher low temperatures and lower high temperatures. Addressing a quality-of-life issue through a paving strategy was innovative and taxpayers have been very supportive of the program. Also, due to the insulating effects of the additional AR-ACFC mix, thermal stresses within the PCCP are hypothesized to be lower leading to a longer service life of the PCCP and a good return on a significant public works investment.
- **Evolution of Cool-Roof Standards in the US**. *Lawrence Berkeley National Laboratory* (2008). Cool-roof requirements are designed to reduce building energy use, while energy-neutral cool-roof credits permit the use of less energy-efficient components (e.g. larger windows) in a building that has energy-saving cool roofs. Both types of measures can reduce the life-cycle cost of a building (initial cost plus lifetime energy cost). This paper

reviews the technical development of cool-roof provisions in the ASHRAE 90.1, ASHRAE 90.2 and California Title 24 Standards, and discusses the treatment of cool roofs in other standards and energy-efficiency programmes. The techniques used to develop the ASHRAE and Title 24 cool-roof provisions can be used as models to address cool roofs in building energy-efficiency standards worldwide. http://coolcolors.lbl.gov/assets/docs/Papers/Akbari-and-Levinson-2008-Evolution-of-cool-roof-standards-ABER-WEB-FINAL-2008-09-04.pdf

VII. Environmental Management Programs

Focus areas: Sustainability

A. Research needs and opportunities

- General best practices reports similar to the Sustainable Aviation Resource Guide would be beneficial for the FHWA. Research has concentrated on individual programs, but an industry wide scan for best practices has not been attempted to date in a comprehensive manner. The proposed course from Washington State University may be a good starting point for a general guide for highway sustainability programs, as well as the best practices research currently underway for the AASHTO Standing Committee on the Environment.

B. Ongoing and completed research

- **Evaluate the Interactions between Transportation-Related Particulate Matter, Ozone, Air Toxics, Climate Change, and Other Air Pollutant Control Strategies**. *Cambridge Systematics* (In progress). The purpose of this research is to identify cost-effective transportation strategies that will reduce multiple pollutants so that State officials can achieve the goals of contributing towards attainment of various air quality standards, as well as reducing toxins and GHG emissions. This research involves doing a literature search on the methodologies for determining the cost-effectiveness of strategies to reduce multiple pollutants in order to determine the state-of-the-art, and a survey of State efforts to determine the current state-of-the-practice. The outcome of this research would establish the feasibility of a more detailed, rigorous NCHRP study to examine these effects. That study would likely require different types of modeling (traffic, emissions, dispersion, etc). http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2623

- **Research for the AASHTO Standing Committee on the Environment. Task 4. Environmental Stewardship Practices, Policies, and Procedures for Road Construction and Maintenance**. *National Cooperative Highway Research Program* (In progress). The objective of this project is to produce a compendium of best practices in environmental stewardship in the areas of construction and maintenance. Many States have successfully implemented initiatives to enhance environmental stewardship and change the culture in construction and maintenance organizations to better avoid and minimize these potential impacts. One good example is Pennsylvania Department of Transportation's (PENNDOT) Strategic Environmental Management Program (SEMP). Other more specific initiatives have been aimed at the following: erosion and sedimentation control, improvements in energy efficiency, recycling and use of recycled

materials, facility management, wetland and stream preservation, Context-Sensitive Solutions, hazardous material substitution, and pursuit of International Organization for Standardization (ISO) certifications. http://environment.transportation.org/resources/research_news/nchrp.aspx

- **A Preliminary Analysis of the Environmental Impacts of the Clean Truck Program in the Alameda Corridor, California**. *University of California, Irvine* (2010). The objective of this paper is to quantify the reduction in emissions attributable to the Clean Trucks Program, with a focus on Nitrogen Oxide (NOx) and Particulate Matter (PM2.5). The authors' approach is innovative, as it relies on micro-simulation (TransModeler) to capture the link between congestion and pollutant emissions. The authors find that the Clean Trucks Program could contribute significantly to NOx (~27%) and PM2.5 (~25%) emissions for all of the freeway traffic in the study area. These preliminary results suggest that the Clean Trucks Program is promising, but its cost-effectiveness should be analyzed. http://tris.trb.org/view.aspx?id=911425
- **Assessing Mechanisms for Integrating Transportation-Related Greenhouse Gas Reduction Objectives into Transportation Decisionmaking**. *National Cooperative Highway Research Program* (2010). The objective of NCHRP Project 20-24(64) was to provide a factual basis for judging the merits of alternative methods that State DOTs and MPOs can use for managing GHG emissions from transportation. The project was undertaken in order to help policymakers understand (a) how these alternative approaches to GHG emissions would affect States and metropolitan areas, (b) what approaches may be most effective for evaluating mobile-source GHG emission-management strategies, and (c) what particular tools are available to support the implementation of these alternative approaches. http://trb.org/Main/Blurbs/Assessing_Mechanisms_for_Integrating_Transportatio_163179.aspx
- **Modeling Reduced Traffic Emissions in Urban Areas: The Impact of Demand Control, Banning Heavy Duty Vehicles, Speed Restriction and Adaptive Cruise Control**. *Delft University of Technology* (2010). Traffic emissions have become the main source of air pollution in urban areas, where breaches of the European Union (EU) limit values frequently occur. To reduce these emissions, local traffic measures can be implemented complementary to regional and national measures. In this paper the impact of various traffic measures at a single intersection is investigated using a traffic model and an emission model. The measures included are traffic demand control, banning Heavy Duty Vehicles (HDVs), speed restriction and Adaptive Cruise Control (ACC). It was found that reducing traffic demand by 20% led to about 23% reduction in terms of CO2, NOx and PM10 emissions. Banning HDVs led to a significant reduction of NOx and PM10 emissions. Although speed restriction reduced CO2 emissions by 7%, both NOx and PM10 emissions increased, especially from HDVs. ACC reduced both CO2 and NOx by 3%, but increased PM10 by 3%. Finally, the paper briefly discussed the approach of how cooperative road-vehicle systems can be used to reduce traffic emissions in urban areas. http://tris.trb.org/view.aspx?id=911065
- **Toward Sustainable Transport: Conventional and Disruptive Approaches in the U.S. Context**. *University of North Carolina, Chapel Hill* (2010). This discussion paper

considers four sectors in which transportation-relevant policies or programs are conceived and delivered. Then, it orders the four sectors roughly along a continuum from conventional to disruptive. And, finally, it assesses the potential of these four sectors for moving the U.S. towards a more sustainable future. http://tris.trb.org/view.aspx?id=908600

- **Develop an Asset Management Tool for Collecting and Tracking Commitments on Selected Environmental Mitigation Features**. *University of Wisconsin, Madison* (2009). Wisconsin has constructed many environmental mitigation projects in conjunction with transportation projects that have been implemented according to the National Environmental Policy Act. Other mitigation projects have been constructed pursuant to discussions and negotiations with Wisconsin DNR. These projects offset or replace a certain environmental function(s) lost as a result of construction of the transportation project. Examples include: stormwater management facilities, wetland replacement projects, stream restoration projects, reforestation projects, construction of sound walls, and replacement of parklands and wildlife crossing structures. http://www.ntis.gov/search/product.aspx?ABBR=PB2010103405
- **Greenroads: A Sustainability Performance Metric for Roadway Design and Construction**. *University of Washington, Seattle* (2009). Greenroads is a performance metric for quantifying sustainable practices associated with roadway design and construction. Sustainability is defined as having seven key components: ecology, equity, economy, extent, expectations, experience, and exposure. Greenroads sets "achievement levels" at different point values in order to provide recommended scoring levels. www.greenroads.us/
- **Prioritization of Transportation Projects for Economic Stimulus with Respect to Greenhouse Gases.** *University of California, Davis* (2009). This report provides a high level framework to aid in the selection of transportation infrastructure improvement projects that can help to reduce GHG emissions and enhance the existing infrastructure through strategic improvements in operations and in preservation and maintenance. The primary objective in this effort was to develop a consistent and reliable framework to quickly identify and categorize those projects with the greatest potential for a reduction in project level GHG emissions. Admittedly, there are other important factors that play a role in assessing projects, including cost, regional-scale impacts, co-pollutants and operational impacts such as reductions in delay. These factors, while important, were not a primary focus in this study. Finally, although created to address the prioritization of projects in California, the framework is based on widely applicable transportation and GHG-related principles. http://dn.engr.ucdavis.edu/images/GHG_Report.pdf
- **Sustainable Aviation Resource Guide: Planning, Implementing, and Maintaining a Sustainability Program at Airports**. *Airports Council International* (2009). This document contains information on resources for sustainable aviation. Section 1 of the report examines a number of definitions of sustainability. Sections 2 and 3 present a direction for an airport operator to engage in planning, implementing, and maintaining a program for sustainability. A database is also presented, which includes existing sustainability practices. http://tris.trb.org/view.aspx?id=913264

- **Sustainable Roadway Design and Construction: An Online Course**. *Washington State University, Pullman* (2009). The purpose of this research was to create and deliver an online course in sustainable transportation infrastructure. Currently, there are no such courses. Course content would focus on: 1. The concept of sustainability 2. Systems for evaluating sustainability 3. Specific materials, methods, and practices either in use currently or experimental that are more sustainable than current methods 4. An introduction to life cycle assessment and life cycle cost analysis for transportation infrastructure with an emphasis on roads and pavements. http://tris.trb.org/view.aspx?id=914504

VIII. Carbon Sequestration

Focus areas: Climate Change, Sustainability

A. Research needs and opportunities

- Additional biological and economic research is needed to effectively analyze GHG emissions and to determine how vegetation present in highway ROW can be incorporated into biological carbon sequestration efforts. Individual States and regions need data and guidance on structuring and evaluating biological carbon sequestration activities.

B. Ongoing and completed research

- **Carbon Capture and Sequestration (CCS)**. *Congressional Research Service* (2009). This paper explores opportunities for sequestering and storing CO_2 generated by industrial power generation plants. Although the U.S. EPA estimates that the transportation sector is responsible for 33 percent of U.S. CO_2 emissions, electricity generation plants are responsible for 42 percent of emissions, and they are the primary focus of the paper. Storage and sequestration options that are considered include CO2 injections into deep rock formations and other geological features. The paper discusses the role of pipeline safety and transportation of CO_2 if large-scale carbon capture and storage operations are put in place. The paper does not address biological carbon sequestration practices that are based on ROW management (e.g. sequestering carbon in ROW vegetation). http://ncseonline.org/NLE/CRSreports/09July/RL33801.pdf

- **Carbon Sequestration Pilot Program: Implementation and Next Steps**. *FHWA- STEP* (2009). This paper documents the elements likely required in order to implement a carbon sequestration process tailored to State DOTs. Findings are based on the challenges, key lessons, and preliminary results from New Mexico Department of Transportation's (NMDOT) initial five months of implementing FHWA's Carbon Sequestration Pilot Program (CSPP). http://tris.trb.org/view.aspx?id=903035

- **Not Just a Pretty Face: Roadside Vegetation Plays Practical, Safety and Economic Roles**. *Better Roads, Volume 79, Issue 5* (2009). This article describes a novel roadside vegetation management program that saves money, reduces maintenance, reduces carbon emissions, and returns unused areas of ROW to the way they looked a few hundred years ago. The project, known as the Hoosier Roadside Heritage Program and undertaken by the Indiana Department of Transportation and a private group called Save the Dunes, involves planting wildflower seeds native to the area along U.S. 12. The article also describes a similar partnership between the Mississippi Department of Transportation and

the Mississippi State University.
http://tris.trb.org/results.aspx?q=&datein=all&index=%22Indiana%20Department%20of%20Transportation%22+IT:141997

- **The Potential for Carbon Sequestration in the United States**. *Congressional Budget Office* (2007). This report explores the economic feasibility of various types of biological carbon sequestration as part of a broad climate change policy. The report examines the potential for sequestration with various carbon pricing scenarios.
http://www.cbo.gov/doc.cfm?index=8624

- **The Cost of U.S. Forest-Based Carbon Sequestration**. *Pew Center on Global Climate Change* (2005). This paper explores whether carbon sequestration should be part of the domestic portfolio of compliance activities to address global climate change. It achieves this by assessing the cost of supplying forest-based carbon sequestration in the U.S. There are several key factors that affect estimates of the cost of forest carbon sequestration (e.g. tree species, land values, discount rates, analytical methods, and others). The report concludes that sequestration opportunities ought to be included in the economic modeling of climate policies and that a carbon sequestration program ought to be included in a cost-effective portfolio of compliance strategies when and if the U.S. enacts a mandatory domestic GHG reduction program.
http://www.pewclimate.org/docUploads/Sequest_Final.pdf

IX. Criteria Pollutants and Greenhouse Gases

Focus areas: Climate Change

A. *Research needs and opportunities*

- Conduct coordinated research to advance the state of science regarding the relationship between criteria pollutants and greenhouse gases.
- Identify and examine policy and programs to provide an understanding of GHG emissions reduction potentials from on-road vehicles through scenario analysis or case studies.
- Examine emissions reduction potential of strategies for both criteria pollutant and greenhouse gases.
- Establish a public outreach network to facilitate information sharing and communication.

B. *Ongoing and completed research*

- **MOVES vs. EMFAC: A Comparison of Greenhouse Gas Emissions Using Los Angeles County** *U.C. Davis-Caltrans Air Quality Project* (2009). The U.S. Environmental Protection Agency is developing a new generation emission model, MOVES (Motor Vehicle Emission Simulator), to replace MOBILE6. MOVES changes the basis for mobile source emissions estimation from average speed to modal activity. Researchers examined differences in features, methods, and results between MOVES and EMFAC, the mobile source emissions model approved for California. Using a Los Angeles County, California application; two greenhouse gases, carbon dioxide (CO2) and methane (CH4); and two analysis years, 2002 and 2030, researchers analyzed how underlying activity data and emission factors contributed to observed differences between

the two models. At the county level, for 2002 MOVES produced similar CO2 emissions, but only 42% of the CH4 emissions estimated by EMFAC; for 2030, MOVES produced 40% higher CO2 emissions and CH4 emissions were nearly double the estimates provided by EMFAC. Important contributing factors to these differences are the activity data and emission rates embedded in MOVES. The default vehicle activities indicated a younger fleet and higher miles traveled for light-duty trucks by 2030. The CO2 emissions differences between the two models appear to be mainly affected by the magnitude of forecasted vehicle miles traveled; CH4 emissions results tend to hinge on the base emission rates. EPA considers the underlying MOVES database for CO2 and CH4 emissions to be a draft and emissions results will likely change with upcoming model releases. http://dn.engr.ucdavis.edu/images/Paper1.pdf

- **Synthesis of Greenhouse Gas Emission Inventory Methodologies for State Transportation Departments**. *NCHRP* (pending). The purpose of the research will be to provide DOTs with assistance on how to collect, assemble, quantify, and report their GHG emissions, for a variety of reasons, including future mandatory reporting requirements where applicable. There are some aspects of DOT operations for which activity data required to quantify GHG emissions will likely be readily available or easy to gather, such as energy consumption data associated with the operation of commercial and institutional buildings and fleet operations. There are other more unique aspects of DOT operations that may prove more difficult to gather and disaggregate appropriate data for, including the energy consumption of street lighting, stoplights, and other small but numerous sites across an entire state.
  http://ncseonline.org/NLE/CRSreports/09July/RL33801.pdf

- **Evaluate the Interactions between Transportation-Related Particulate Matter, Ozone, Air Toxics, Climate Change, and Other Air Pollutant Control Strategies.** *NCHRP* (pending). The purpose of this research is to identify cost-effective transportation strategies that will reduce multiple pollutants so that state officials can achieve the goals of contributing towards attainment of various air quality standards, as well as reducing toxics and GHG emissions. This research involves doing a literature search on the methodologies for determining the cost-effectiveness of strategies to reduce multiple pollutants to determine the state-of-the-art, and a survey of state efforts to determine the current state-of-the-practice. The outcome of this research would establish the feasibility of a more detailed, rigorous NCHRP study to examine these effects. That study would likely require different types of modeling (traffic, emissions, dispersion, etc).
  http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2623

- **Assessment of the Impacts of Global Change on Regional U.S. Air Quality: A Synthesis of Climate Change Impacts on Ground-Level Ozone (An Interim Report of the U.S. EPA Global Change Research Program)** *EPA* (2009). In 2000, the US EPA ORD Global Change Research Program (GCRP) initiated a research and assessment program devoted to the evaluation of the potential impact of global change on US air quality. The regional air quality modeling results from earlier research, focusing primarily on the sensitivity of air quality to changing climate, are the subject of the 2007 GCAQ Interim assessment report. Phase 2 of this effort is focused upon the incorporation of possible national and regional population; land use, energy production and transportation technology scenarios with global climate scenarios with to produce

integrated projections of the effects of global change on US air quality. The ultimate goal of the EPA GCRP air quality research and assessment effort is to provide air quality managers with the scientific information and tools to evaluate the implications of global change for their programs – and enhance their ability to adapt to global change, if needed. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=203459

X. Alternative Energy Sources

Focus areas: Energy, Climate Change, Sustainability

A. Research needs and opportunities

- Additional research is needed to determine how the transportation network can explore the generation and use of energy from alternative sources, such as solar, wind, geothermal, and others.

B. Ongoing and completed research

- **Feasibility Study of Using Solar or Wind Power for Transportation Infrastructure**. *NCHRP* (pending). The purpose of this research is to provide DOTs with technical and case study data on the use of solar or wind power as an alternative power source for across a wide variety of transportation infrastructure settings. The research will consider what technologies exist or are about to become commercially viable that have not been applied to transportation settings but with some thought/creativity could have a transportation application. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2846

WHITE PAPER 4

BACKGROUND

This white paper, the last in a series of four, is intended to inform the opening session by providing a synthesis representing views from select Transportation Research Board (TRB) Committees regarding ongoing and completed research related to the workshop's focus area topics and future research needs in those cross-cutting topic areas. The paper also discusses the effectiveness of outreach efforts on the completed research.

Subject matter experts from the following TRB Committees contributed to this white paper:

- ***ADC70 Transportation Energy*** — This committee considers energy efficiency, use, and policy in passenger and freight transportation; resulting impacts on energy consumption, energy security, and the environment; GHG emissions; and related public concerns.

- ***ADC80 Alternative Transportation Fuels and Technologies*** — This committee considers institutional, behavioral, environmental, economic, technological, and policy implications associated with the introduction and potential extended use of alternative transportation fuels and enabling technologies, and promotes policy analysis, evaluation, and planning to address those implications.

- ***ADD40 Transportation and Sustainability*** — This committee advances the understanding of how transportation and sustainability relate and how transportation can contribute to achieving sustainability for economic growth, social equity, and a healthy environment.

- ***ADD50 Environmental Justice in Transportation*** — This committee identifies, advances, and publishes research to expand understanding of the effects and implications of transportation policies, procedures, and actions on minority and low-income populations, and seeks to improve evaluation tools and methodologies.

The white paper team also gathered opinions from members of AASHTO and the FHWA. To gather input for the research white paper, the team first convened a telephone conference with the TRB Committee co-chairs and subject matter experts who were available to participate. Three questions guided the conversation:

1. What research has been or is being conducted in the interest areas?
2. How effective has outreach on that research been?
3. What research gaps or needs currently exist?

Afterwards, two representatives polled their respective committees to solicit additional suggestions for research opportunities, while the white paper team followed-up individually with those unable to join the conference call. Information gathered on the call was also supplemented with materials emailed to the white paper team after the conference call, follow-up phone calls with additional experts the TRB Committee points of contact provided, as well as library and Internet searches for academic and professional literature.

The following section outlines the research topics that the subject matter experts identified as of interest to their committees. For each of the research topics, the following information is provided:

- The cross-cutting focus area to which the research topic relates;
- An explanation of the research needs and opportunities related to the topic; and
- A summary of the ongoing and completed research related to the topic that the white paper team identified. A website link is included for the research results and publications that are available online.

CRITICAL PROJECT AREAS

The subject matter experts identified nine broad areas related to the cross-cutting areas that are of interest to their committee. The research topics identified are:

- Climate Change Adaptation
- Behavior Change
- Sustainability Performance Metrics
- Renewable Fuels Standards
- Energy Distribution Infrastructure Requirements
- Cost of Highway Pricing for Specific Populations
- Health Impacts of Transportation
- Climate Change, Displacement, and Environmental Justice Populations
- Economic Impact of Transportation on People and Communities

I. Climate Change Adaptation

Focus area: Climate Change

A. Research needs and opportunities

According to white paper contributors, the concept of adaptation in transportation is somewhat more nascent than that of climate change mitigation. Therefore, numerous research needs and opportunities related to climate change adaptation were noted on how to:

- Determine or identify the most effective ways to reconcile differences among the diverse array of relevant decision makers, each of whom have different climate change capacities and information needs.
- Overcome the perception that the uncertainties regarding climate change should limit the implementation of adaptive measures.
- Create climate change scenarios that are relevant to transportation planning.
- Use damage functions or develop guidelines for translating potential climate change effects to impacts. There needs to be better “downscaling” of continental-level data to make it more applicable at local levels.
- Estimate the cost-effectiveness of adaptation options.

B. Ongoing and completed research the white paper team identified

- **Gulf Coast Study, Phase 2**. *U.S. Climate Change Science Program* (In progress). Phase 1, completed in 2008, studied how changes in climate over the next 50 to 100 years could affect transportation systems in the U.S. central Gulf Coast region and discussed how to account for potential impacts in transportation planning. Phase 2 will build on the information developed in Phase 1 to develop more definitive information about impacts at the local level in the Mobile, AL region and will focus analysis on the key transportation links, for day-to-day systems operations (passenger and freight) and emergency management. The study will develop more precise tools and guides for State DOT and MPO planners to use in deciding how to adapt to potential climate impacts and determine vulnerability for key links for each mode. Phase 2 will also develop a *risk assessment tool* to allow decision makers to understand vulnerability to climate change and develop a process to implement transportation facility improvements in a systematic manner.
- **Interim Framework on Conducting Assessments of Transportation Infrastructure Vulnerable to Global Climate Change Effects**. *FHWA - STEP* (In progress). The project's first phase will address what should reasonably be assumed by practitioners with regard to climate change impacts, its effects differentiated by geographic area**,** and data to be used in conducting assessments (including data gaps). The Framework itself will include criteria to be considered, recommended categories for existing and planned infrastructure, and methods to assess importance, redundancy and scale. FHWA will conduct a pilot in 3-4 States to test the conceptual framework for vulnerability assessments and inform the Interim Framework.
- **Strategy to Address Adaptation to Climate Change Effects**. *FHWA - STEP* (In progress). The strategy is being developed by the FHWA Adaptation Working Group. The strategy will include the relevance of impacts/adaptation to FHWA program areas, identify program vulnerabilities, and discuss FHWA's ongoing, planned activities. The strategy will provide FHWA with a common strategic framework as the Agency addresses climate change impacts through policies, regulations, and programmatic activities.
- **Transportation's Role in Reducing U.S. Greenhouse Gas Emissions**. *USDOT* (2010). The report examines GHG emission levels and trends from the transportation sector and analyzes the full range of strategies available to reduce these emissions. The report analyzes five categories of policy options for implementing the strategies. http://ntl.bts.gov/lib/32000/32700/32779/DOT_Climate_Change_Report_-_April_2010_-_Volume_1_and_2.pdf
- **Transportation Adaptation to Global Climate Change**. (2009). This white paper was commissioned to identify the policy options available to support proactive measures for addressing climate change adaptation in transportation. It is intended to inform Congress and other policymakers about policy options at the Federal level. www.bipartisanpolicy.org/sites/default/files/Transportation%20Adaptation%20%283%29.pdf

- **Design Standards for U.S. Transportation Infrastructure: The Implication of Climate Change**. *Georgia Institute of Technology* (2008). This paper examines the changes to engineering design practice that might occur given climate-induced changes in environmental factors.
- **Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study**. *U.S. Climate Change Science Program* (2008). This multiyear research program studied how short- and long-term changes in climate could affect transportation systems in the U.S. central Gulf Coast region and how transportation decision makers could address possible impacts. Included in the analysis are the effects on roads, airports, rail, transit systems, and ports. www.climatescience.gov/Library/sap/sap4-7/final-report/sap4-7-final-all.pdf
- **Integrating Climate Change into the Transportation Planning Process**. *FHWA – STEP* (2008). The objective of this study is to advance the practice and application of transportation planning among local, State, and regional transportation planning agencies in order to successfully meet growing concerns about the relationship between transportation and climate change. www.fhwa.dot.gov/hep/climatechange/index.htm
- **The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure**. *USDOT Climate Change Center* (2008). The study uses multiple data sources to identify the potential impact of sea level rise on land and transportation infrastructure along the Atlantic coast from Florida to New York. www.bv.transports.gouv.qc.ca/mono/0965210.pdf
- **TRB Special Report 290**. *National Research Council* (2008). This report explores the consequences of climate change for U.S. transportation infrastructure and operations. www.trb.org/news/blurb_detail.asp?ID=8794

II. Behavior Change

Focus area: Sustainability

A. Research needs and opportunities

Much of the recent research within the topic of climate change has emphasized the role of vehicle technology and alternative fuels in reducing GHG emissions. While further research on such topics is warranted, an equally important area for additional research is how to change individuals' behaviors, including their driving styles, mode choices, vehicle purchases, and housing location choices. There is also a need to research the potential roles of new media, social networking, crowd-sourcing, cloud computing, and other information technologies (IT) that could dramatically change consumer behavior independent of price.

B. Ongoing and completed research the white paper team identified

- **Attitude-Based Target Groups to Reduce the Ecological Impact of Daily Mobility Behavior**. *Environment and Behavior, 42:3-43* (2010). This study analyzes the usefulness of an attitude-based target group approach in predicting the ecological impact of mobility behavior. Based on a survey of 1,991 inhabitants of three large German cities, constructs derived from an expanded version of the Theory of Planned Behavior were

used to identify distinct attitude-based target groups. The opportunities and limits of reducing the ecological impact of mobility behavior on the basis of an attitude-based target group approach are discussed.

- **Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses**. *Journal of Environmental Psychology, 28:2* (2008). Combining the habit discontinuity hypothesis and the self-activation hypothesis, this paper predicts that context change enhances the likelihood that important values are considered and guide behavior. This prediction was tested in the domain of travel mode choices among university employees who had recently moved versus those who had not recently moved. The results support the notion that context change can activate important values that guide the process of negotiating sustainable behaviors.
- **Emotions, Habits, and Rational Choices in Ecological Behaviors: The Case of Recycling and Use of Public Transportation**. *Journal of Environmental Psychology, 28:1* (2008). Two field studies examined the role of attitudes, subjective norms, perceived control, anticipated emotions, past behavior, and desire in the prediction of pro-environmental behavior intention. Results of the two studies indicate that negative anticipated emotions and past behavior are significant predictors of desire to engage in pro-environmental action. Desire, in turn, positively predicts pro-environmental behavior intentions. A direct link between past behavior and intentions was also detected. Implications of the results for the promotion of pro-environmental behavior are discussed.
- **Comparing and Combining Theories to Explain Proenvironmental Intentions: The Case of Commuting-Mode Choice**. *Environment and Behavior 39:731-753* (2007). This article addresses the need for systematic theory comparison and development in environmentally significant behavior research. Using logistic regression (N = 398), models based on Schwartz's norm-activation theory (NAT) and Ajzen's theory of planned behavior (TPB) were compared as explanations of drivers' intentions to reduce or maintain their car use for commuting. It is argued that combining NAT and TPB constructs accounts for a range of influences on car-use intentions that neither individual theory fully captures.

III. Sustainability Performance Metrics

Focus area: Sustainability

A. Research needs and opportunities

Some State DOTs may need assistance in developing appropriate metrics for assessing the sustainability of outcomes from policy decisions. Life cycle analysis is a powerful tool to support the analysis of sustainability outcomes, and therefore needs to be a principle component of sustainability performance measures.

B. Ongoing and completed research the white paper team identified

- **The Greenroads Sustainability Performance Metric**. *University of Washington.* Greenroads is a sustainability performance metric, or rating system, for roadway design and construction. It is applicable to new and reconstructed/rehabilitated roadways. It

awards points for approved sustainable choices/practices and can be used to assess roadway project sustainability. While not a research project, this program can inform future research on sustainability performance measures. www.greenroads.us/

- **GreenLITES**. *New York State DOT.* GreenLITES (Green Leadership in Transportation Environmental Sustainability) is a self-certification program that distinguishes New York Department of Transportation (NYSDOT) transportation projects and operations based on the extent to which they incorporate sustainable choices. While not a research project, this program can inform future research on sustainability performance measures. www.nysdot.gov/programs/greenlites
- **NCHRP 08-74: Sustainability Performance Measures for State DOTs**. *Texas A&M University.* The objective of this currently underway project is to develop a guide for State DOTs and other transportation agencies to use in order to measure the sustainability of their networks, systems, facilities, projects, and activities, at the appropriate scales, stages (long-range planning, programming, project development, design, construction, maintenance, operations), and timeframes. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2500
- **Sustainable Mobility and Accessibility Research and Transportation (SMART)**. *University of Michigan Transportation Research Institute*. SMART is a project currently underway that works with local and international partners from diverse sectors and disciplines to understand and develop new theoretical perspectives and to generate practical, innovative solutions that tell a holistic and hopeful story for the future of city regions and the people in them. Current research includes "*Metropolitan Accessibility and Transportation Sustainability: Comparative Indicators for Policy Reform.*" www.um-smart.org/

IV. Renewable Fuels Standards

Focus area: Energy

A. Research needs and opportunities

The Renewable Fuel Standard 1 (RFS1) was established under the Energy Policy Act of 2005. RFS1 mandated a phase-in of renewable fuels in motor vehicle fuel over a seven-year time period: from 4 billion gallons in 2006 to 7.5 billion gallons by 2012. The mandates applied to major U.S. refiners, blenders, and importers, while allowing a temporary exemption for small refineries.

Signed into law in 2007, the Energy Independence and Security Act of 2007 (EISA) sought to increase energy efficiency and renewable energy availability. EISA required revisions to RFS1, including new volume standards for advanced biofuels that must be added to transportation fuel each year. The resulting RFS2 includes new definitions and criteria for eligible renewable fuels and fuel feedstocks. Congress gave the EPA responsibility for implementing new regulations for RFS2 and EPA proposed new regulations for the program in May 2009.

Subject matter experts suggested that more research needs to be conducted on the implications of RFS2 before any regulations are implemented.

B. Ongoing and completed research the white paper team identified

- **The National Renewable Energy Laboratory's (NREL) Technology Integration and Utilization Group**. Evaluates the performance of new vehicle and fuel technologies as they move into commercial use and works with industry to develop technical solutions and support to overcome problems that may result. NREL has produced multiple publications and presentations on an array of renewable fuels related topics. See the following links: www.nrel.gov/vehiclesandfuels/nfti/publications.html; www.nrel.gov/vehiclesandfuels/npbf/pubs_biodiesel.html; www.nrel.gov/vehiclesandfuels/npbf/pubs_liquid.html; and, www.nrel.gov/vehiclesandfuels/npbf/pubs_advanced.html.
- **Draft Regulatory Impact Analysis: Changes to Renewable Fuel Standard Program**. *U.S. Environmental Protection Agency* (2009). www.epa.gov/oms/renewablefuels/420d09001.pdf
- **Alternative & Advanced Fuels: Emerging Fuels**. *Alternative Fuel and Advanced Vehicle Data Center* (2008). www.eere.energy.gov/afdc/fuels/emerging.html
- **[Updated] Report for Congress: Selected Issues Related to an Expansion of the Renewable Fuel Standard**. *Congressional Research Service, RL34265* (2008). www.nationalaglawcenter.org/assets/crs/RL34265.pdf
- **Selected Issues Related to an Expansion of the Renewable Fuel Standard**. *CRS Report for Congress* (2007). http://assets.opencrs.com/rpts/RL34265_20071203.pdf
- **Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply**. *U.S. Department of Energy and U.S. Department of Agriculture* (2005). The purpose of this report is to determine whether U.S. land resources are capable of producing a sustainable supply of biomass sufficient to displace 30% or more of the country's present petroleum.

V. Energy Distribution Infrastructure Requirements

Focus area: Energy

A. Research needs and opportunities

In order to accommodate future sources of renewable energy, the Nation's power grid needs to be modernized to ensure efficient delivery to end users. Development of the smart grid involves updating the existing power grid to employ real-time, two-way communication technologies that allow consumers to connect directly with power suppliers. This would give consumers the ability to choose where their electricity comes from and when they want it delivered. While significant work is ongoing to determine how development of the smart grid would be most effectively accomplished, there is a research need to better identify future energy distribution infrastructure requirements.

B. Ongoing and completed research the white paper team identified

- **Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center.** The FREEDM Systems Center, headquartered at North Carolina State, was established by the National Science Foundation in 2008. The FREEDM Systems Center will partner with universities, industry, and national laboratories in 28 States and 9 countries to develop technology to revolutionize the Nation's power grid and speed renewable electric energy technologies into every home and business. The Center is supported by an initial five-year, $18.5 million grant from NSF with an additional $10 million in institutional support and industry membership fees. A large number of utility companies, electrical equipment manufacturers, alternative energy start-ups, and other established and emerging firms are part of this global partnership. Currently funded projects are listed at www.freedm.ncsu.edu/index.php?s=3&p=43.

- **Grid Research**. *Argonne National Laboratory* (In progress). As the smart grid moves from concept to reality, Argonne National Laboratory is helping to ensure this technology will interact seamlessly with the emergence of plug-in hybrid electric vehicles (PHEVs). Looking to jointly develop new PHEV technology and accelerate its consumer acceptance and commercialization, the U.S. DOE and Sweden signed a Memorandum of Understanding to collaborate and:

  - Develop PHEV vehicle instrumentation, vehicle-to-grid hardware and smart-charging systems;
  - Research customer behavior in field testing;
  - Quantify national, utility and customer benefits; and
  - Develop convenient, "open" charging stations for all electric-based vehicles.

  www.transportation.anl.gov/features/2008_us_sweden_phev_research.html

- **Lockheed Martin Research**. (In progress). Lockheed Martin has partnered with Penn State University to research advisory and control methods, predictive and diagnostic modeling and simulation, cyber security, and the development of a test bed for exploration, experimentation, and validation of Advanced Meter Infrastructure and smart grid technologies. www.lockheedmartin.com/news/press_releases/2009/0226_smart-grid-research-penn-state.html

- **HV-BPL Phase 2: Field Test Report**. *National Energy Technology Laboratory (NETL)* (2009). This document provides a record of the collective learning from a joint AEP/Amperion/DOE HV-BPL trial to operate a high capacity Broadband over Powerline (BPL) connection operating on the in-service, 0.77 mile, 69 kV Transmission Line between the two substations near Columbus, Ohio. www.netl.doe.gov/smartgrid/referenceshelf/reports/HV-BPL_Final_Report.pdf

- **Smart Grid in 2010: Market Segments, Applications, and Industry Players**. *Green Tech Media Research* (2009). This paper provides a comprehensive look at the drivers, characteristics, market segments, applications, and the leading companies that are defining next-generation, intelligent power grids. www.gtmresearch.com/report/smart-grid-in-2010

- **The Smart Grid: An Introduction**. *U.S. DOE* (2008). This report explores the nature, challenges, opportunities, and necessity of smart grid implementation. www.oe.energy.gov/SmartGridIntroduction.htm

VI. Cost of Highway Pricing for Specific Populations

Focus area: Livability

A. *Research needs and opportunities*

There has been an increased use of pricing policies to manage road congestion in recent years. Recent research has looked at how agencies are assessing the impacts of pricing policies as well as whether the impacts disproportionally affect specific populations. Further research is needed in order to analyze the completed research in this field, compare and contrast approaches and methodologies used to assess impacts, and validate the results.

B. *Ongoing and completed research white paper team identified*

- **Congestion Pricing and Environmental Justice** (2009). At the request of the Washington State Department of Transportation, PRR developed a methodology for conducting an environmental justice analysis of tolled facilities. This paper outlines PRR's research methodology, applies the findings of the research to an environmental justice analysis, and outlines recommendations for how to present the analysis to the public and policymakers. www.trforum.org/forum/viewabstract.php?id=343&PHPSESSID=eb6898004d82401aba1f22f60388608e

- **Equity and Congestion Pricing: A Review of the Evidence** (2009). As congestion pricing has been studied and implemented more widely, a body of evidence based on both real-world implementations and models of proposed and hypothetical congestion pricing systems has been growing. While a number of papers have been published in this area, it has been difficult to reach general conclusions about whether congestion pricing is equitable. This report provides an overview of the literature from both economists and transportation planners to highlight what is known about the equity implications of congestion pricing. www.rand.org/pubs/technical_reports/2009/RAND_TR680.pdf/

- **Does Urban Road Pricing Cause Hardship to Low-Income Car Drivers? An Affordability-Based Approach**. *Transportation Research Record 2067* (2008). A road pricing proposal in Edinburgh, Scotland was used as a case study to assess the potential for road pricing-related hardship. A quantitative definition of hardship was developed on the basis of an affordability measure derived from the utilities sector, supplemented by two additional conditions to account for the fact that transportation in itself is not a basic need. By using this definition, it was demonstrated that households in the lowest income quintile already spent an unaffordable proportion of their income on motoring costs; they spent as much as about 40%, whereas the affordability threshold was 32.5%. http://trb.metapress.com/content/h173322l1625909/fulltext.pdf

- **Income-Based Equity Impacts of Congestion Pricing – A Primer**. *FHWA, Office of Transportation Management* (2008). This equity primer examines the impacts of congestion pricing on low-income groups, public opinion as expressed by various income

groups, and ways to mitigate the equity impacts of congestion pricing. http://ops.fhwa.dot.gov/publications/fhwahop08040/fhwahop08040.pdf

VII. Health Impacts of Transportation

Focus area: Livability

A. *Research needs and opportunities*

It is widely understood that transportation planning decisions impact public health. However, further research is needed to collect data and factual evidence to identify contributing factors to those health impacts. Conventional transportation planning tends not to capture cumulative health impacts resulting from transportation decisions. There is an applied research need to understand the value of health impact studies. In addition, guidance and recommendations need to be developed to inform transportation and planning agencies on how to incorporate health impacts into the decisionmaking process, and how to mitigate the negative health impacts.

B. *Ongoing and completed research the white paper team identified*

- **Journal of Urban Health: Bulletin of the New York Academy of Medicine; "Characterizing Urban Traffic Exposures Using Transportation Planning Tools: An Illustrated Methodology for Health Researchers."** (2010). Exposure to elevated levels of vehicular traffic has been associated with adverse cardiovascular and respiratory health effects in a range of populations, including children, the elderly, and individuals with pre-existing heart conditions, diabetes, obesity, and genetic susceptibilities. This paper briefly reviews current approaches for characterizing traffic exposure and then presents a detailed method that public health officials and other researchers can employ in performing screening assessments. Particular emphasis is given to defining areas of potential concern within a specific locale and, with appropriate caveats, in epidemiologic studies examining traffic-related health impacts at the intra-urban scale.
- **Integrating Human Health into Environmental Impact Assessment: An Unrealized Opportunity for Environmental Health and Justice**. *Environmental Health Perspectives 2008; 116(8): 991-1000* (2008). The paper reviews the purpose and procedures of environmental impact assessment (EIA), existing regulatory requirements for health effects analysis, and potential barriers to and opportunities for improving integration of human health concerns within the EIA process. http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info:doi/10.1289/ehp.11132
- **Transportation Research Record 2123; Environmental Impacts of a Major Freight Corridor: A Study of I-710 in California**. (2008). The objective of this paper is to explore a new approach to estimating vehicle emission impacts of freight corridor operations related to the port area, particularly those associated with heavy duty diesel trucks. The approach involves use of a microscopic traffic simulation model to capture detailed vehicle trajectories and congestion effects (ultimately including the effects of Intelligent Transportation System strategies), emissions modeling, and modeling the spatial dispersion of pollutants in the corridor. This approach facilitates the estimation of

the health and environmental justice impacts of freight corridor operations. www.its.uci.edu/its/publications/papers/ITS/UCI-ITS-WP-08-3.pdf

- **Transportation Research Record 2125; Mitigating Diesel Truck Impacts in Environmental Justice Communities Transportation Planning and Air Quality in Barrio Logan, San Diego, California**. (2008). Barrio Logan is a neighborhood of San Diego, California and government agencies recognize it as an environmental justice community. This work provides the first comprehensive documentation of the unique process and solutions that lead to traffic operational improvements designed to mitigate local impacts originating from diesel trucks. The study fills in the gap in knowledge by performing a local-scale analysis of diesel particulate matter (DPM) emissions in Barrio Logan. http://dn.engr.ucdavis.edu/images/AQMit-Report4.pdf
- **Use of Health Impact Assessment in the U.S.: 27 Case Studies, 1999-2007**. *American Journal of Preventative Medicine 34 (3): 241-256* (2008). CDC scientists examined 27 Health Impact Assessments (HIAs) that were completed in the U.S. between 1999-2007. HIAs help planners and others consider the health consequences of their decisions. The study results found that more work is needed to document the impact of HIAs and thereby increase their value in decisionmaking processes. http://www.cdc.gov/healthyplaces/publications/AJPM_HIAcasestudies_March2008.pdf
- **The Healthy Development Measurement Tool**. *San Francisco Department of Public Health, Program on Health, Equity and Sustainability.* The Healthy Development Measurement Tool is a comprehensive evaluation metric to consider health needs in urban development plans and projects. HDMT explicitly connects public health to urban development planning in efforts to achieve a higher quality social and physical environment that advances health. www.thehdmt.org/

VIII. Climate Change, Displacement, And Environmental Justice Populations

Focus area: Climate Change

A. *Research needs and opportunities*

Climate change is likely to lead to displaced communities and research suggests that low-income persons will be affected disproportionately. The impacts of the displacements on other communities and public transport systems, particularly community-based systems or those in rural or small urban areas, have been of particular concern. Research is needed to identify (1) the impacts of displaced persons on local public transport systems, and (2) what transport resources displaced persons need to aid in recovery.[1]

B. *Ongoing and completed research the white paper team identified*

- **Challenge of Evacuating the Carless in Five Major U.S. Cities: Identifying the Key Issues**. (2009). This paper examines carless and special needs evacuation planning for five selected U.S. metropolitan areas: Chicago, Miami, New Orleans, New York, and San Francisco. The findings from this study highlight issues that government agencies face as

[1] TRB Research Needs Statements, *Climate Change, Displacement, and Environmental Justice Populations.* http://rns.trb.org/dproject.asp?n=14034

they plan for the needs and concerns of carless and special needs populations. The paper concludes with a discussion of overall themes emerging from the focus groups around coordinating emergency preparedness at a regional scale. http://trb.metapress.com/content/a8l124108712t77n/fulltext.pdf

- **Evacuating Populations with Special Needs: Routes to Effective Evacuation Planning Primer Series**. *FHWA, Office of Operations* (2009).This primer, third in the *Routes to Effective Planning* primer series, focuses on evacuating people who need assistance in leaving an area, particularly people with disabilities, aging populations, people living in congregate or residential care facilities, and those with household pets. http://ops.fhwa.dot.gov/publications/fhwahop09022/index.htm
- **National Study on Carless and Special Needs Evacuation Planning: A Literature Review**. (2008).This study provides guidance to ensure that future evacuations efficiently and effectively accommodate disadvantaged populations, including people who for any reason lack access to private automobile transportation. http://planning.uno.edu/docs/CarlessEvacuationPlanning.pdf

IX. Economic Impact of Transportation on People and Communities

Focus area: Livability

A. *Research needs and opportunities*

Cumulative assessments of the economic impact of transportation projects are typically limited to the most direct or proximate effects of project development. Research is needed to develop approaches for assessing the comprehensive economic impacts of transportation decisions on specific populations and communities. This research includes cumulative effects on household location, employment, and cost of transportation as well as indirect effects on the cost of goods and services.[2] Additional research is needed regarding the disproportionate costs of transportation and the impacts associated with shifting fuel sources on low-income and minority communities.

B. *Ongoing and completed research the white paper team identified*

- **Interactions between Transportation Capacity, Economic Systems, and Land Use Merged with Integrating Economic Considerations Project Development**. The objectives of this currently underway project are: (1) to provide a resource to help determine the net changes in the economic systems of an area impacted by a transportation capacity investment; (2) to provide data and results from enough structured cases that project planners in the future can use the cases to demonstrate by analogy the likely impacts of a proposed project or group of projects (plan); (3) demonstrate how this fits into collaborative decisionmaking for capacity expansion.
- **Relocation Assistance Retrospective Study.** *FHWA- STEP, Office of Real Estate Services* (2009). The purpose of this research is to determine the economic impact of transportation projects by performing an in-depth retrospective survey of the actual costs

[2] TRB Research Needs Statement, *Economic Impact of Transportation on People and Communities*. http://rns.trb.org/dproject.asp?n=14036

that business incur as a result of being required to relocate from the project area and determine the percentage of businesses that remain in operation for at least two years after their relocation. The information gathered will be utilized to develop quantitative and qualitative data which can be used to assess the adequacy of benefit levels established in the Uniform Act and provided to impacted business community. http://www.fhwa.dot.gov/hep/step/fy09rp.htm

- **Transportation Research Record; "Environmental Justice (EJ) Concentration Zones for Assessing Transportation Project Impacts"** (2006). An important component of any EJ assessment methodology is the identification of EJ communities in a project area. The conventional approach classifies communities by means of threshold values into target and non-target EJ populations. Research has demonstrated, however, that threshold values are largely influenced by the chosen community of comparison. In addition, the spatial distribution of target and non-target EJ populations within the affected area changed when the scale of geographic analysis changed. Because it has been argued that effective EJ analysis should consider all minority and low-income population groups regardless of their size, this research presents an innovative approach to identify the concentration of EJ individuals in affected project areas. The paper describes the approach and presents the results from testing it.

ADDITIONAL RESEARCH NEEDS AND OPPORTUNITIES

In addition to the specific research topics highlighted above, the subject matter experts identified additional research gaps and opportunities as outlined in TRB's *Special Report 299: A Transportation Research Program for Mitigating and Adapting to Climate Change and Conserving Energy* (See Appendix A). That report contains a synthesis of the current literature on the transportation and climate change field. It includes specific proposals for research as well as a recommendation for the creation of an overarching comprehensive research program to coordinate and organize needed research in the future. Supplementing Special Report 299, TRB sponsored a climate change research needs workshop in Washington D.C. on January 9, 2010. One of the purposes of the meeting was to review, prioritize, and refine research needs statements prepared for the workshop. The statements included 36 discrete research proposals, each with complete problem statements, objectives, and estimated costs. See **Appendix A** for a comprehensive list of proposed research topics outlined in these two documents.

EFFECTIVENESS OF OUTREACH FOR CURRENT RESEARCH

Members of the working group noted limited outreach of research results beyond the traditional transportation community. There is an opportunity for broader and more strategic partnering with researchers representing other industries on issues such as energy and environment, which could allow for research to have a broader impact. The Conduct of Research, Technology Transfer, and Library and Information Sciences for Transportation Committees may be the appropriate leads to identify how to broaden the dissemination of research results. In addition, requiring research proposals to include a dissemination strategy, with identification by the researcher of the cross-cutting disciplines that would benefit from the research, would create a broader audience for research efforts.

CONCLUSION AND NEXT STEPS

From the discussions with and information provided by the participating Committees and representatives, several recommended next steps emerged. These potential next steps are:

- The transportation research community should address the difficulties of defining these four broad concepts, especially sustainability and livability, and attempt to come up with shared definitions for the transportation community.

- Future research on livability should include the new role of highways in Livable Communities. Research should consider the processes and methods for incorporating highways in the planning, design, and construction of Livable Communities, including: the role of highways to reconnect communities; adding bike and pedestrian facilities into highway projects where feasible; reducing travel times from congestion; applying congestion pricing; using CSS and other green technologies; and improving safety, especially for rural locations.

- The transportation research community should continue to develop and document best practices and guidance for the four topic areas.

- The transportation research community should continue to define and address both short-term and long-term goals with respect to the four topic areas. For example, research that addresses climate change-related modifications to transportation investments must address the likely near-term impacts of climate change, while also mitigating the investments' contribution to future climate change.

- The transportation research community should ensure that research efforts assess the impacts of policies and specific investments at multiple scales. The relevant scales range from the global to the regional, the watershed, the local, and the urban.

- The transportation research community, and TRB in particular, should consider communication and dissemination strategies to be an integral part of all funded research.

- Transportation research proposals should, where possible, include quantifiable deliverables to promote consistent research quality.

When identifying future research needs, participants are also encouraged to consider existing research and steps that can be taken to further promote, disseminate, and apply what has been learned. It is equally important to consider both the research and dissemination approach being taken. As more cross-cutting issues and interests emerge, it is important to design a research agenda – addressing to whom and how the results get shared – that considers the relationships and interdependencies across cross-cutting areas.

Participants may wish to consider the following questions in preparation for the Research Needs Workshop to help assess the progress in advancing a cross-cutting research agenda and mainstreaming results:

1. Are research statements being developed and distributed for refinement to an interdisciplinary group of practitioners, academics, and others?
2. Are the research information management tools keeping up with users' needs?
3. Is an interdisciplinary group of practitioners, academics, and others participating in a rating and ranking system to prioritize research agendas and funding?
4. Are research panels, advisory groups, and peer review teams comprised of interdisciplinary practitioners, academics, and others?
5. Are SOWs and research deliverables geared towards supporting subject matter experts as well as interdisciplinary professionals?
6. Are research funding organizations and partners collaboratively working on outreach strategies that appeal to and influence interdisciplinary professionals?
7. Are formal and informal evaluation methods capturing input on the spread, piloting, and adoption of research findings?

APPENDIX A. WHITE PAPER # 4 – COMPREHENSIVE LIST OF PROPOSED RESEARCH TOPICS: SPECIAL TASK FORCE (STF) ON CLIMATE CHANGE AND ENERGY AND THE TRB EXECUTIVE COMMITTEE'S SPECIAL REPORT 299

STF Research Needs Statements (organized by mode)

Aviation

- Understanding and reducing the contribution of landside traffic to GHG emissions at airports
- Impact of non-CO2 emissions from jet aircraft

Design and Construction

- The Effects of Rising Temperatures on Transportation Infrastructure
- Quantify and Incorporate Environmental Benefits into Life Cycle Costing Models for Roadways
- Research Needs on Construction Pollution

Energy and Alternative Fuels

- Analyzing Social Costs and Benefits of Advanced Biofuel and Other Low Carbon Fuels
- Analyzing Pathways for the Transition to High Efficiency/Low GHG Emitting Vehicles
- Alternative Fuel Life Cycle Analysis for Trains, Planes, and Ships
- Assessing Modal Energy Intensities
- Assessing the Limits of Advanced Biofuel Supply for Transportation
- Assessing Direct and Indirect Lifecycle GHG Impacts of Advanced Fuels and Vehicles
- Assessing the Effectiveness of a Low Carbon Fuel Standard in a World of International Leakage

Freight Marine and Rail

- Climate Impacts of Supply Chains
- Rail Impacts of Climate Change
- Clean Freight Corridors
- Port Gateway Planning for Freight, Climate, and Energy

Operations and Maintenance

- Transportation Performance Measures for Climate Change
- Improved Operational Efficiency and the Impact on GHG
- Induced Demand from Operational Efficiency GHG Impact

Planning and Environment

- Land Use Models
- The Energy and Climate Impacts of Alternative Modes of Transportation
- Develop Climate Change Modeling Outputs

Policy

- Comprehensive Evaluation Framework

- Compilation and Analysis of Court Decisions Regarding GHG Emissions
- Examine the Relationship of Climate Change and GHG Mitigation with Transportation Infrastructure Security
- Constructs to Enable Multiple Agencies to Develop Policies Relating Climate Change and Critical Transportation Infrastructure Protection

SR 299 Research Topic Areas (organized by policy area)

Policy Guidance and Outreach

- Life Cycle GHGs
- Cost-Effectiveness, Including Co-Benefits and Costs
- Low-Hanging Fruit
- Land Use and VMT
- National and Local Data Gaps
- Educational Outreach for Policymakers and Practitioners
- New Tools and Technologies

Measurement and Estimation

- Cost-effectiveness of individual mitigation strategies and combinations of strategies
- Life cycle analysis for modal comparisons
- Full social cost accounting
- Co-benefits and costs

Travel Behavior and Modeling

- Individual, household, and life cycle activities
- Demographic changes
- Urban goods movement
- Land use interactions
- New, cost-effective approaches to data collection and dissemination
- Next-generation trip generation models
- Opportunities for passenger and freight mode shift
- Potential for trip substitution
- Incorporating uncertainty in models used for policy analysis

Policy Analysis

- Successes and failures of past transportation interventions to meet Federal air quality standards
- Lessons from abroad
- Implementing user charges
- Integrated vehicle-fuel scenarios: for assessments of the potential of alternative vehicles and fuels to meet GHG emission reduction targets
- Equity
- Institutions: Research on how to harmonize institutions at the regional scale
- Benefits of new investments in less energy-intensive modes
- Program evaluation

- National level analysis

APPENDIX B. WHITE PAPER CONTACTS

White Paper #1 Contacts
ADC10 Environmental Analysis in Transportation
ADD20 Social and Economic Factors of Transportation
ADD30 Transportation and Land Development

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White Paper #2 Contacts
ADA60 Public Involvement in Transportation
ADC30 Ecology and Transportation
ADC50 Historic and Archeological Preservation in Transportation

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ADC20 Transportation and Air Quality
ADC60 Waste Management and Resource Efficiency in Transportation
ADC40 Transportation-Related Noise and Vibration
AV030 Environmental Impacts of Aviation

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White Paper #4 Contacts
ADC70 Transportation Energy
ADC80 Alternative Transportation Fuels and Technologies
ADD40 Transportation and Sustainability
ADD50 Environmental Justice in Transportation

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